Essays on economic policies and economy of financial markets in developing and emerging countries

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Essays on Economic Policies and Economy of Financial Markets in Developing and Emerging Countries

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General Introduction

The inflation targeting debate

Until the early 1990s, the design of monetary policy typically centered around nominal money growth. Central banks chose a growth rate of nominal money for the medium term; and then through about short-term monetary policy in terms of deviations of money growth rate from the target. However, during the 1970s and the 1980s, frequent and large instabilities in money demand posed significant challenges for central banks. They found themselves torn between endeavoring to keep a stable target for money growth and maintaining credibility through announcing money growth bands, or adjusting to shifts in money demand for stabilizing output in the short run and inflation in the medium run. In this context, a new rethinking of monetary policy took place, starting from 1990 with the Federal Reserve Bank of New Zealand, based on inflation targeting.

Under this new framework, central banks publicly announce an inflation target over a time horizon, generally at the medium-term of one to three years. Monetary authorities—independent from the fiscal authorities—also explicitly communicate regularly with markets and private agents that the primary goal of monetary policy is to keep inflation stable and low. This monetary regime has attained significant popularity, as reflected in the number of central banks currently operating under inflation targeting. Indeed, about 37 central banks are currently using inflation targeting as their monetary policy framework, and about 30 countries are considering the possibility of embracing it in a near future (Hammond, 2012; IMF, 2014).

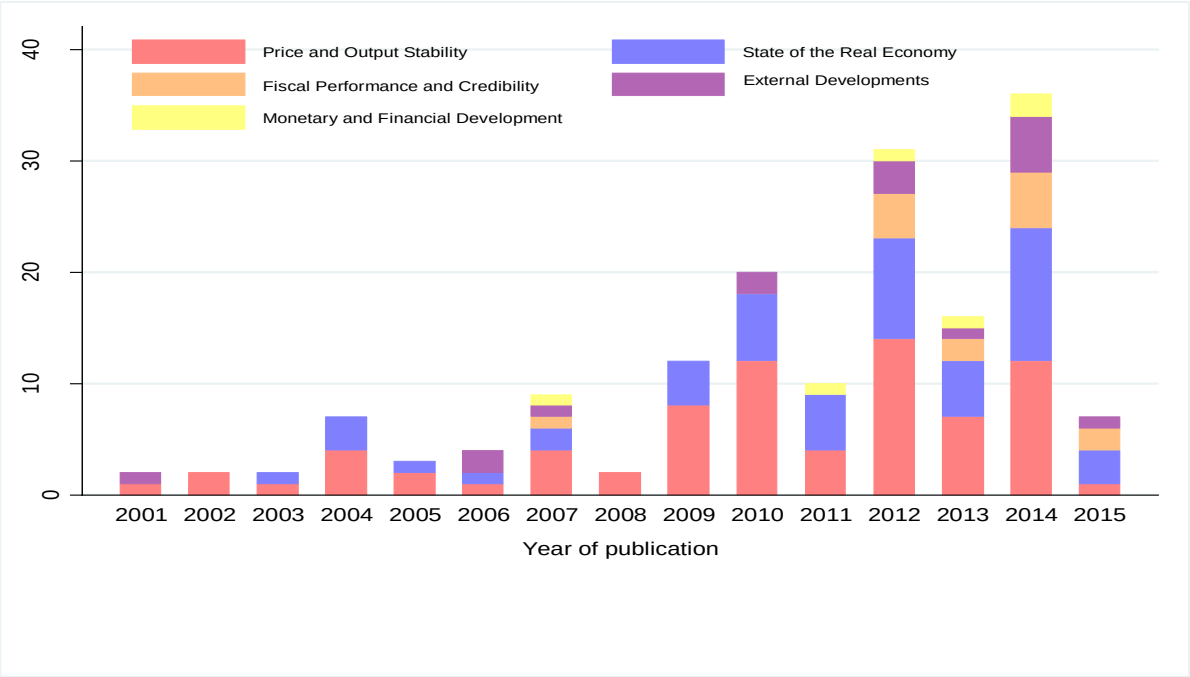
However, the debate about its relevance and macroeconomic consequences remains inconclusive, both at the theoretical and the empirical levels. At the theoretical level, on the one hand, proponents of inflation targeting highlight the merit of this monetary policy regime, as it combines elements of both rules and discretion (Bernanke, 2004; King, 2005).[1] In particular, they point out that its credibility and flexibility-enhancing properties allow central banks to address the dynamic inconsistency problem, and thereby anchors more firmly inflations expectations. Better inflation expectations are then associated to lower and stable actual inflation that will result in lower sacrifice ratio and thereby eliminating the short-term inflation-output tradeoff.

[1] The inflation targeting debate is not really new. For instance, during the last years of Alan Greenspan as Chairman of the Federal Reserve of the United States, an important debate took place on why the Federal Reserve should or should not adopt inflation targeting. A nice summary of this debate is reported in Friedman (2004) and Mishkin (2004).

On the other hand, opponents of inflation targeting point out the theory of constructive ambiguity, arguing that inflation targeting, through the explicit announcement of a numerical target for inflation, considerably constraint the discretion of monetary policy makers. The recent financial crisis has rekindled further this debate about the relevance of inflation targeting on at least two main fronts. First, many countries experienced deflation episodes in the aftermath of the crisis, raising questions about the appropriateness of inflation targeting for preventing the economy from being stuck at the Zero-Lower Bound or helping countries escape from it (Walsh, 2011). Second, the crisis laid bare the limits of price stability for ensuring financial stability, especially in the face of large asset price fluctuations. In particular, it is argued that inflation targeting, by focusing exclusively on inflation, contributed to the build-up of financial instabilities (Taylor, 2007; Frankel, 2012), and constrained monetary policy in dealing with balance sheet imbalances (Borio, 2014).

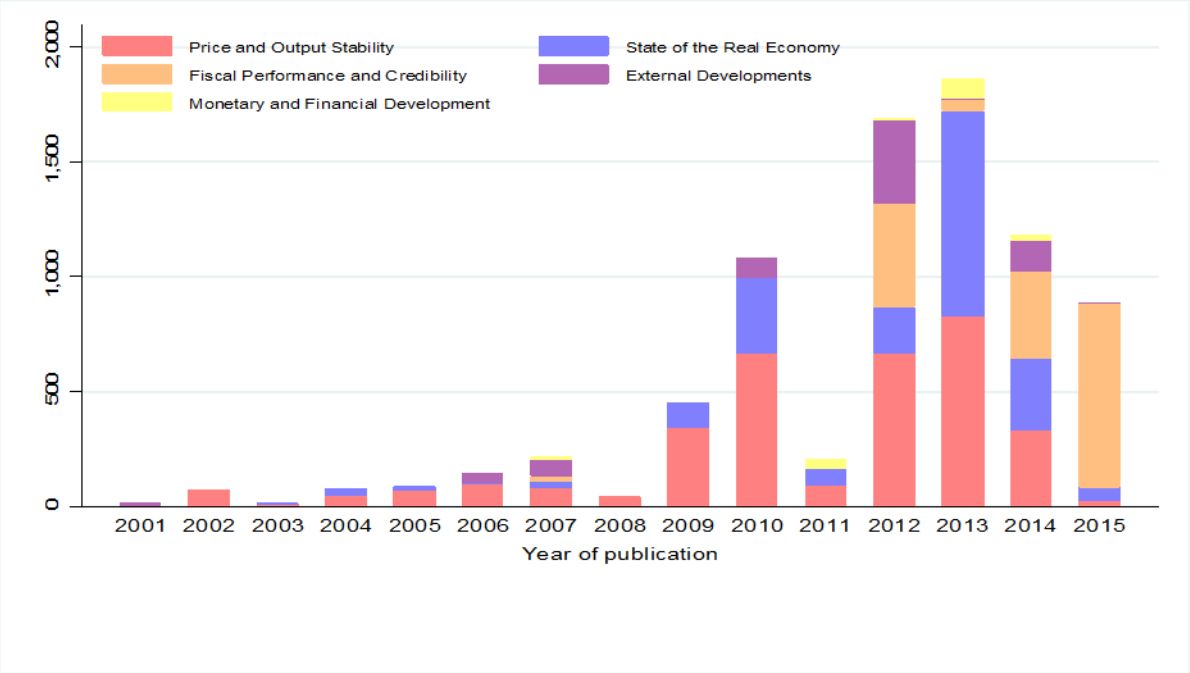
At the empirical level, many papers have analyzed the macroeconomic performance of inflation targeting, but without reaching a general consensus. Figures 1.1 and 1.2 summarize the spread of empirical studies and estimates of the effect of inflation targeting adoption, since its first adoption to the year 2015, on *Price and Output Stability* (as seized by the inflation rate and its volatility, and growth volatility), *State of the Real Economy* (as captured by the economic growth rate), *Fiscal Performance and Credibility* (as captured by fiscal discipline, sovereign spreads or debt ratings, and institutional quality), *External Developments* (as measured by exchange rate volatility, balance of payment components, capital or financial openness), and *Monetary and Financial Development* (as seized by broad money growth, deposit rates, bond market health, or financial dollarization). A noticeable pattern from these figures is that this empirical literature bourgeoned in the early 2000s before abounding from 2010 onwards. On average, 14 studies and 537 estimates were carried out a year. Figure 1.3 highlights the plethora of the conflicting findings of the estimated effect of inflation targeting on selected outcomes, namely inflation rate, inflation volatility, real GDP growth, and real GDP growth volatility. For instance, on the level of inflation, 44 percent of the estimates during the period 2001-2015 reported a favorable effect, while 17 and 39 percent reported an unfavorable and nil effect, respectively. On the volatility of inflation, 41 percent found a reducing-volatility property of inflation targeting, while 9 and 50 percent reporting an unfavorable and nil effect, respectively. Finally, on the real GDP growth (volatility of real GDP growth), 52 percent (25 percent) found a favorable, 17 percent (16 percent) found an unfavorable effect, and 32 percent (59 percent) concluded a nil effect, respectively.

Figure 1.1. Inflation targeting related empirical studies.



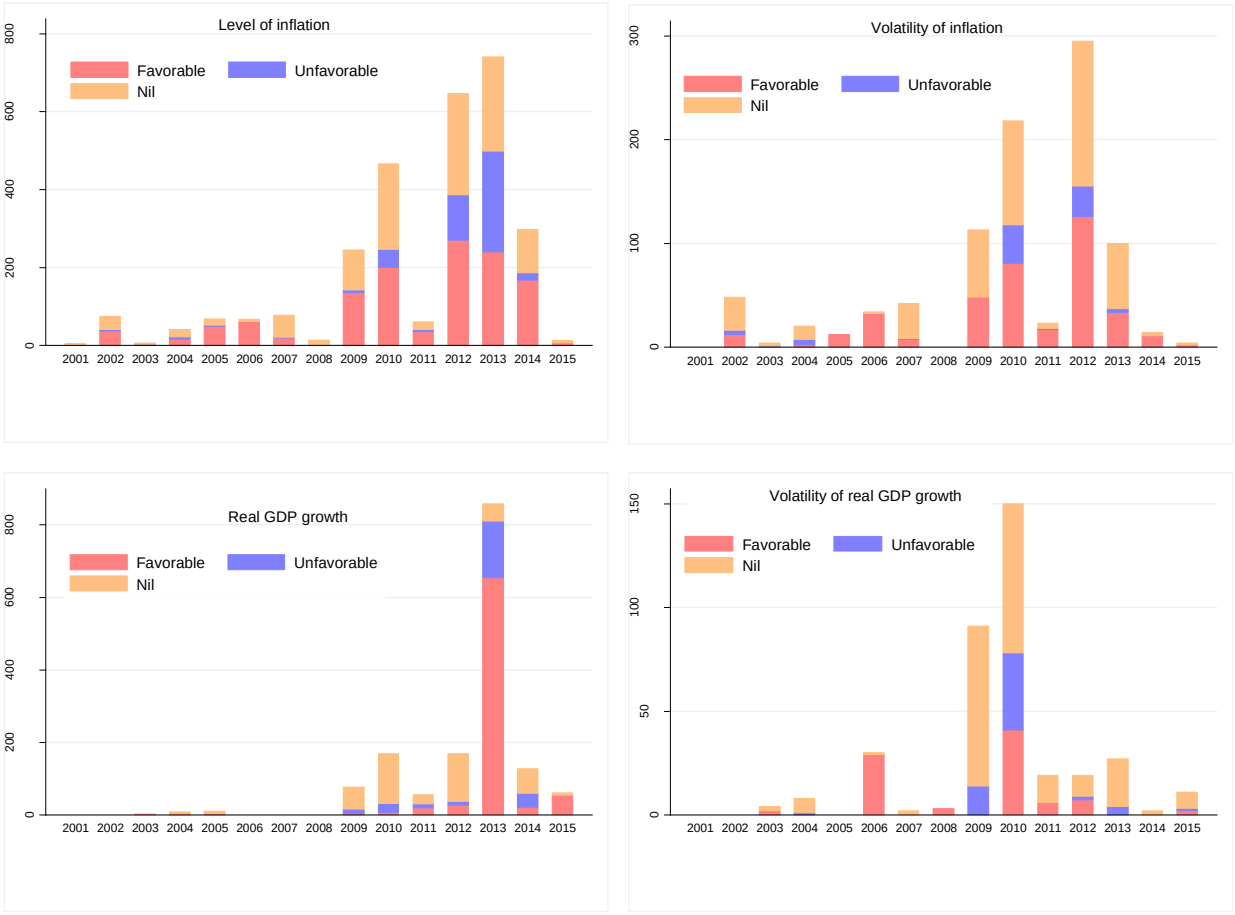
Notes: This figure presents the number of empirical studies on the macroeconomic performance of inflation targeting (on the y-axis) per year of publication and sectoral groups. The data come from the meta-database used in the Chapter 1 of this dissertation.

Figure 1.2. Inflation targeting related empirical estimates.



Notes: This figure presents the number of empirical estimates on the macroeconomic performance of inflation targeting (on the y-axis) per year of publication and sectoral groups. The data come from the meta-database used in the Chapter 1 of this dissertation.

Figure 1.3. Favorable, unfavorable, and nil estimates of inflation targeting on different outcomes.



Notes: The figure presents the number of favorable, unfavorable, and nil estimates of the effect of inflation targeting on the level of inflation and its volatility, and the real GDP growth and its volatility, using a threshold p-value of 10 percent. The data come from the meta-database used in the Chapter 1 of this dissertation.

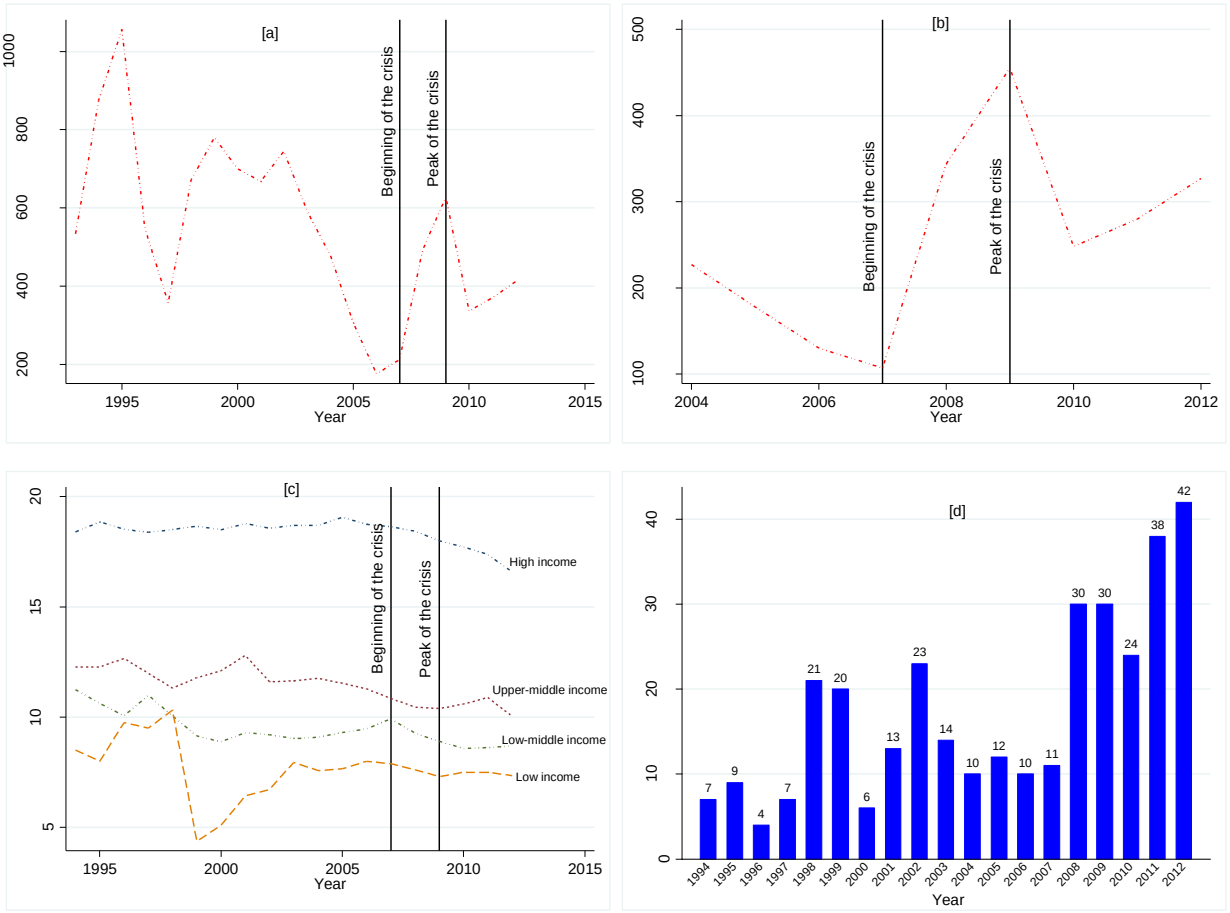
Given this very conflictual literature, both at the theoretical and empirical levels, different questions naturally emerge, on at least two main dimensions. The first one is related to the real effect of inflation targeting and can be formulated as follows: do countries having adopted inflation targeting really experience better economic outcomes? The second question is related to the large heterogeneity in results reported in primary studies. In particular, how can we explain these tremendous differences in findings?

A sizeable increase in risk for sovereign entities

On the other hand, the recent crisis engendered major macroeconomic imbalances, such as large unemployment, low economic growth, rapid expansion of government debts, and fiscal and

current account deficits. This resulted in a worsening financial markets access conditions, and particularly in a sizeable increase of sovereign debt risk. Generally speaking, sovereign risk is measured by (i) government debt ratings from rating agencies, (ii) yield spreads with respect to a country's sovereign bonds assumed as risk-free, or (iii) Credit Default Swaps spreads. Figure 1.3. reports the evolution of sovereign risk, measured through (i), (ii), and (iii). Figure 1.3. [a] and [b] present the evolution of bond yield spreads (the well-known *EMBI Global*) and credit default swaps spread for emerging countries on which data are available. Figure 1.3. [c] shows

Figure 1.3. Evolution of sovereign debt risk.



Notes: This figure presents the evolution of sovereign debt risk, measured through bond spreads, credit default swaps spreads, and debt ratings. Figure 1.3. [a] and [b] show the evolution of the bond spreads and credit default swaps spreads for emerging countries. Figure 1.3. [c] reports the evolution of Standard and Poor's long-term foreign currency ratings per income group. Figure 1.3. [d] presents the total number of Standard and Poor's ratings downgrade for rated countries around the world. Data on bond spreads and credit default swaps spreads come from Bloomberg and Reuters, respectively. Data for ratings are extracted from Standard and Poor's website.

the evolution of Standard and Poor's long-term foreign currency debt ratings for different groups of countries: high-income, upper-middle income, low-middle income, and low income, according

to the World Bank classification. Figure 1.3. [d] reports the total number of ratings downgrade (including ratings levels and outlook) by Standard and Poor's per year. As can be seen from Figure 1.3, from the beginning of the crisis (2007) to its end (2009), bond spreads in emerging countries have almost tripled from 200 basis points to 600 (Figure 1.3. [a]); credit default swaps spreads have more than quadrupled from 100 to 450 (Figure 1.3. [b]); and countries, irrespectively of the income group, have experienced a decrease in their credit ratings quality (Figure 1.3. [c]). In particular, the total number of sovereign ratings downgrade by Standard and Poor's around the world increased from 11 to 30 (Figure 1.3. [d]).

This increase in risk has revived the debate on the role that financial innovations play in triggering financial crises. In particular, some market observers highlighted the prominent role of a particular financial derivative—credit default swaps trading—in the emergence of the 2007 subprime mortgage market crisis in the US; the Greek debt crisis (in the aftermath of the financial crisis) and its spread toward other peripheral Eurozone countries (Buiter, 2009; Soros, 2009; Stultz, 2010). This concern led, for instance, German regulators to prohibit *naked* credit default swaps trading on the bond market in May 2010, and the European Union Parliament voted in July 2011 for their exclusion from Eurozone debt market. Despite these criticisms, some industrial and academic experts also argue that credit default swaps trading should not affect financial stability, due to their relative small proportion compared to debt outstanding (Pickel, 2009; Stultz, 2010). Others insist that the presence of credit default swaps yields better aggregation of information and beliefs, more complete markets, and greater bond market liquidity, making it easier for distressed borrowers to issue bonds (Greenspan, 2004; Salmon, 2010).

The need for developing long-term bond market in developing countries

The sizeable increase in risk and financial instability has also revived the interest—started from the 1990s financial crises—on the need to develop long-term bond markets in developing countries, particularly in local currency. Indeed, during and shortly after the crisis, many developing countries that are dependent on external grants and concessional loans for funding government expenditures encountered worsening financing constraints when western donors were facing extreme fiscal challenges. Within this context, the African Development Bank announced in 2012 that it plans to raise a bond program of 40 billion US$ to address the heavy gap of infrastructures in Africa. The Kenya government has also successfully issued new bonds

for infrastructures financing, raising money for transport, energy and water projects. Beyond this lesson of the crisis, policymakers acknowledge that various benefits may arise from promoting long-term bond market development in developing countries. Indeed, a liquid bond markets helps sustain economic stability by providing funds that could finance fiscal stimuli during economic downturns (Mu et al., 2013). Deeper bond markets may also improve the intermediation of savings between savers and users of capital, foster risk diversification between different groups of investors, and contribute to the development of the financial system particularly in countries where the financial system is dominated by banks.

Yet, developing a publicly-traded long-term sovereign bond market in developing world is not without difficulties. For example, some mature countries lack a long-term bond market because the cost of setting it up is potentially large (World Bank, 2001). Other countries face problems related to the high risk of default, weakness of the regulator, absence of a credible and stable government, or lack of sound fiscal and monetary policies. However, a lack of a bond market may also play an important role in determining a country's macroeconomic instability, through for instance the occurrence of maturity or currency mismatches (Rose and Spiegel, 2016). This raises the empirical question about the potential contribution of developing long-term bond markets on macroeconomic stability.

The value-added of this dissertation

This dissertation aimed at addressing the links between macroeconomic policies and financial markets through the three paragraphs developed above. It is constituted of three parts. The first part is devoted to a meta-regression analysis on the macroeconomic effects of inflation targeting adoption. The second part focuses on government bond markets risk and stability, and the last part deals with the disciplining effect of bond market participation i.e. *bond vigilantes*.

The first part, constituted of one chapter, takes advantage of the debate about the merits and macroeconomic consequences of inflation targeting previously discussed. It constructs for the first time a large and very unique meta-database of 8,059 estimated coefficients on the macroeconomic effects of inflation targeting adoption from a very broad sample of 113 primary studies. Building on this unique meta-database, the chapter then provides an inflation targeting meta-regression analysis on several macroeconomic outcomes, including *Price and Output Stability* (as seized by the inflation rate and its volatility, and growth volatility), *the State of the Real Economy* (as captured by the economic growth rate), *Fiscal Performance and Credibility*, *External*

Developments, and *Monetary and Financial Development*. Using a mixed effect multilevel estimator and probit regressions, the chapter adds several interesting results to the existing literature. First, the literature on the macroeconomic effects of inflation targeting adoption is subject to two types of publication selection bias. On the one hand, authors, editors and referees favor a particular direction of results when analyzing the effects of inflation targeting adoption on inflation volatility and real GDP growth. On the other hand, they promote statistically significant results. Second, once purged for these publication biases, inflation targeting has a genuine effect in lowering inflation rate and real GDP growth volatility, but no significant genuine effect on inflation volatility and on the level of real GDP growth. Third, differences across estimated coefficients in the inflation targeting literature are mainly driven by the characteristics of the study, including its sample characteristics, inflation targeting implementation parameters, the time coverage, the estimation techniques, the set of control variables considered or country-specific factors, and the publication formats. The sample characteristics are indeed paramount for the effectiveness of inflation targeting, in that in most meta-regression analysis, using a sample of developing countries increases the likelihood of finding a statistical and beneficial effect of inflation targeting. Regarding inflation targeting parameters, the use of conservative starting inflation targeting dates as opposed to default starting dates tends to improve the beneficial effect of inflation targeting. The same applies when the time horizon of the used samples covers the Great Moderation and the recent Great Recession (as opposed to covering only the Great Moderation), or when the study compares inflation targeting countries to a country group wherein money growth and exchange rate Targeters are lumped together. Moreover, when researchers account for endogeneity issues, they are more likely to report statistical beneficial effects of inflation targeting. The results also point to the prominence of country-specific factors in affecting the estimated effects of inflation targeting in the literature, including fiscal and exchange rate regime arrangements, trade openness, financial development, central bank autonomy and investment level. Finally, Publication formats are also a source of heterogeneity, which however varies from one meta-regression analysis to another.

To sum up, this first part provides for the first time an interesting framework to take stock of the existing literature on the macroeconomic consequences of one of the most market oriented monetary policy regime—inflation targeting.

The second part of the thesis, composed of three chapters (Chapters 2, 3 and 4), is devoted to government bond markets risk and stability. Chapter 2 analyzes how notation agencies and bondholders perceive the sovereign risk of inflation targeting emerging countries, compared to emerging countries under money or exchange rate targeting. It tests the hypothesis that inflation targeting countries could be treated differently by rating agencies and bondholders in terms of sovereign debt risk due to the limits it imposes on seigniorage revenues i.e., the fiscal disciplining effect reported in Rose (2007), Freedman & Ötker-Robe (2009), Lucotte (2012), Minea & Tapsoba (2014); or its resulting Keynes-Oliveira-Tanzi effect (Tanzi, 1992); or its credibility effect; or simply through the induced *Fisher effect* and *purchasing power parity effect*. To test this hypothesis, the chapter uses a large sample of emerging countries and develops of formal empirical analysis—propensity score matching—to deal with the self-selection and endogeneity issue of inflation targeting adoption. The results suggest that inflation targeting adoption significantly increases sovereign debt ratings and decreases government bond yield spreads in emerging countries. These results remain robust to different specifications including post-estimation tests, controlling for unobserved heterogeneity, altering the sample, controlling for additional covariates, or using system-GMM estimates. In addition, the chapter unveils interesting sensitivities in the effect of inflation targeting adoption on sovereign debt risk. First, it finds that, sometimes, full-fledged inflation targeting outperforms partial inflation targeting in reducing sovereign debt risk. Second, it emphasizes the importance of structural characteristics, together with the retained measure of sovereign debt risk. Regarding ratings, inflation targeting adoption improves them more in the "good" phase of the business cycle, in a context of strong fiscal stance, and exclusively in upper-middle income emerging countries. Regarding spreads, inflation targeting adoption has no significant impact in "bad" times, under a loose fiscal stance, and in lower-middle income emerging countries. Third, accounting for dynamics in estimating the impact of inflation targeting adoption reveals yet again the importance of the retained measure of sovereign debt risk: (i) adopting inflation targeting significantly affects ratings, but not spreads, in the year of adoption; (ii) this positive effect on ratings increases in time and then stabilizes at levels comparable to baseline values; (iii) despite increasing in time, the favorable effect on spreads remains below baseline values.

Chapter 3 analyzes the link between wealth transfers capital inflows—remittances and official development aid—and bond yield spreads in emerging countries. It examines whether these two types of wealth transfers and countercyclical capital flows can play an insurance

mechanism by absorbing negative shocks affecting bond markets. The chapter begins by pointing out the symmetry between the cyclical nature of bond spreads and the two types of capital flows. It then employs an instrumental variable strategy to tackle the potential endogeneity issues of remittances and development aid. Several interesting results emerge. First, remittances inflows significantly reduce bond spreads in emerging countries. Second, official development aid inflows do not affect spreads. Third, the effect of remittances on spreads is larger in less developed financial system, increases with the degree of trade openness, is larger in low fiscal space regime, and is larger in no-remittances dependent countries. The chapter provides several possible interpretations of the mechanism behind these results. Regarding remittances, given the fact that remittances increase the fiscal space in recipient country and are countercyclical in nature, remittances can reduce the government marginal cost of raising revenue and act as an insurance mechanism against negative shocks which affect bond markets. It also highlights speculatively the potential role of remittances securitization and diaspora bonds. Regarding development aid, the chapter emphasizes that the donors interest in aid allocation and the specific rational behavior of bondholders may be at work.

Chapter 4 looks at the effect of one of the most important and controversial financial innovation of the past decades—credit default swaps—on the occurrence of sovereign debt crises. It draws on established theoretical works to empirically test the hypothesis that credit default swaps trading initiation increases the occurrence of sovereign debt crises in credit default swaps trading countries compared to non-credit default swaps countries. Based on a comprehensible sample of developed and developing countries, the results confirm this hypothesis: countries with credit default swaps contracts on their debt are more prone to sovereign debt crises. In addition, the findings unveil that the impact of credit default swaps initiation is sensitive to countries' characteristics and the considered time span. Regarding the former, the effect is found to be (i) larger for developing, compared to developed countries, (ii) significant for credit default swaps countries with speculative debt rating grades at the time of credit default swaps initiation but not for countries with investment grades, (iii) larger for countries with "low" degree of public sector transparency, and (iv) larger for countries with lower Central Bank independence. Regarding the later, the adverse cumulative effect of credit default swaps trading on sovereign debt crises occurrence becomes significant only starting 2005, and converges towards its benchmark magnitude over time.

The last part of the thesis is related to *bond vigilantes*. It constitutes of two chapters. Chapter 5 analyses the relationship between the introduction of a sovereign bond market and tax revenue mobilization behavior using a large sample of developing countries. It tests the hypothesis that the access to international financial market can have a disciplining effect on fiscal authority's behavior through the increase in domestic revenue mobilization. To assess this prediction, it applies a variety of propensity score matching to address the self-selection bias in bond market participation. The results suggest that the existence of a long-maturity sovereign bond market significantly encourages governments in developing countries to improve their tax revenue mobilization. This finding is sensitive to the bond market country structural characteristics, namely the stance of monetary and fiscal policies, the exchange rate regime, the level of economic development, the degree of financial openness, and the degree of financial development of the banking sector. In addition, the chapter reveals that bond market participation has an effect both on the composition and the instability of tax revenue mobilization.

Chapter 6 extends the bond vigilantes hypothesis developed in Chapter 5 by looking at the effect of *domestic* bond market participation on financial dollarization in developing countries. It first shows theoretically that domestic bond market participation can have an effect of the level of financial dollarization in domestic bond market countries through different channels including the currency substitution channel, the market development channel, the institutional channel, and the portfolio channel. It then employs an entropy balancing approach to test empirically the theoretical prediction. The findings are as follows. First, the presence of domestic bond market in developing countries significantly reduces financial dollarization. Second, the impact of domestic bond market participation on financial dollarization (i) is larger for inflation targeting countries compared to non-inflation targeting countries, (ii) is apparent exclusively in a non-pegged exchange rate regime, and (iii) is larger when there are fiscal rules that constrain the discretion of fiscal policymakers. Lastly, the induced drop in inflation rate and its variability, nominal exchange rate variability, and seigniorage revenue are potential transmission mechanisms through which the presence of domestic bond market reduces financial dollarization in domestic bond market countries.

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Part 1. Settling the Inflation Targeting Debate

Chapter 1. Settling the Inflation Targeting Debate: Lights from a Meta-Regression Analysis[2]

Abstract:

Inflation targeting (IT) has gained much traction over the past two decades, becoming a framework of reference for the conduct of monetary policy. However, the debate about its very merits and macroeconomic consequences remains inconclusive. This paper digs deeper into the issue through a meta-regression analysis (MRA) of the existing literature, making it the first ever application of a MRA to the macroeconomic effects of IT adoption. Building on 8,059 estimated coefficients from a very broad sample of 113 studies, the paper finds that the empirical literature is subject to two types of publication bias. First, authors, editors and referees favor a particular direction of results when assessing the effects of IT on inflation volatility and real GDP growth; second, they promote statistically significant results. Once purged for these publication biases, we uncover a genuine effect of IT in lowering inflation and real GDP growth volatility, but no significant genuine effect on inflation volatility and the level of real GDP growth. Interestingly, our results indicate that the impact of IT varies systematically across studies, depending on the sample properties, the time coverage, the estimation techniques, country specific factors, IT implementation parameters, and the publication formats.

Keywords: Inflation targeting, Meta-analysis.

JEL codes: E5, C83

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I believe the claims commonly made for inflation targeting at the conceptual level – in particular, that inflation targeting usefully enhances the transparency of monetary policy – are not just unproved, but false. To the contrary, as actually practiced, inflation targeting is a framework not for communicating the central bank's goals but for obscuring them. In crucial ways, it is not a window but a screen. It promotes not transparency, at least not in the dictionary sense of the word, but opaqueness.

— Benjamin Friedman, International Finance (2004, p. 130)

I do think that Ben gets it exactly wrong when he criticizes inflation targeting for encouraging 'don't ask, don't tell'. To the contrary, I believe that inflation targeting can actually help to deal with the problem that Ben raises, making it easier for central bankers to be more transparent about their desire to keep output fluctuations low.

— Frederic Mishkin, International Finance (2004, p. 124)

I. Introduction

Since its first adoption by the Reserve Bank of New Zealand in 1990, Inflation targeting (IT) has gained much traction over the past two decades, becoming a framework of reference for the conduct of monetary policy. About 37 central banks are currently using IT as their monetary policy framework, and about 30 countries are considering the possibility of embracing IT in a near future (Hammond, 2012; IMF, 2014).

However, the debate about its relevance and macroeconomic consequences remains inconclusive. On the one hand, some authors indeed challenge the very merits of this new monetary policy framework. For instance, Greenspan (2007), building on the "constructive ambiguity" theory, argues that IT adoption has considerably constrained the discretion of monetary policymakers. Joseph Stiglitz also points out that IT leads central banks to raise interest rates mechanically whenever changes in prices exceed the targeted level, which can substantially reduce the aggregate demand and increase the price of non-traded goods and services, particularly in developing countries (Stiglitz, 2008). The recent financial crisis has rekindled further this debate about the relevance of IT on at least two main fronts. First, many countries experienced deflation episodes in the aftermath of the crisis, raising questions about the appropriateness of monetary policy frameworks, including IT (as opposed to price level targeting), for preventing

the economy from being stuck at the Zero-Lower Bound (Walsh, 2011). Second, the crisis laid bare the limits of price stability for ensuring financial stability, especially in the face of large asset price fluctuations.[3]

On the other hand, the proponents of IT rather underscore the credibility and flexibility-enhancing properties of IT, on account of the enhanced central bank transparency and accountability that this new monetary policy framework entails (Bernanke et al., 1999; Bordo & Siklos, 2014; Walsh, 2009). Such enhanced transparency and accountability should in turn allow IT central banks to anchor more firmly inflation expectations, thus providing them with more room to expand the economy in the face of adverse shocks without jeopardizing the credibility of monetary policy. In a similar vein, IT central banks are expected to have more leeway for assigning greater weights to long-term considerations and pursuing other objectives, including economic activity stabilization, through less aggressive policy rate adjustments. As such, Bernanke & Mishkin (1997) argues that IT is best described as a "framework of constrained discretion, not a mechanical policy rule".

Beyond the above-mentioned conflicting theoretical views about the merits of IT, a large part of the debate is actually taking place in the empirical literature, wherein mixed results are found regarding the macroeconomic performances of IT countries versus non-IT countries. For instance, Johnson (2002) analyzes the effect of IT on the level and variability of expected inflation using a sample of industrial countries. He finds that the level of expected inflation falls after the announcement of inflation targets, but neither the variability of expected inflation nor the inflation forecast error has been affected by IT adoption. Ball & Sheridan (2003) provide a quite different interpretation when examining the economic performance of IT in industrial countries. They show that once controlling for regression to the mean, there is no evidence that IT improves performances, as measured by the behavior of inflation, output, or interest rates. Lin & Ye (2007, 2009) rather point out that previous studies, including Johnson (2002) and Ball & Sheridan (2003), do not take account of the self-selection issue in their identification strategies, which can lead to misleading conclusions. They thus make use of propensity scores-matching (PSM) methods to correct for self-selection, and find that IT adoption has been associated with significant downward trends in inflation and its dynamics in developing countries, though the effect proved not statistically significant in the case of developed countries. However, Brito & Bystedt (2010) argue

[3] This sparked debates as to whether monetary policy should aim at "leaning against the wind" or "cleaning up the mess when the bubble bursts" (Cúrdia & Woodford, 2010; Bernanke, 2010).

that Lin & Ye's PSM does not account for time trends, countries' unobservable characteristics or persistence. As a result, they build on GMM estimates controlling for common time effects, and find no evidence that IT improves economic performance in developing countries.

In light of the plethora of conflicting findings on the macroeconomic effects of IT adoption, this study takes aims at digging deeper into the driving factors behind such diverging results. It takes advantage of the meta-regression analysis (MRA), a quantitative method that is increasingly used in Economics to take stock of existing findings on a given research question (Stanley, 2001; Rusnak et al., 2013; Neves et al., 2016). The goal is not to uncover the "true" value of the parameter under investigation, but rather to explain why there is so much variation across the estimates reported in studies investigating the same phenomenon. This method allows shedding lights on controversial issues, which explains its growing popularity in various fields of international economics. Recent applications of meta-analysis in economics include studies about the trade effect of monetary union (Rose & Stanley, 2005), the correlation of business cycle between countries (Fidrmuc & Korhonen, 2006), the effect of distance on trade (Disdier & Head, 2008), the effect of minimum wage on employment (Card & Krueger, 1995), the impact of natural resources on economic growth (Havranek et al., 2016), the trade effect of the euro (Havranek, 2010), analysis of capital controls (Magud et al., 2011), the influence of monetary policy on price level (Rusnak et al., 2013), and the relationship between inflation and central bank independence (Klomp & De Haan, 2010).

MRA allows testing for the existence of a publication selection bias, that is, a particular tendency from editors, referees, and/or researchers, to promote results that are consistent with the theory or are statistically significant. MRA thus allows assessing whether there is a genuine effect associated with a given policy, once adjusted for such a publication bias. It also allows identifying the main drivers of estimates heterogeneity across studies.

This paper adds to the existing literature on two main grounds. First, we construct a large MRA database, consisting of 8,059 estimated coefficients from 113 empirical studies on the macroeconomic effects of IT. To the best of our knowledge, this is the first application of a MRA to the macroeconomic effects of IT. Second, compared with previous MRA-based studies, we do not focus on a unique outcome variable. We rather analyze the effect of IT adoption on several macroeconomic outcomes, including *Price and Output Stability* (as seized by the inflation rate and its volatility, and growth volatility), *the State of the Real Economy* (as captured by the economic

growth rate), *Fiscal Performance and Credibility*, *External Developments*, and *Monetary and Financial Development*. This makes our paper the largest meta-analysis ever carried out in economics.

Using a mixed effect multilevel estimator and probit regressions, we unveil far-reaching results. First, the literature on the macroeconomic effects of IT adoption is subject to two types of publication selection bias. On the one hand, authors, editors and referees favor a particular direction of results when analyzing the effects of IT adoption on inflation volatility and real GDP growth. On the other hand, they promote statistically significant results. Second, once purged for these publication biases, we uncover a genuine effect of IT in lowering inflation rate and real GDP growth volatility, but no significant genuine effect on inflation volatility and on the level of real GDP growth. Third, we find that differences across estimated coefficients in the literature are mainly driven by the characteristics of the study, including its time coverage, the estimation techniques, the set of control variables considered, country-specific factors, IT implementation parameters, and the publication formats.

The remainder of the paper is structured as follows. Section 2 introduces the methodological approach of the meta-analysis versus meta-regression analysis (MRA). Section 3 discusses the meta-sample construction and the definition of associated *moderator* variables. Section 4 discusses the MRA results, while section 5 briefly concludes.

II. Meta-Analysis and Meta-Regression Analysis: Methodological Approaches

We proceed in three steps to nail down the genuine macroeconomic effects of IT. First, we build a representative sample of empirical studies related to the macroeconomic effects of IT (called *meta-sample* henceforth).[4] Second, we collect the estimated coefficients from these selected studies. It is worth noting that we do not systematically collect one estimate per study, but as many estimates as possible, insofar notable methodological differences exist in at least one of the following dimensions: IT group/control group, nature of data, model specification, time coverage, or the estimation technique. Third, we assess the presence of publication selection bias and genuine effects in the collected estimates, and explore the drivers of heterogeneity among the selected studies.

[4] The sample includes studies issued in peer-reviewed economic journals, books, Ph.D. dissertations, or working paper series.

2.1. Model specification

Given that our meta-analysis revolves around multiple (as opposed to a single) IT-induced outcome variables, we synthesize the collected estimates using the t-student value to create a binary variable equaling one if the collected estimate is significantly positive, and zero otherwise. Alternatively, when the collected estimate is significantly negative, we rather use the absolute value of the t-student to create a binary variable equaling one if the collected estimate is significantly negative, and zero otherwise. Following the synthesis of collected estimates, we conduct a meta-analysis to explore the drivers of heterogeneity between the selected studies. More specifically, we estimate the following equation:

$$e_i = \alpha + \sum_{k=1}^{n} \gamma_k X_{ik} + \sum_{k=1}^{n} \delta_k K_{ik} + u_i \qquad (1)$$

where e_i is the standardized effect (t-student or absolute value of t-student when the t-student is negative) of the ith estimate; X_i and K_i are respectively dummy and continuous variables representing relevant characteristics of the collected studies and aimed at capturing systematic differences between a given study and others from the literature; γ_k and δ_k stand for the unknown meta-regression coefficients to be estimated; and u_i is the meta-regression disturbance term.

2.2. Publication selection bias and genuine effect

The sample of collected estimates might be subject to publication selection bias, that is, a particular tendency from editors, referees, and/or researchers to promote results that are consistent with the theory or are statistically significant. The meta-analysis literature indeed distinguishes two types of publication biases: Type I bias, which occurs when editors, referees, and/or researchers favor a particular direction of results; and Type II publication bias, which occurs when editors, referees, and/or researchers promote statistically significant results. Those biases mostly stem from the confluence of authors' self-censoring attitudes and editors' inclination to accept papers with highly significant estimates (Stanley et al., 2008).[5] Adjusting for these

[5] When facing smaller samples and limited degrees of freedom, researchers tend to look for alternative econometric "tools" (proxies, estimation techniques, model specifications) that would be amenable to more statistically significant and larger estimated coefficients, thus leading to Type II publication bias.

publication biases thus allows isolating the "genuine effect" or "true effect" (if any) of IT adoption (Stanley & Doucouliagos, 2012).

2.3. From Meta-analysis to Meta-regression analysis

Meta-regression analysis (MRA), also known as meta-regression is an extension of a standard meta-analysis, which allows examining the extent to which statistical heterogeneity among estimates from multiple studies can be related to one or more study characteristics (Thompson & Higgins, 2002). Meta-analysis is somehow an attempt to summarize and "make sense" of these disparate findings.

As a regression on estimates from existing regressions, the meta-analysis methodology consists of combining all these existing estimates, investigating their sensitivity to changes in the underlying assumptions associated with their estimation, identifying and filtering out possible biases in their estimation, and explaining the diversity of results across these studies in terms of study features heterogeneity (Rose & Stanley, 2005). When collecting data for a meta-analysis, three cases can be considered regarding the distribution of the "true effect": (i) the *Fixed Effects* case, wherein only one estimate exists per study, and all studies have the same true effect; (ii) the *Random Effects* case, in which only one estimate exists per study, and true effects are heterogeneous across studies; and (iii) the *Panel Random Effects* case, wherein studies have multiple estimates, and true effects are heterogeneous both across and within studies (Reed et al., 2015).

Since we use more than one IT estimate from each study, it is important to account for the fact that estimates within one study are likely to be dependent (Disdier & Head, 2008). As a result, equation (1) above is likely to be misspecified. Following, Doucouliagos & Laroche, (2009) and Doucouliagos & Stanley (2009), we apply the mixed-effects multilevel model, which allows for within-study dependence, that is, unobserved between-study heterogeneity.

2.4. Estimation technique

In our case, the between-study variance represents the excess variation in observed IT effects expected from the imprecision of results within each study. So as to capture the between-study heterogeneity while controlling for within study influence, we use a mixed-effects multilevel model, which accounts for within-study dependence through the inclusion of a random individual

effect for each study (Doucouliagos & Stanley, 2009). More specifically, we consider the following equation (2):

$$t_{ij} = \beta_0 + \beta_1 \left({}^{1}/_{SE_{ij}} \right) + \lambda_j + \epsilon_{ij} \qquad (2)$$

where t_{ij} stands for the t-student of ith estimate from the jth study; SE_{ij} for the standard error of of ith estimate from the jth study; β_0 and β_1 for the unknown meta-regression coefficients to be estimated; and ϵ_{ij} for the meta-regression disturbance term. We correct for heteroscedasticity by dividing the t-student by the standard error of the estimated IT effect, and capture within-study dependence through the inclusion of the study-level random effects component (λ_j). In line with the funnel asymmetry test (FAT), we then assess the existence of Type I publication bias by testing the null hypothesis of $\beta_0 = 0$ in equation (2). By replacing the left-hand side of equation (2) with the absolute t-student value, we get equation (3), which is key for assessing the presence of Type II publication selection bias (that is, $\beta_0 = 0$ in equation (3)).

$$\left|t_{ij}\right| = \beta_0 + \beta_1 \left({}^{1}/_{SE_{ij}} \right) + \lambda_j + \epsilon_{ij} \qquad (3)$$

In addition, following Stanley & Doucouliagos (2012), we carry out the precision-effect test (PET) that is testing the null hypothesis of β_1 equaling zero in equation (2), or the absence of any *genuine* effect after purging for the publication selection bias. Rejecting the null hypothesis would thus signal the presence of a genuine effect.

A key remaining issue that needs to be addresses for a proper application of the mixed-effect model to our meta-sample is estimating the *between-study* variance. Several methods have been proposed to estimate the *between-study* variance in meta-regressions. Following, Thompson & Sharp (1999) and Benos & Zotou (2014), we compute the unknown variance of the random effect model through an iterative residual (restricted) maximum likelihood process (REML).[6] The

[6] Random effect model-based unknown variance can be computed through an iterative residual (restricted) maximum likelihood process (REML), the Empirical Bayes (EB) method (Morris, 1983), or a moment-estimator (MM). The most commonly method for estimating the *between-study* variance is REML, as it avoids not only downward biased estimates of the *between-study* variance, but also under-estimated standard errors and anti-conservative inference (Thompson & Sharp, 1999).

multivariate meta-regression then takes the following form (Doucouliagos & Stanley, 2009; Cipollina & Salvatici, 2010):

$$t_{ij} = \beta_0 + \beta_1 \left({}^{1}/_{SE_{ij}} \right) + \beta_k \frac{x'_{ij}}{SE_{ij}} + \lambda_j + \epsilon_{ij} \quad (4)$$

or

$$|t_{ij}| = \beta_0 + \beta_1 \left({}^{1}/_{SE_{ij}} \right) + \beta_k \frac{x'_{ij}}{SE_{ij}} + \lambda_j + \epsilon_{ij} \quad (5)$$

where x'_{ij} stands for a set of meta-independent variables, capturing empirical study characteristics from the meta-sample.

We perform our MRA using the multilevel mixed effects restricted maximum likelihood (RML) estimator. In addition, we make use of Probit-ME meta-regressions to identify country-specific characteristics that affect the likelihood of finding beneficial macroeconomic effects associated with IT adoption. Three groups of variables can indeed be distinguished when putting the probit-based estimates in perspective with the MRA-based ones, namely: (i) variables that are statistically significant in both cases, and bear the same sign; (ii) variables that are significant in both cases, but bear with opposite signs; and (iii) variables that are statistically significant in the probit regressions, but not in the MRA, or vise versa.

For the sake of further robustness check, we also employ the cluster-robust weighted least squares (WLS) to assess the sensitivity of the results to the chosen estimator.[7] The associated results are consistent with the baseline. They are not reported for space purpose, but are available upon request.

III. Meta-samples and moderator variables

We now turn to the strategy used to put together the meta-dataset, along with the *moderator* variables employed in the MRA.

[7] The cluster-robust weighted least squares (WLS) is the simplest and most commonly used in MRA (see for instance Doucouliagos & Stanley, 2009; Efendic et al., 2011). It clusters the collected estimates by study and computes robust standard errors, and then uses the inverse of the standard error (1/SE) as an analytical weight.

3.1. Database construction

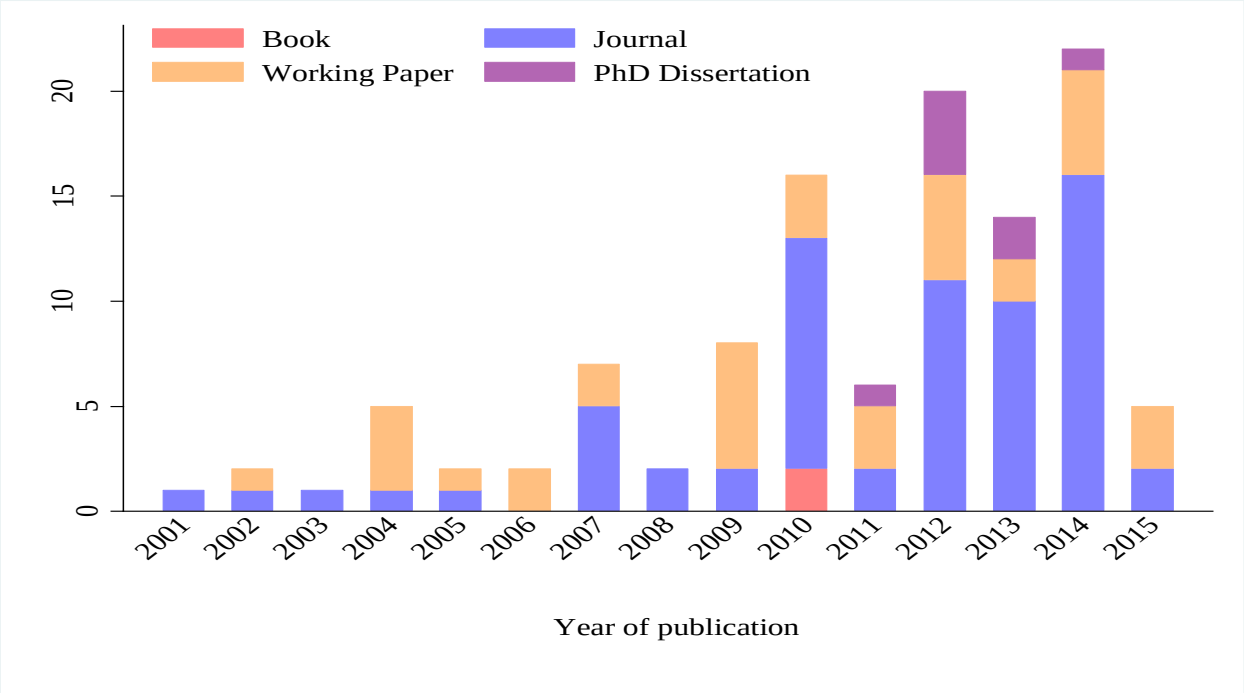
3.1.1. Studies collection

Before going any further, let us emphasize that our main goal is to build a MRA database that circumscribes to the extent possible studies that dealt with the empirical macroeconomic consequences of IT. We follow a four-step approach, in line with Stanley (2001) and Stanley et al. (2013). First, we dig into Google Scholar citations of IT-related seminal papers (Ammer & Freeman, 1995; Bernanke & Mishkin, 1997; Masson & al, 1997; Svensson, 1997a; Mishkin & Posen, 1997; Bernanke & al, 1999; Kuttner & Posen, 1999), and gradually into some more recent studies (Truman, 2003; Ball & Sheridan, 2004; Rose, 2007; Lin & Ye, 2007, 2009). This first round of exploration yields 7,537 candidate studies. Second, using "Inflation targeting" and "Monetary Policy Regime" as research keywords, we widen our search field to internet and academic databases such as "Science Direct", "JSTOR", "RePec Ideas", "Google Scholar", "Wiley" and "NDLTD".[8] Third, for studies that are not freely available online, we reach out bilaterally to the authors. Fourth, we rely on interlibrary loans systems to access undisclosed studies (owing to copyrights or non-responses).

We then narrow down further the selection criteria within the set of collected studies from the search process above, by excluding non-empirical studies. Within the collected empirical studies, we exclude those that do not consider at least one indicator of IT as explanatory variable. This leaves us with a meta-dataset of 113 studies on the empirical macroeconomic effects of IT adoption. Figure 1 below highlights these 113 studies, along with their publication year and formats. A noticeable pattern is that the IT-related empirical literature bourgeoned in the early 2000s before abounding from 2010 onwards. On average, 14 studies were carried out a year.[9]

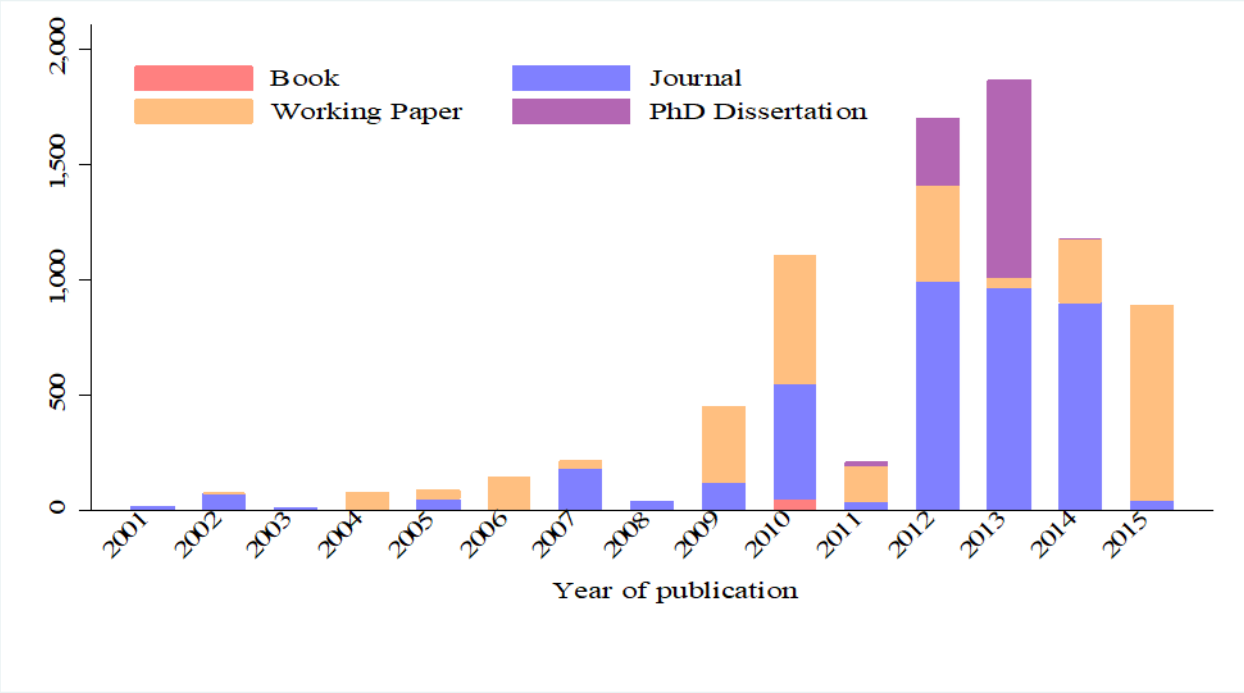
[8] Our search ended on July 12, 2015.
[9] The number of studies per year ranges between 1 and 22.

Figure 1. IT-related empirical studies retained in our MRA.



Notes: This figure presents the number of studies included in the MRA (on the y-axis) per year and type of publication.

Figure 2. Number of estimated IT coefficients in our MRA.



Notes: This figure presents the number of estimated IT coefficients included in the MRA (on the y-axis) per year and type of publication.

3.1.2. Estimates collection

We collect, from each retained study, estimates of IT effects, as well as information on the IT implementation forms, the size and composition of the sample, the estimation techniques, the covariates used, the publication year and formats, the authors' personal information (based institution, Google scholar citations), and other relevant information for the MRA. From the 113 empirical studies, we collected 8,059 estimates of IT on several macroeconomic outcome variables.

On balance, the collected studies relied on samples made up of 15 Inflation targeting countries (ITers) against 41 non-Inflation targeting countries (non-ITers). A striking feature of the literature lies in the plethora of estimates per study, with 71 regressions on average. Figure 2 shows the frequency of these estimates per year and type of publication. Such a pattern owes much to a growing tendency from researchers to prove to the extent possible, the robustness of their results, through a multiplication of sensitivity tests (for instance using alternative IT adoption dates, or investigating the effect of IT on various outcomes indicators in a single study, etc.).

3.1.3. Putting the collected estimates together

Since our study aims at conducting a large MRA on multiple macroeconomic effects of IT (as opposed to a MRA on a single macroeconomic effect of IT), it is critical to synthesize the collected estimates into fairly comparable sets of outcome indicators, for implementation purpose– overcoming the high number of outcome variables. To this end, we split our collected estimates into the following five meta-regression groups. The first group, dubbed *Price and Output Stability*, consists of studies that analyze the stabilizing effects of IT, as captured by its influence on price dynamics (inflation level, inflation volatility, and inflation persistency or inflation expectations anchoring[10]), and on the stability of the real economy (volatility of GDP growth rate, output gap, and unemployment rate variability). 3,370 estimates from 75 studies are retained in this group. For the sake of robustness check, we further split this group into three more homogeneous sub-groups: (i) a group of studies that examine the effect of IT exclusively on the level of inflation, (ii)

[10] Proxy for monetary policy credibility.

another group of studies interested in the effect of IT exclusively on the volatility of inflation, (iii) and a group of studies dealing solely with the effect of IT on the volatility of GDP growth.

The second group includes studies that analyze the costs associated with IT adoption. More specifically, this group, labelled as *State of the Real Economy*, focuses on the output costs of IT (real GDP growth rate, and unemployment rate), the disinflation costs of IT or sacrifice ratio, the competitiveness costs of IT (real effective exchange rate, credit to the private sector, policy rate and its volatility), and the financial stability costs. 53 studies, with 2,085 estimates meet the criteria for this group. Again, for robustness purpose, we narrow down further this group into a more homogeneous block, consisting of studies that focus on the consequences of IT exclusively on the level of real GDP growth.

The third group lumps together papers that explore the effect of IT on fiscal policy performance and credibility, as captured by fiscal discipline, sovereign spreads or debt ratings, and institutional quality. This group, labelled as *Fiscal Performance and Credibility*, is made up of 14 studies containing 1,700 estimates. The fourth building block, called *External Development*, regroups studies that assess the impact of IT on external volatility (exchange rate volatility), a balance of payment component (current account, financial account), and a measure of capital or financial openness. *External Development* comprises 16 studies, corresponding to 733 estimates. The fifth and last group, dubbed as *Monetary and Financial Developments*, includes studies concerned with the influence of IT on liquidity conditions (broad money growth), financial depth (deposit rates, bond market health, and degree of financial dollarization). Six studies, corresponding to 171 estimates make up this group.

Note however that a proper meta-analysis requires at least roughly 20 studies (Stanley, 2016). As a result, we discard *External Development*, *Fiscal Performance and Credibility*, and *Monetary and Financial Developments* from our multivariate MRA, as they contain only 16, 14 and 6 studies, respectively.[11] This leaves us with two groups in the multivariate analysis, *Price and Output Stability* and *State of the Real Economy* groups. Appendix 1 reports the five meta-regressions groups along with their associated studies, the dependent variables in each study, and some descriptive statistics on the estimates. A key feature of the retained meta-database lies in the significant heterogeneity across the estimates, both between and within studies in each group, as exemplified by the different mean value (which can be positive or negative) of the estimate within

[11] Nevertheless, we report in Appendix 4, results of publication bias tests for these three discarded groups for illustration purposes.

each study. In the following, we aim at explaining this heterogeneity across studies, also known as *excess study-to-study variation*, through the MRA.

3.2. Sources of heterogeneity

We now highlight key variables (called *moderators*) that likely drive the heterogeneity among the collected estimates. As it is common in empirical studies, an omission bias is likely to "pollute" the MRA coefficients. However, a high number of covariates relative to the number of studies may also lead to misleading results (Thompson & Higgins, 2002). We thus need to strike a right balance between the risk of an omission bias and the risk of a high number of covariates-driven bias. More details on the moderators can be found in Appendix 2.

3.2.1. Sample characteristics

The sample composition is bound to play a key role in any study aimed at assessing the macroeconomic consequences of IT. The empirical literature indeed finds distinct results, depending on the composition of the sample: IT is broadly found to lead to beneficial effects on price stability in developing countries, but to mixed results in advanced economies or when lumping together developed and developing countries. For instance, analyzing the influence of IT in developed and developing countries, respectively, Lin & Ye (2007, 2009) find that IT adoption helps bring down both inflation and its variability in developing countries, but fail to find a statistically significant effect in developed countries.

We test for the role of sample composition through two dummy variables: (i) a binary variable taking one if the study is based on a sample of developing countries, zero otherwise; (ii) a binary variable equaling one if the study relies on a mixed sample (pool of developed and developing countries), zero otherwise. Half of the regressions from our meta-dataset relies on a sample of developing countries, while 18 percent of the regressions build on pools of advanced and developing economies. We label this source of heterogeneity as "*Sample characteristics*".

3.2.2. IT parameters

Factors related to the implementation forms of IT, or to some extent to the definition of the counterfactual (control group or comparison group) could also be at work in the heterogeneity found on the impact of IT. We dub this source of heterogeneity as "*IT characteristics*", and account

for it through the following two dimensions. First, we distinguish two implementation forms of IT: *soft* or *partial* IT versus *full-fledged* IT, as captured by two starting dates of IT adoption, namely *default* starting date and *conservative* starting date, in line with Rose (2007).[12] More specifically, we capture the influence of IT implementation forms through a dummy variable equaling one if a collected estimate results from conservative starting dates, zero otherwise. About 37 percent of the regressions from our meta-dataset stem from conservative IT starting dates.

Second, we factor in the role of the counterfactual definition, as the latter may weigh significantly on the results. To this end, we include a dummy variable equaling one when a collected estimate is based on benchmarking IT countries against a control group that lumps together alternative monetary policy frameworks (money growth targeting, exchange rate targeting), and zero otherwise (when money growth targeting and exchange rate targeting are not lumped together in the control group). About 91 percent of regressions from our meta-dataset benchmark inflation targeters against a pool of money growth targeters and exchange rate targeters.

3.2.3. Estimation technique characteristics

The chosen estimation technique may constitute another source of heterogeneity among the collected estimates. It is indeed commonly agreed that a key difference between estimation techniques lies in their degree of effectiveness in handling endogeneity issues, which in turn determines the extent to which a study results carry a dose of bias. Lin & Ye (2007) for instance points out that unlike simple ordinary least squares (OLS) and difference-in-difference (DD), propensity score-matching (PSM) techniques are more effective in addressing self-selection issues. While acknowledging that the PSM corrects for self-selection, Brito & Bystedt (2010) though argue that PSM cross-sectional nature does not allow controlling for time trends, unobservable variables and persistence, thus pointing to a superiority of the Generalized Methods of Moments (GMM). We account for the role of estimation techniques-driven heterogeneity through the following four dummy variables: (i) a binary variable equaling one if a collected estimate stems from a GMM estimation, zero otherwise; (ii) a binary variable equaling one if a collected estimate results from an instrumental variable (IV) estimation, zero otherwise; (iii) a

[12] *Default* starting dates are those announced by central banks themselves, while *conservative* starting dates are those set by external analysts.

binary variable equaling one if a collected estimate comes from a PSM estimation, zero otherwise; and (iv) a binary variable equaling one if a collected estimate stems from a DD estimation, zero otherwise. Around 76 percent of collected estimates stem from study that build on the estimation techniques underlying the above-defined dummies, the remainder from OLS, fixed or random effects, or time series methods. We label this source of heterogeneity as "*Estimator characteristics*".

3.2.4. Control variables-related characteristics

Differences in the specification of the covariates vector might also drive the heterogeneity in estimates across studies, as the chosen vector influences the extent to which the estimate is free of bias. We factor in the role of covariates vector-driven heterogeneity, dubbed as *Control variables characteristics*, through a dummy variable taking the value one if the collected estimate results from a regression that accounts for most commonly used control variables, and zero otherwise. The most commonly used covariates include government debt, fiscal balance, trade openness, exchange rate regime, central bank autonomy, financial development (broad money growth, credit to the private sector), level of economic development, investment, output variability or output gap, population, institution, level or variability of inflation, financial openness, and financial reforms.

3.2.5. Sample structure characteristics

Heterogeneity in estimates may reflect heterogeneity in the time span considered for the evaluation of the IT impact. One the one hand, some critics of IT, including Dueker & Fisher (1996) and Cecchetti & Ehrmann (2000), indeed argue that the alleged performance of IT in the literature actually might just reflect common trend effects (favorable economic environment of the 1990s, known as the "Great Moderation"). Other critics, including Stiglitz (2008), argue that IT is being put at test by the recent global financial crisis, which could entail its demise, in light of the zero-lower-bound, whereby IT Central Banks would be undershooting their inflation targets. On the other hand, proponents of IT rather stress out the prominent role of credible monetary policy frameworks, including notably IT adoption, in anchoring inflation (see, e.g., Bernanke, 2004). With regard to coping with the global financial crisis, Krugman (1999), Gonçalves & Carvalho (2009), and Andersen et al. (2015) also point out that IT countries absorbed better the adverse effects of the shocks without jeopardizing monetary policy credibility

(through temporary deviations from the target) and thus experienced lower sacrifice ratios, thanks to their more firmly anchored inflation expectations.

So as to gauge the time-sensitivity of the collected estimates, labelled as "*Sample structure characteristics*", we discriminate among the collected estimates based on the period coverage of the studies from which they are originating from. More specifically, we distinguish two major time spans: the Great Moderation (1990s until the recent Great Recession) and the recent Great Recession (post-2007). We introduce a dummy variable taking the value one if the collected study covers both the Great Moderation and the recent Great Recession, and zero otherwise (when the study covers only the Great Moderation). In addition, we test whether the relative number of ITers and non-ITers in a study can be a source of heterogeneity. To this end, we control for the ratio between ITers and non-ITers.

3.2.6. Publication characteristics

Finally, we factor in "qualitative difference" across studies, dubbed as "*Publication characteristics*", in three dimensions. First, we incorporate a dummy variable equaling one if a study is published in a peer-reviewed journal, zero otherwise (working papers, Ph.D. dissertations, or contribution to a book). Second, we account for the RePec impact factor of the outlet at the period of the meta-data construction. Third, we account for the role of US affiliation–a common feature in most MRA, through a dummy equaling one if at least one of the co-author is based in a US institution.

IV. Results

Let us now turn to the results. First, we discuss the results of both the *publication selection bias* and *genuine effect* tests for the five MRA groups of collected estimates, namely "*Price and Output Stability*", "*State of the Real Economy*", "*External Development*", "*Fiscal Performance and Credibility*", and "*Monetary and Financial Development*". Second, we discuss key results related to the role of *moderators* highlighted above, and focusing exclusively on the first two MRA groups, using a multivariate analysis.[13]

[13] We do not present the multivariate analysis associated with the three other MRA groups (*Fiscal Performance and Credibility, External Development, Monetary and Financial Development*) for reasons discussed in section 3.1.3. Results for Type II publication bias on "*External Development*", "*Fiscal Performance and Credibility*", and "*Monetary and Financial Development*" are presented in Appendix 4.

4.1. Publication selection bias and genuine effect

4.1.1. Publication selection bias

Publication selection bias is a key matter of concern, in that researchers and reviewers may systematically favor a particular direction of results, that is, results that are consistent with the theory (Type I publication bias), or promote results that are statistically significant (Type II publication bias). At a glance, Figure 3 below points to the likelihood of such biases. To test formally for the presence of these two types of publication bias, we build on a restricted model. More specifically, we estimate equations (2) and (3) above using a mixed effect (ME) estimator. Table 1 reports the associated results on "*Price and Output Stability*" and "*State of the Real Economy*". Columns [1] and [5] present results for Type II publication bias, using the absolute t-statistics, while columns [2], [3], [4] and [6] depicts results for Type I publication bias, considering continuous t-values for the level of inflation, volatility of inflation, volatility of real GDP growth, and the level of real GDP growth as the dependent variable (most commonly outcome variables used in studies on the effects of IT), respectively.

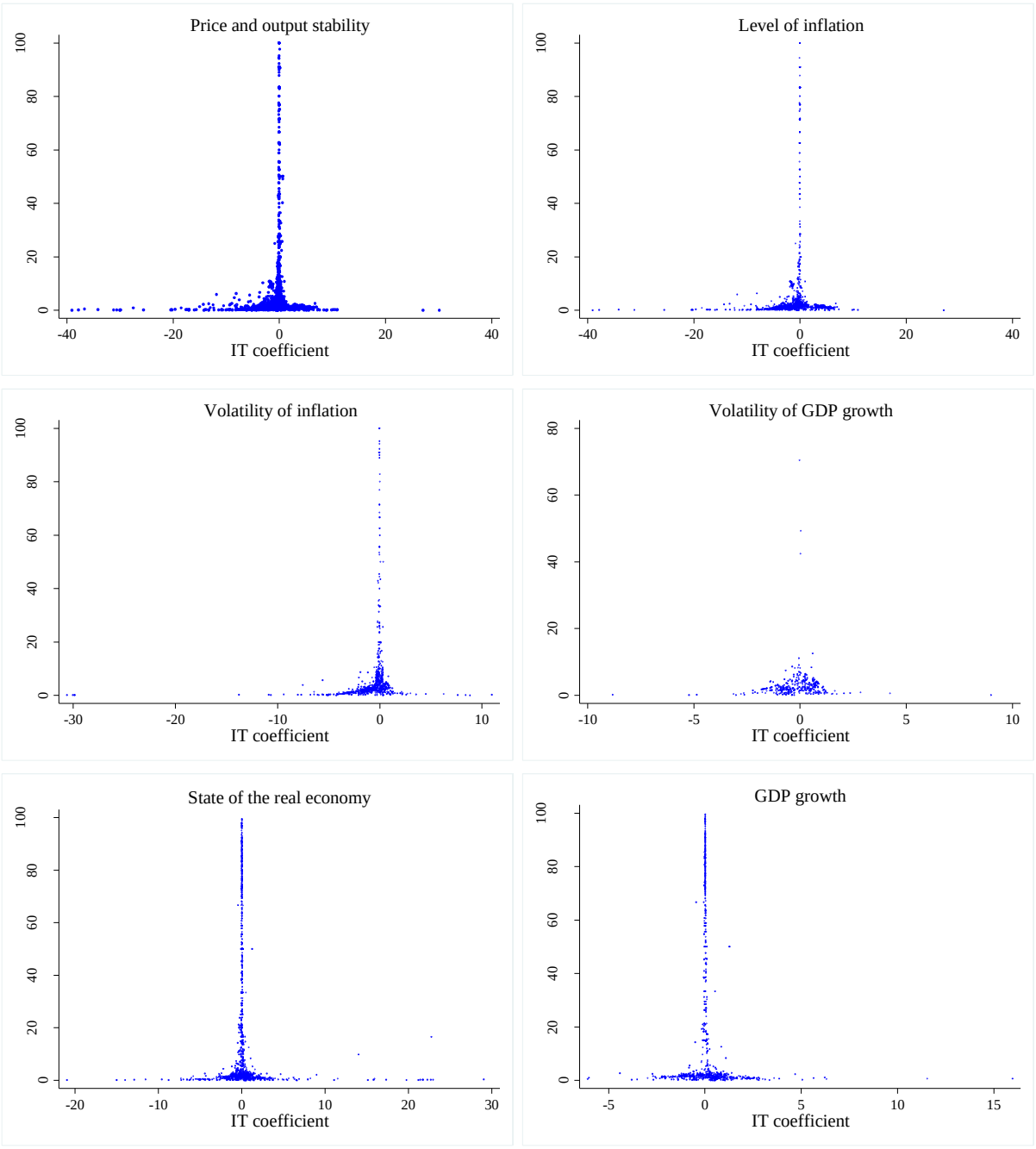
Let us first focus on Type II publication bias results (Table 1, columns [1] and [5]). The intercepts ("constant") in these regressions are positive and highly significant, pointing to the existence of Type II publication bias in each of the two meta-regressions groups (*Price and Output Stability* as a whole, and *State of the Real Economy* as a whole).[14] This finding suggests that researchers and reviewers systematically promote statistically significant results, irrespective of the considered MRA group, which is in line with most MRA findings (De Long & Lang, 1992; Card & Krueger, 1995; Ashenfelter & Greenstone, 2004; Havranek & Irsova, 2011; Rusnak et al., 2013; and Neves et al., 2016).

So as to refine the assessment of publication bias and derive the genuine macroeconomic effects of IT (if any), we narrow down our meta-data to sets of more homogeneous groups, consisting of estimates whereby inflation and its volatility, as well as real GDP growth and its volatility are the outcome variables. Results associated with these more homogenous meta-data are reported in Columns [2], [3], [4] and [6] of Table 1, and show that the intercepts in columns [3] and [6] are significant. This suggests the presence of a Type I publication bias (here the dependent variables are the t-statistics value of the collected estimate, as opposed to the absolute

[14] Similar results are found when considering the other three MRA groups (Appendix 4). We also report funnel graphs associated with these three MRA groups in Appendix 3.

value used when considering the synthesized meta-groups as a whole, namely *Price and Output Stability* and *State of the Real Economy*) in studies having analyzed the effect of IT on inflation volatility or real GDP growth. In other terms, researchers, editors and referees tend to favor

Figure 3. Funnel graphs



Notes: We plot the estimated coefficient of IT on the corresponding outcome variable on the horizontal, and the precision of the estimate (1/standard error) on the vertical axis.

studies that find inflation stabilizing and growth-enhancing effects associated with IT adoption. Our results also point to a rather "little to modest" selectivity in the IT-inflation volatility or IT-growth literature, as supported by the associated FAT values.[15] We do not detect any Type I publication bias in the IT-inflation or IT-volatility of growth literature, since the intercepts in columns [2] and [4] are statistically insignificant.

The results for Type I and Type II publication biases still hold when we consider only estimates from studies published in peer-reviewed journals, as depicted in Table 2. More importantly, the coefficient for publication bias on real GDP growth (in column [6]) is now about 1.3, suggesting the existence of "substantial" selectivity in published studies on the IT-growth literature.

4.1.2. Genuine effect

Columns [2], [3] and [5] of Table 1 allow going beyond publication selection bias, and testing for the existence of genuine effects of IT adoption on inflation, growth volatility and growth.[16] The estimated effects of IT corrected for publication bias (slope coefficients reported in columns [2] and [4]) suggest a negative effect of IT adoption on the level of inflation and on growth volatility. Put simply, once corrected for publication bias, IT adoption is found to reduce inflation and stabilize growth. However, the magnitude of these genuine effects are rather small. We do not uncover, after correcting for publication bias, any effect of IT adoption on the volatility of inflation as well as on the level of growth (columns [3] and [6]). Note however that this does not mean that IT has no effect on inflation volatility and the level of growth, but that the effect depends on several factors, which will be discussed in the next section. The beneficial genuine effects of IT adoption on both the level of inflation and the volatility of growth still hold when we consider only estimates from studies published in peer-reviewed journals (see columns [2] and [4] of Table 2). The magnitude of the IT effect on inflation (GDP growth volatility) is smaller (larger) than in Table 1.

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[15] A FAT value smaller than 1 is synonymous of "little to modest" selection bias, while a FAT test value ranging between 1 and 2 rather signals "substantial" selectivity (Doucouliagos & Stanley, 2013).

[16] In regressions wherein t-statistics absolute values are used as dependent variable, the coefficients associated with the *precision* parameter, that is 1/(standard error), should not be interpreted as genuine effects, as the meta-group (*Price and Output Stability* or *State of the Real Economy*, for instance) consists of a synthesis of studies that do not rest on a single outcome variable.

Table 1. Publication Selection Bias and Genuine Effect Tests

	[1]	[2]	[3]	[4]	[5]	[6]
	Price and Output Stability				**State of the Real Economy**	
	Whole group	Level of inflation	Volatility of inflation	Volatility of GDP growth	Whole group	Level of GDP growth
Genuine effect						
1/(standard error)	9.49e-04**	-0.079***	-1.35e-04	-0.008***	-1.30e-05	4.96e-05
	(4.64e-04)	(0.005)	(1.33e-04)	(0.002)	(2.73e-05)	(3.66e-05)
Publication bias						
Constant	3.562***	1.590	-0.878*	0.252	3.294***	0.967***
	(1.144)	(2.789)	(0.511)	(0.270)	(0.890)	(0.368)
Observations	3,344	1,887	920	346	2,066	1,537
Studies	75	58	38	23	52	34

Notes: The Table presents results of publication selection bias and genuine effect tests for the *Price and Output Stability*, and *State of the Real Economy* meta-groups. Columns [1] and [5] report the results for each group, using the absolute value of the t-statistic of the collected IT estimate as dependent variable. Columns [2], [3], [4] and [6] present the MRA results for more homogeneous groups (level of inflation, volatility of inflation, volatility of real GDP growth, and level of real GDP growth, respectively), using the t-statistic of the estimate of IT as dependent variable. All estimates are obtained using a mixed-effects multilevel model. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2. Publication Selection Bias and Genuine Effect Tests: Published Estimates Only

	[1]	[2]	[3]	[4]	[5]	[6]
	Price and output stability				**State of the real economy**	
	Whole group	Level of inflation	Volatility of inflation	Volatility of GDP growth	Whole group	Level of GDP growth
Genuine effect						
1/(standard error)	9.61e-05	-0.002*	-9.98e-05	-0.015**	-1.97e-05	0.002
	(1.06e-04)	(9.28e-04)	(7.86e-05)	(0.007)	(1.58e-05)	(0.004)
Publication bias						
Constant	2.982***	-1.252	-0.876**	0.312	3.720**	1.344**
	(0.506)	(0.794)	(0.422)	(0.468)	(1.606)	(0.667)
Observations	2,162	1,365	543	75	651	312
Studies	42	30	18	9	25	13

Notes: The table presents results of the publication selection bias and genuine effect tests for the Price and Output Stability, and State of the Real Economy meta-groups. Columns [1] and [5] report the results for each group, using the absolute value of the t-statistics of the estimate of IT as the dependent variable. Columns [2], [3], [4] and [6] present the MRA results for more homogeneous groups (level of inflation, volatility of inflation, growth volatility, and level of growth, respectively), using the t-statistic of the estimate of IT as the dependent variable. All estimates are obtained using a mixed-effects multilevel model. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

To sum up, these results show that the literature on the macroeconomic effects of IT adoption is subject to two types of publication bias: authors, editors and referees (1) favor studies that find inflation stabilizing and growth-enhancing effects associated with IT adoption, and (2)

promote statistically significant results. We also find that, after correcting for publication selection bias, IT adoption still proves effective in reducing the level of inflation and stabilizing growth. In the following section, we tweak further the analysis by exploring the extent to which some specific factors outlined above (section 3.2.) could explain the heterogeneity across findings in the empirical literature.

4.2. Drivers of heterogeneity

We make use of a mixed effect restricted maximum likelihood (REML) estimator and a Probit model to address the following two questions: (i) what characteristics affect the significance of the collected estimates? (ii) What factors explain the likelihood of having a significant coefficient with a particular sign? Tables 3 and 4 report the associated results.

4.2.1. Results of the mixed effect estimator

Let us first discuss the results from the mixed effect estimator, in which the t-value of the collected estimate (or its absolute value[17]) is the dependent variable.

(i) Mixed Effect Results on the Price and Output Stability meta-group

Columns [1] to [4] of Table 3 depict the results on the *Price and Output Stability* meta-group.

Role of the Sample composition

The coefficient associated with the *Developing* (*Mixed*) *countries* dummy variable is positive (negative) and statistically significant in column [1] of Table 3. This indicates that compared with studies that build exclusively on a sample of developed countries, studies that rely on a sample of developing countries (or on a pool of developed and developing countries) conclude to more (or less) statistically significant relationship between IT and *Price and Output Stability*-related variables. Analogously, results reported in column [2] and [3] of Table 3 suggest that studies based exclusively on a sample of developing countries (as opposed to a mix of developed and developing countries) are more likely to conclude in favor of IT effectiveness in bringing

[17] When the meta-sample consists of a synthesis of studies that do not rest on a single outcome variable.

down inflation and its variability. This latter finding is in line with most existing studies that point out that IT is more effective in achieving price stability in developing countries (Gonçalves & Salles, 2008; Lin & Ye, 2009; Yamada, 2013). The rationale behind such a finding is that monetary policy credibility has yet to be earned in developing countries, so that a successful implementation of IT helps anchor inflation expectations more firmly and close this credibility gap (Bernanke et al., 1999; and Mishkin, 2000).

In column [4] of Table 3, the dummy variables for the *Developing* countries sample and *Mixed* sample exhibit statistically insignificant coefficients. This finding is in line with a few studies that show a lack of systematic difference between developing IT countries and non-IT developing countries in dampening real GDP growth volatility (IMF, 2005; and Gemayel et al., 2011).[18]

Role of Estimation techniques

The chosen estimation technique also matters for the effect of IT on variables from the *Price and Output Stability* meta-group. The MRA indeed shows that studies that employ PSM, GMM or IV estimation techniques yield more statistically significant results (see column [1], Table 3), while studies that rely on DD estimator lead to less significant estimates. Columns [2] and [3] show that PSM, GMM or IV-based studies tend more to conclude in favor of IT effectiveness in lowering inflation or its variability while DD-based studies tend more to report inflation-enhancing effects of IT, both in level and variability. As regards real GDP growth volatility, results in column [4] point to no significant influence of the chosen estimation techniques on the estimates (GMM, DD), except PSM-based studies that are found to more often lead to positive associations between IT and growth volatility.

Role of Control variables

The MRA results show that the vector of covariates specification also affects the estimates. On the one hand, controlling for *Fiscal balance*, *Central Bank autonomy*, *Financial development*, and *GDP per capita* in regressions leads to strengthened significance of the associated estimates, while

[18] Note however that Neumann & von Hagen (2002), IMF (2006), Batini & Laxton (2007), Gonçalves & Salles (2008), Lin & Ye (2009) and Fang & Miller (2011) find that IT adoption has been followed by a downward trend in output volatility, notably in developing countries.

accounting for *Government debt* or *Trade openness* leads to weakened significance of the associated estimates of IT on variables from the Price and Output Stability meta-group (column [1], Table 3). On the other hand, the significantly negative coefficients associated with *Fiscal balance*, *Exchange rate regime*, and *Financial development* in column [2] of Table 3 suggest that accounting for these variables in regressions tends to lead to larger inflation-reducing effects of IT, while the significantly positive coefficients associated with *Government debt*, *Trade openness*, and *Central Bank autonomy* in columns [2] and [3] rather signals that their inclusion in regressions contributes to smaller inflation or inflation volatility-reducing effects associated with IT adoption. Put differently, the effectiveness of IT in bringing down inflation is stronger in countries with higher fiscal balances, greater flexible exchange rate regime and deeper financial systems, but weaker in countries having higher central bank autonomy, plagued with debt overhang, and more open to trade.

Moreover, countries with healthier public finances (higher fiscal balance, or lower debt-to-GDP ratio), and hence freer of fiscal dominance, are indeed less prone to experience an unpleasant monetarist arithmetic-type failure of IT to curb inflation, as pressures on the monetary authority to generate seigniorage revenues to satisfy the present value budget constraint are less likely in such contexts (Sargent & Wallace, 1981; Leeper, 1991; Sims, 1994; and Woodford, 1994). The stronger effectiveness of IT under greater exchange rate flexibility and deeper financial system is also in line with the existing literature, which regards exchange rate flexibility and financial development as key preconditions for a successful implementation of IT, in view of the need to commit to price stability as the overriding goal of monetary policy and of the need to have a well-greased transmission mechanism of monetary policy for a proper IT functioning (Masson et *al.*, 1997; Debelle et *al.*, 1998; Agénor, 2000; Mishkin, 2000; Amato & Gerlach, 2002; Sims, 2004; Bernanke & Woodford, 2004; Batini & Laxton, 2007; and Freedman & Ötker-Robe, 2009).

The limited effectiveness of IT for achieving price stability in more open economy could be explained by the fact that fixed exchange rates (which are more amenable to exchange rate targeting rather than IT) stands as a better option for more open economies, especially for those that are contemplating to foster trade integration (see, for example, Frankel & Rose, 2002). However, the mitigating effect of greater central bank independence on the price stabilizing property of IT is somewhat puzzling, as central bank independence ("operational" at least) is rather viewed in the literature as a key precondition for a successful IT adoption (Mishkin, 2000; Amato & Gerlach, 2002; and Freedman & Ötker-Robe, 2010). A possible explanation might be

that the proxies (usually turnover rates of central bank governors) used in most studies do not really capture central bank "operational independence", that is the autonomy to set interest rates in a way to achieve the monetary policy objective, which is what actually matters for the effectiveness of IT. Another explanation could be that a central bank might not meet the operational independence perquisite, but embarks into "soft" IT, in a "tie your hands" strategy aimed at gradually fostering greater operational central bank independence, before subsequently switching into a full-fledged IT (Batini & Laxton, 2007; Alpanda & Honig, 2014).[19]

With regard to real GDP growth volatility, column [4] of Table 3 report a significantly positive coefficient associated with public debt, and significantly negative coefficients associated with both central bank autonomy and country's level of development (as captured by per capita real GDP). These findings suggest that studies that account for the role of fiscal sustainability (government debt), central bank independence and the level of development are more likely to conclude in favor of stronger IT effectiveness in stabilizing growth. A corollary is also that the growth-stabilizing property of IT is magnified in more developed countries, with sound public finances and greater central bank independence.

Role of IT implementation forms and sample structure

The MRA shows that the implementation forms of IT matter for its impact on price and output stability. More specifically, we find a statistically significant and positive coefficient associated with the *Conservative starting dates* dummy variable in column [1] of Table 3, which indicates that studies relying on conservative dates of IT tend to find more significant effects of IT on variables from the *Price and Output Stability* meta-group. Moreover, the coefficient associated with *Conservative starting dates* dummy is significantly negative in column [2], suggesting that *Conservative starting dates*-based studies more likely result in stronger IT effectiveness in reducing inflation. Put differently, full-fledged IT implementation delivers larger inflation reductions than soft IT.

Relatedly, our findings show that the structure of the used sample, as captured by the inflation Targeters-to-non inflation Targeters ratio, matters for empirical investigation. Table 3 indeed reports a statistically significant and positive coefficient associated with the Inflation

[19] Alpanda & Honig (2014) for instance find evidence supportive of a large inflation-reducing effect of IT in countries with low central bank independence.

Targeters-to-non-Inflation Targeters ratio in column [1], which signals that the relative number of countries included in the IT comparison group tends to enhance the significance of IT effects on variables from the Price and Output Stability meta-group.

Role of Publication characteristics

We do not find a significant difference between published and unpublished studies except for published studies having analyzed the effect of IT on inflation volatility (negative coefficient in column [3] of Table 3). However, studies with at least one co-author with a US affiliation report more significant effects of IT on the Price and Output Stability meta-group (column [1], Table 3). In addition, studies with at least one co-author from the US tend to find larger inflation or inflation variability-reducing effect of IT (columns [2]-[3], Table 3), but smaller growth-stabilizing effect of IT (column [4], Table 3). The results also indicate that the higher the impact factor of the journal in which a study has been published, the smaller the inflation-reducing and growth-stabilizing effects associated with IT adoption (columns [2] and [4], respectively).

(ii) Mixed Effect Results on the State of the real economy meta-group

Let us now look at the Mixed Effects results on variables from the *State of the Real Economy* meta-group (columns [5]-[6], Table 3).

Role of Sample Composition

We do not find a systematic difference between studies that build exclusively on developing countries sample and those that use a mix of developing and developed countries, when it comes to affecting not only the significance but also the magnitude of the growth effect of IT (columns [5] and [6], respectively, Table 3).

Role of Estimation techniques

Results in column [5] of Table 3 indicate that using GMM or PSM methods does not make any difference to the significance of the growth effect of IT. However, DD estimator-based studies

Table 3: Drivers of Heterogeneity, using Mixed Effect Estimator

	[1]	[2]	[3]	[4]	[5]	[6]
	Price and output stability				**State of the real economy**	
	Whole group	Level of inflation	Volatility of inflation	Volatility of GDP growth	Whole group	Level of GDP growth
1/Standard error	0.398**	1.495***	0.277***	-0.619	0.287***	-0.127***
	(0.161)	(0.189)	(0.00668)	(0.380)	(0.0357)	(0.0356)
Constant	2.230***	-1.040***	-0.419***	1.024***	2.518***	1.950***
	(0.102)	(0.145)	(0.109)	(0.329)	(0.263)	(0.131)
Sample characteristics						
Developing	0.105***	-0.0371**	-0.0151***	-0.172	-0.00101	0.0163
	(0.00465)	(0.0194)	(0.00477)	(0.245)	(0.00498)	(0.0192)
Mixed	-0.0428***	0.185***	-0.0137***	0.268	-0.00105	0.0138
	(0.00547)	(0.0162)	(0.00438)	(0.199)	(0.00430)	(0.0166)
Estimation characteristics						
PSM	0.0979***	-0.186***	-0.00908	1.937**	0.0261	-1.491**
	(0.00795)	(0.0177)	(0.00666)	(0.818)	(0.0218)	(0.675)
GMM	0.566***	-0.489***	-0.443***	-0.00365	-1.11e-05	-2.33e-05
	(0.0333)	(0.0777)	(0.0892)	(0.0992)	(0.000198)	(8.24e-05)
DD	-0.0428***	0.0379***	0.0760*	0.157	-0.259***	0.0113
	(0.00660)	(0.00978)	(0.0481)	(0.111)	(0.0388)	(0.112)
IV	0.297***	-0.404***	-0.257***			
	(0.00665)	(0.0286)	(0.00863)			
Control variables characteristics						
Government debt	-0.169***	0.0700***	0.0175*	1.400*	0.272	-0.789
	(0.00692)	(0.0163)	(0.00963)	(0.782)	(0.254)	(0.898)
Fiscal balance	0.124***	-0.0564**	-0.00767	-0.224	-0.00552	-0.0209
	(0.00665)	(0.0224)	(0.0210)	(0.202)	(0.109)	(0.0561)
Trade openness	-0.199***	0.431***	0.0901*	-0.318	0.0447**	-0.0149
	(0.0131)	(0.0497)	(0.0474)	(0.285)	(0.0211)	(0.0543)
Exchange rate regime	0.00385	-0.0934**	-0.0917	-1.037	-0.118***	1.448**
	(0.00643)	(0.0476)	(0.0581)	(0.748)	(0.0343)	(0.680)
Central Bank autonomy	0.0474***	0.0292*	0.0114	-0.558*	0.00436	-0.865***
	(0.00900)	(0.0178)	(0.0112)	(0.310)	(0.130)	(0.297)
Financial development	0.0977***	-0.214***	0.0158	0.563	-0.539***	0.198***
	(0.0114)	(0.0276)	(0.0292)	(0.502)	(0.0474)	(0.0653)
GDP per capita	0.0319***	-0.0856***	-0.0483	-1.723**		
	(0.00880)	(0.0308)	(0.0360)	(0.743)		
Investment					-0.285***	0.103***
					(0.0353)	(0.0185)
IT characteristics						
Conservative starting date	0.0381***	-0.0811***	0.00904	0.101	-7.61e-06	-4.75e-06
	(0.00621)	(0.0129)	(0.00889)	(0.132)	(0.000208)	(8.65e-05)
Benchmark Policy regime: IT	-0.714***	-1.670***				
	(0.161)	(0.179)				
Study period characteristics						
Ratio targeters/non-targeters	0.0756***	0.00407	-0.00477	0.0714	-0.00233	0.0307
	(0.00341)	(0.0102)	(0.00400)	(0.289)	(0.00954)	(0.0369)
Post 1990 - Post 2007	0.0782***	-0.0583*	-0.174***	-0.0965	-0.0938***	0.00105
	(0.00755)	(0.0312)	(0.0318)	(0.888)	(0.0211)	(0.0174)
Publication characteristics						
Journal	-0.00397	-0.00429	-0.0937***	0.0645	0.675***	-0.147***
	(0.00420)	(0.00590)	(0.0347)	(0.233)	(0.0709)	(0.0371)
Impact score	-0.00176	0.0235***	0.0218	0.381***	-0.663***	0.103**
	(0.00309)	(0.00663)	(0.0138)	(0.145)	(0.0762)	(0.0443)
US co-author	0.246***	-0.110***	-0.254***	0.183*	-0.236***	0.0756***
	(0.00577)	(0.0207)	(0.00640)	(0.0958)	(0.0388)	(0.0270)
Wald Chi2 (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	2,993	1.715	863	328	1,743	1,270
Studies	75	58	38	23	52	34

Notes: The Table presents results of the multivariate meta-regression for the *Price and Output Stability*, and *State of the Real Economy*. Columns [1] and [5] report the results for each group using the absolute value of the t-statistic of the collected estimate of IT as dependent variable. Columns [2], [3], [4] and [6] present the MRA results for more homogeneous groups (level of inflation, volatility of inflation, real GDP growth volatility, and level of real GDP growth, respectively), using the t-statistic of the estimate of IT as the dependent variable. All the estimates are obtained using a mixed-effects multilevel model. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

report less significant IT effects on variables from the *State of the Real Economy* meta-group. In addition, using PSM leads to larger growth reducing effects of IT (column [6]).

Role of Control variables

The specification of the covariates vector matters for the estimated effect of IT on variables from the *State of the Real Economy* (columns [5] to [6], Table 3). More specifically, controlling for the *Exchange rate regime*, *Financial development*, and *Investment* leads to less significant effects of IT on the State of the Real Economy (column [5]), while controlling for *Trade openness* increases the significance of the effect. When looking particularly at the growth effects of IT (column [6]), it appears that the coefficients associated with *Exchange rate regime*, *Financial development* and *Investment* are significantly positive, suggesting that IT adoption is more likely to contribute to bolstering growth in countries with flexible exchange rate regime, deeper financial systems and higher investment levels. Such findings are in line with the literature that identifies financial development and public investment as key drivers of economic growth (King & Levine, 1993; Domar, 1947). However, the coefficient associated with *Central Bank autonomy* is negative and highly significant, suggesting than the IT-driven disinflation costs are higher in countries with greater central bank independence, in line with Bleich et al. (2012) who find that IT adoption drives up central bank aversion to inflation.

Role of IT characteristics and sample structure

We find no role of the implementation forms of IT (as captured by the *conservative starting dates dummy*) on its effects (significance and size) on the *State of the Real Economy* (columns [5] to [6]). In addition, and as opposed to the results on the *Price and Output Stability* meta-group, the Mixed Effect results indicate that using a sample that covers from the Great Moderation (1990s) to the Great Recession (post-2007) leads to less significant effects on the *State of the Real Economy* (column [5]) compared to a sample covering only the Great Moderation, though such a game-changer role vanishes once we focus exclusively on the growth effect of IT.

Role of Publication characteristics

The Mixed results show that publication characteristics play a role on findings related to the effects of IT on the *State of the Real Economy*. More specifically, studies published in journals lead to more statistically significant IT effects, while those published in high-quality journals (higher impact factor) and co-written with at least one author from a US institution report less statistically significant effect of IT on variables from the *State of the Real Economy* meta-group (column [5]). However, when singling out the effect on economic growth, we find that studies published in journals tend to show smaller growth costs of IT, while those published in high-quality journals (higher impact factor) and co-written with at least one author from a US institution more likely report growth-enhancing effects of IT.

4.2.2. Results of Probit regressions

Table 4 presents results obtained from probit regressions for the *Price and Output Stability* meta-group and the *State of the Real Economy* meta-group. As a reminder, we use as dependent variable, a dummy variable equaling 1 if a study reports a statistically significant and beneficial IT effect on variables from the *Price and Output Stability* meta-group (with a risk error of 10%), zero otherwise. As regards variables from the *State of the Real Economy* meta-group, we rather use as dependent variable, a dummy equaling 1 if a study reports a significant IT-driven cost, zero otherwise.

(i) Probit Results on the Price and Output Stability meta-group

Columns [1] to [4] of Table 4 present the results for this *Price and Output Stability* meta-group. Consistent with the mixed effect-based results above, we find that studies building exclusively on developing countries increase the probability of finding a beneficial effect of IT on variables from the *Price and Output Stability meta-group*, inflation, inflation volatility and real GDP growth volatility. However, studies building on a pool of developed and developing countries reduce the probability of uncovering growth-stabilizing properties of IT. As far as estimation techniques are concerned, the results indicate that employing *PSM*, *GMM* or *IV* estimator increases the likelihood of finding a beneficial effect of IT on the *Price and Output Stability*. PSM-based studies are more likely to reveal inflation or inflation volatility-reducing effects of IT while DD-based papers are less likely to conclude in favor or growth-stabilizing effects of IT. These differences

across results underscore once again the pivotal role of identification strategies, thus calling for carefully choosing them, with a view to preventing misleading policy recommendations.

The specification of control variables vector also influences the probit-based results. Regarding the whole *Price and Output Stability* meta-group, we find that studies that control for *Government debt*, *Trade openness*, *Exchange rate regime* or *Central Bank autonomy* have lower probability of finding beneficial effects of IT while those that account for *Fiscal balance* or *Financial development* have higher probability of ending up with beneficial effects of IT. In other terms, IT stands as a useful tool for macroeconomic stability in fiscally healthier countries (lower debt-to-GDP ratio and higher fiscal balances) and with greater exchange rate flexibility, lower trade openness and central bank independence. The same applies when we look at the results on inflation more specifically, except that the coefficient associated with *Financial development* is no longer significant. Column [3] shows that controlling for *Government debt* or *Trade openness* reduces the effectiveness of IT in bringing drown inflation volatility. With regard to growth volatility, we find that studies that control for *Government debt* or *Central Bank autonomy* (*Fiscal balance*) are more likely to find a positive (negative) effect of IT on growth volatility. These findings may indicate that government recourse to countercyclical fiscal policy in bad times through debt-financed spending outweighs any growth-stabilizing effect of IT.

The implementation forms of IT (as captured by the *Conservative starting dates* dummy), matter for the probit-based results. The coefficient associated with that dummy is indeed significantly positive for the *Price and Output Stability* meta-group as whole, as well as for inflation or inflation volatility in isolation, which suggests that fully-fledged IT delivers stronger macroeconomic stability than soft IT, consistently with the mixed effect-based results above. Relatedly, we find that the definition of the monetary policy framework against which IT is benchmarked matters for the results. Contrary to the mixed effect-based results, the coefficient associated with the *Benchmark Policy Regime* dummy variable is significantly positive. This finding indicates that the probability of finding a beneficial effect of IT on price and output stability is higher when the study compares IT to a control group that lumps together any non-IT monetary policy framework (money growth targeting, exchange rate targeting, etc.).

The structure of the used sample also influences study findings. The probit results indeed show that papers that use samples covering from the Great Moderation (1990s) to the Great Recession (post-2007) more likely report favorable effects of IT on *Price and Output Stability* or inflation rate.

Finally, the probit results highlight a significant role of the publication characteristics. Papers published in journals are more likely to report inflation or inflation volatility-reducing effects but growth volatility-enhancing effect, while papers with at least one US-based co-author are more likely to report favorable IT effects on price and output stability as whole, including on inflation.

(ii) Probit Results on the State of the Real Economy meta-group

Let us discuss now the probit results on the *State of the Real Economy* meta-group (columns [5] to [6], Table 4). The coefficient associated with the *Developing* dummy is negative and statistically significant, suggesting that the probability of finding significant IT-driven disinflation costs is lower when the study builds on a sample of developing countries exclusively. Such findings are at odds with Brito & Bystedt (2010) who show that the price-stabilizing property of IT comes at the expense of output in developing countries.

The estimation techniques also affect the direction of the results. When estimates are obtained from *PSM* or *DD*, the likelihood of finding an IT-driven output costs increases, while it decreases when the estimates stem from GMM-based regressions. Regarding control variables, most of them are not statistically significant. However, we find evidence showing that the probability of IT-driven output costs declines in countries with greater exchange rate flexibility and higher public investment. Besides, we find that IT-driven costs on the *State of the Real Economy* as a whole are more likely in fiscally undisciplined countries (high public debt and low fiscal surplus).

The implementation forms of IT also matters, as the coefficient associated with the *conservative starting dates* dummy is significantly positive (column [6]), suggesting that the output cost is higher under a fully-fledged IT compared to a soft IT, though the estimated cost is quantitatively insignificant. Consistent with the mixed effect-based results, we also find that the probability of finding adverse IT effects on the real economy, and to a less extent on growth, declines when a study builds on a sample that that is not overwhelmingly composed of non-ITers, and covers from the Great Moderation (1990s) to the Great Recession (post-2007).

Finally, we find evidence supportive of a role played by the publication characteristics. Studies published in peer-reviewed journals are indeed less likely to report adverse IT effects on

Table 4: Drivers of Heterogeneity, using Probit Regressions

	[1]	[2]	[3]	[4]	[5]	[6]
	Price and output stability				**State of the real economy**	
	Whole group	Level of inflation	Volatility of inflation	Volatility of GDP growth	Whole group	Level of GDP growth
1/Standard error	-0.563***	-0.616***	-0.202*	0.138	0.640***	1.063***
	(0.0507)	(0.0676)	(0.107)	(0.156)	(0.215)	(0.404)
Constant	-0.168***	0.0532	-0.653	-1.327***	-1.153**	-1.603***
	(0.0283)	(0.0420)	(0.399)	(0.239)	(0.470)	(0.417)
Sample characteristics						
Developing	0.0661***	0.0328***	0.588***	0.349*	-0.282**	-0.197***
	(0.0106)	(0.0117)	(0.128)	(0.204)	(0.113)	(0.0742)
Mixed	0.0445***	0.0107	0.378***	-0.563	-0.197	-0.171***
	(0.00930)	(0.00710)	(0.111)	(0.357)	(0.143)	(0.0642)
Estimation characteristics						
PSM	0.0221***	0.0219***	0.0310***	0.0392	0.0561	0.672**
	(0.00453)	(0.00840)	(0.00870)	(0.327)	(0.0970)	(0.292)
GMM	0.103***	0.0430	0.0572	0.0926	-0.0102	-4.30e-05***
	(0.0192)	(0.0497)	(0.0469)	(0.128)	(0.0206)	(2.16e-08)
DD	-0.00108	-0.0143	0.0531	-0.638*	0.153	0.371*
	(0.00460)	(0.0205)	(0.140)	(0.384)	(0.146)	(0.197)
IV	0.0268***	0.141	0.0163			
	(0.00705)	(0.0912)	(0.0325)			
Control variables characteristics						
Government debt	-0.0231***	-0.0188**	-0.0232***	0.956**	3.526**	
	(0.00413)	(0.00775)	(0.00624)	(0.397)	(1.624)	
Fiscal balance	0.0651***	0.0404**	-0.0217	-1.117***	-3.779**	-0.0132
	(0.0107)	(0.0169)	(0.598)	(0.238)	(1.666)	(0.0130)
Trade openness	-0.0329***	-0.0538*	-0.116*		0.0220	-0.264
	(0.00965)	(0.0277)	(0.0700)		(0.0356)	(0.388)
Exchange rate regime	-0.0510***	-0.135***	-0.356		-0.140	-0.767**
	(0.0103)	(0.0314)	(0.528)		(0.196)	(0.376)
Central Bank autonomy	-0.0176***	-0.0159*	-0.00432	0.867***	0.0305	0.0350
	(0.00440)	(0.00872)	(0.00561)	(0.267)	(0.162)	(0.446)
Financial development	0.0243***	0.0126	-0.136		0.0610	0.393
	(0.00889)	(0.0186)	(0.429)		(0.332)	(0.645)
GDP per capita	-0.0123*	0.0975***	0.0847			
	(0.00693)	(0.0294)	(0.401)			
Investment					-0.714	-0.771**
					(1.439)	(0.301)
IT characteristics						
Conservative starting date	0.0183**	0.0214*	0.0551**		0.134	2.58e-05***
	(0.00826)	(0.0126)	(0.0245)		(0.185)	(1.46e-08)
Benchmark Policy regime: IT	0.495***	0.647***				
	(0.0486)	(0.0576)				
Study period characteristics						
Ratio targeters/non-targeters	-0.00257	-0.0161**	-0.000190		-0.200***	-0.380***
	(0.00210)	(0.00756)	(0.000261)		(0.0756)	(0.143)
Post 1990 - Post 2007	0.693***	0.467***	0.101	0.195	-0.348**	-0.391
	(0.186)	(0.160)	(0.199)	(0.175)	(0.173)	(0.342)
Publication characteristics						
Journal	0.000746	0.0681**	0.471***	-0.558**	-0.558***	-0.988***
	(0.00123)	(0.0339)	(0.170)	(0.234)	(0.197)	(0.366)
Impact score	0.00145	0.00720**	-0.0522	0.0382	0.247	0.689*
	(0.00270)	(0.00297)	(0.0968)	(0.0765)	(0.282)	(0.358)
US co-author	0.0657***	0.0372**	0.0986	0.366	-0.240	-0.419
	(0.0122)	(0.0160)	(0.105)	(0.408)	(0.153)	(0.291)
Wald Chi2 (p-value)	0.000	0.000	0.000	0.000	0.0000	0.0000
Observations	2,993	1,715	863	327	1,743	1,268
Studies	59	49	31	21	40	26

Notes: The Table presents results of the multivariate meta-regression for the *Price and Output Stability*, and *State of the Real Economy*. Columns [1] and [5] report the results for each group. Columns [2], [3], [4] and [6] present the MRA results for more homogeneous groups (level of inflation, volatility of inflation, real GDP growth volatility, and level of real GDP growth, respectively). All the estimates are obtained using a Probit regression. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

the *State of the Real Economy* as a whole and on growth. However, studies published in top-ranked journals (high impact) journals more likely report IT-driven output costs.

4.2.3. Robustness checks

We test the robustness of the results reported in Tables 3 and 4 as follows. First, we assess the role of the nature of data. Specifically, we add controls for three additional dummy variables equaling 1 for *Panel*, *Cross-sectional* or *Annual* data, respectively, zero otherwise. Second, we drop very extreme IT estimated effects, with a view to checking robustness to outliers. Third, we employ an alternative estimation strategy for our baseline model, namely estimating the regressions reported in Table 3 using an empirical Bayes iterative procedure and a moment estimator, and using a logit model (instead of the probit model) for the regressions reported in Table 4. These alternative specifications do not qualitatively alter our main results. The results are not reported for space purpose, but are available upon request to the authors.

V. Conclusion

This paper provides the first ever application of a meta-regression analysis (MRA) to the literature on the macroeconomic effects of inflation targeting (IT) adoption. It builds on a unique and very broad dataset of 8059 estimated coefficients of IT from 113 empirical studies. Another key novelty of this paper is that compared to previous MRA studies, it focuses on several outcome dimensions (as opposed to a single outcome variable). The examined dimensions include *Price and Output Stability* (as seized by the inflation rate and its volatility, and growth volatility), *State of the Real Economy* (as captured by the real GDP growth rate, sacrifice ratio, disinflation cost, etc.), *Fiscal Performance and Credibility*, *External Developments*, and *Monetary and Financial Development*. We relied on a mixed effect multilevel estimator, which allows gauging the presence of publication bias and isolate the genuine macroeconomic effects associated with IT adoption. We also made use of the mixed effect restricted maximum likelihood (REML) model and probit regressions to disentangle the between-study variance observed in the literature on the macroeconomic effects of IT adoption. We uncovered several far-reaching results.

First, we show that the literature on the macroeconomic effects of IT adoption is subject to two types of publication bias: (1) authors, editors and referees favor a particular direction of results when analyzing the effect of IT on inflation volatility or real GDP growth, and (2)

promote statistically significant results. This is in line with most existing meta-regressions, including De Long & Lang (1992), Card & Krueger (1995) who suggest that publication bias is an important phenomenon in most area of economic research. Second, once purged for these publication biases, we find some genuine effects of IT on both on the level of inflation and the volatility of economic growth. However, we do not find a genuine effect of IT on inflation volatility or GDP growth once correcting for publication biases, which to some extent reflects the fact that the genuine effect of IT is conditional upon several factors.

Third, differences across studies regarding the impact of IT are systematically affected by sample and empirical choice characteristics, country-specific factors, IT implementation forms, time coverage of the used sample, and publication formats. The sample characteristics are indeed paramount for the effectiveness of IT, in that in most MRA, using a sample of developing countries increases the likelihood of finding a statistical and beneficial effect of IT. Moreover, when researchers account for endogeneity issues, they are more likely to report statistical beneficial effects of IT on price or output stability. The MRA results also point to the prominence of country-specific factors in affecting the estimated effects of IT in the literature, including fiscal and exchange rate regime arrangements, trade openness, financial development, central bank autonomy and investment level. In addition, the use of conservative starting IT dates as opposed to default starting dates tends to improve the beneficial effect of IT. The same applies when the time horizon of the used samples covers the Great Moderation and the recent Great Recession (as opposed to covering only the Great Moderation), or when the study compares IT countries to a country group wherein money growth and exchange rate Targeters are lumped together. Finally, Publication formats are also a source of heterogeneity, which however varies from one MRA to another.

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Appendix 1. Summary Statistics of Studies Included in each Meta-Group

Meta-regression Groups	Authors' names	Publication year	Dependent variables	Number of coefficients	Mean	Standard deviation	Minimum	Maximum
Group 1: *Price and Output Stability*	Kuttner, Posen	2001	level of inflation; persistence of inflation	4	-4.93	5.726389	-11.4	-0.11
	Bratsiotic, Madsen, Martin	2002	inflation persistence	2	-0.395	0.0212132	-0.41	-0.38
	Johnson	2002	level of expected inflation; variability of expected inflation; average error in next-year inflation forecast	72	-0.7593056	1.415075	-8.1	0.86
	Hu	2003	level of inflation; inflation variability; gdp growth variability; output variability	10	-0.7767	0.941244	-2.4268	0.17
	Levin, Natalucci, Piger	2004	change in inflation expectation	4	0.075	0.0925563	0,0000	0.2
	Wu	2004	level of inflation	8	-0.33125	0.0383359	-0.4	-0.28
	Ball, Sheridan	2004	level of inflation; change in sd of inflation; change in sd of trend of inflation; sd of gdp growth rate	32	-0.21	0.6795824	-2.19	0.66
	Fraga, Goldfajn, Minella	2004	level of inflation	5	-0.078	0.4648333	-0.46	0.51
	Petursson	2005	level of inflation; persistence of inflation	20	-0.115	0.0771315	-0.337	-0.02
	Vega, Winkelried	2005	level of inflation; inflation variability; persistence of inflation	48	-1.357167	1.697822	-6.32	0.094
	Batini, Laxtone	2006	level of inflation; inflation variability; inflation forecast; volatility of inflation forecast; gdp growth rate variability; output gap variability	97	-2.407701	2.038846	-10.036	-0.009
	Mishkin, Schmidt-Hebbel	2007	level of inflation; inflation deviation	29	-0.2235517	0.361905	-0.929	1.007
	Fatas, Mihov, Rose	2007	level of inflation; gdp growth rate variability	4	-8.715	9.656754	-20.2	-0.4
	Lin, Ye	2007	level of inflation; inflation variability	28	-0.0010521	0.0011224	-0.0034	0.0009
	Berument, Yuksel	2007	inflation variability	18	-4.760778	18.75554	-79.808	0.081
	Gonçalves, Salles	2008	level of inflation; gdp growth rate variability	6	-1.896667	0.5177516	-2.53	-1.4
	Krause, Mendez	2008	level of inflation; relative preference for inflation stability	34	-0.1122353	0.8646321	-4.596	0.371
	Divino	2009	gdp growth rate variability; output gap variability; unemployment rate volatility	18	4.763889	25.14893	-14.21	97.77
	Fang, Lee	2009	level of inflation; inflation variability; gdp growth rate variability	147	-0.1271578	0.6738672	-2.257	1.9226
	Naqvi,Rizvi	2009	level of inflation; inflation variability; gdp growth rate variability; output gap variability	32	0.1205844	0.9361732	-1.0958	2.3454

Walsh	2009	gdp growth rate variability	14	0.2635	0.0458203	0.206	0.353
Voorden	2009	level of inflation	22	-28.35791	40.50116	-148.4	-2.633
Petursson	2009	inflation variability	8	-0.0014125	0.0003758	-0.0021	-0.0011
Lin, Ye	2009	level of inflation; inflation variability	96	-0.0238802	0.0065846	-0.038	0.001
Schmidt-Hebbel	2009	level of inflation	5	-0.0512	0.0038987	-0.055	-0.045
Brito, Bystedt	2010	level of inflation; inflation variability; gdp growth rate variability	60	1.1755	9.005798	-10.9	65.9
Ball	2010	level of inflation; inflation variability; gdp growth rate variability	19	-0.0452632	0.4068766	-0.66	0.5
Fang, Miller	2010	level of inflation	88	-1.865592	1.800892	-5.1243	1.6489
Kurihara	2010	level of inflation	1	-1.08	.	-1.08	-1.08
Crowe	2010	inflation forecast error	24	-0.3649125	1.224249	-2.83	3.28
Cecchetti, Hakkio	2010	current year inflation forecasts variability; next year inflation forecasts variability	42	-0.0275952	0.0519479	-0.213	0.022
Broz, Plouffe	2010	inflation concern dummy	4	0.2125	0.2767677	-0.081	0.522
Frappa, Mesonnier	2010	real house price growth; house price-to-rent ratio	24	1.549583	1.25089	0.04	4.7
Capistran, Ramos-Francia	2010	dispersion of inflation expectations	20	-1.8886	5.952258	-13.769	10.942
Prasertnukul, Kim, Kakinaka	2010	inflation variability	4	-0.0001275	0.0001325	-0.00030	0.000005
Fang, Miller, Lee	2010	level of inflation; inflation variability; gdp growth rate variability	378	-1.283289	1.749728	-7.3195	1.2194
Filardo, Genberg	2010	level of inflation forecast; variation of inflation forecast	4	0.1125	0.0932291	0.01	0.21
Bousrih	2011	level of inflation; inflation variability	9	1.153544	2.96209	-0.845	8.842
Lanzafame,nogueira	2011	persistence of inflation; persistence of inflation variability; credibility of monetary policy; credibility of monetary policy variability	13	0.0003077	0.0983034	-0.251	0.134
Gemayel, Jahan, Peter	2011	level of inflation; inflation variability; gdp growth rate variability	48	-0.8160417	1.830595	-3.28	7.61
Braeckman	2011	level of inflation; inflation variability; gdp growth rate variability	19	-1.071579	1.118169	-2.94	0.02
Lin, Ye	2012	level of inflation	88	0.0238409	0.011476	0.001	0.07
Garcia-Solanes, Torrejon-Flores	2012	level of inflation; inflation variability; gdp growth rate variability	41	-5.625756	15.60188	-72.85	41.98
Mendonça, Souza	2012	level of inflation; inflation variability	324	-1.245867	2.025026	-8.164	1.005
Chaouech	2012	level of inflation	2	-2.94	3.733524	-5.58	-0.3
Yamada, Bell	2012	level of inflation	2	0.0045	0,0000	0.0045	0.0045
Brito	2012	level of inflation; inflation variability; gdp growth rate variability	91	-0.6901374	1.298919	-7.73	4.71
Kyereboah-Coleman	2012	level of inflation	3	-0.1225967	0.087854	-0.21535	-0.04064
Kaseeram	2012	inflation variability	1	-0.002	.	-0.002	-0.002

Combes, Minea, Tapsoba	2012	level of inflation	4	-0.02825	0.0110868	-0.042	-0.017
Pourroy	2012	level of inflation; inflation variability; excess inflation; excess inflation variability; gdp growth rate variability; Central Bank credibility	12	0.8910833	1.922588	-2.024	4.79
Chu, Sek	2012	level of inflation	14	-0.0039621	0.003537	-0.01437	-0.001169
Willard	2012	change in inflation; change in sd of inflation	23	-0.158913	0.1748373	-0.74	0.04
Abo-Zaid, Tuzemen	2012	level of inflation; inflation variability; gdp growth rate variability	6	-0.8246667	1.311504	-3.197	0.176
Lucotte	2012	level of inflation; inflation variability; gdp growth rate variability	57	-1.976754	1.459367	-5.124	1.19
Levieuge, Lucotte	2013	degree of conservatism of Central Bank	35	0.1525714	0.0233065	0.11	0.21
Arnone, Romelli	2013	level of inflation	20	0.121275	0.2956235	-0.345	0.4568
Amira, Mouldi, Feridun	2013	gdp growth rate variability	6	0.3583333	0.2780228	-0.15	0.59
Fouejieu	2013	change in level of inflation; change in inflation variability; change in gdp growth rate	51	0.3640392	1.271266	-2.778	4.238
Tas, Ertugrul	2013	inflation variance; probability of being in the low-variance of inflation	34	-6.589118	15.40902	-48.21	0.71
Ginindmiza, Maasou	2013	level of inflation; inflation variability	178	-1.786099	1.766168	-10.46	0.72
Yamada	2013	level of inflation	504	1.157599	3.047205	-6.65	7.04
Tas, Demir	2014	level of inflation; inflation target deviation; implicit inflation target	35	-56.46126	146.4437	-718.58	10.49
Ardakani, Kishor, Song	2014	level of inflation; inflation variability	24	-0.665125	0.6284762	-1.872	0.366
Rose	2014	level of inflation; growth in property prices; growth in stock prices	28	-4.382143	7.538742	-30,0000	7.2
Daboussi[a]	2014	level of inflation; inflation variability; gdp growth rate variability	6	-2.606667	1.199861	-3.98	-0.85
Moretti	2014	level of inflation	26	-1.525346	0.2133407	-1.875	-1.152
Alpanda, Honig	2014	level of inflation	25	1.3244	17.51222	-61.62	49.95
Simwinga	2014	level of inflation	2	-3.86	0.1131371	-3.94	-3.78
Brana, Prat	2014	level of inflation	6	-0.8083333	1.628833	-3.87	1.06
Fry-McKibbin, Wang	2014	level of inflation	26	0.334	1.774136	-1.641	6.762
Ayres, Belasen, Kutan	2014	level of inflation	35	-0.4357143	1.380839	-4.535	1.502
Daboussi[b]	2014	level of inflation	10	-1.4264	4.135499	-11.8	4.67
Samarina, Terpstra, De Haan	2014	level of inflation	108	-2.224102	2.082419	-10.728	0.4
Chong, Wong	2015	level of inflation; inflation variability; gdp growth rate variability	23	-16.57196	29.92221	-95.205	1.091
		Total Group 1	3370				

	Hu	2003	gdp growth rate; output variability/inflation variability	4	0.261925	0.491531	-0.21	0.746
	Wu	2004	long term interest rate	4	-0.17	0.0627163	-0.25	-0.1
	Siklos	2004	nominal short-term interest rate	6	-0.318	0.08228	-0.452	-0.198
	Ball, Sheridan	2004	gdp growth rate; long term interest rate; sd of short term interest rate	20	0.271	0.8980968	-1.24	1.85
	Petursson	2005	gdp growth rate; long term interest rate	20	-0.1212	0.3180276	-0.65	0.263
	Batini, Laxtone	2006	volatility of real interest rate	10	-5.3691	1.45708	-8.79	-3.02
	Lin, Ye	2007	long term interest rate; long term interest rate variability	28	0.4461893	0.3173679	0.0426	1.1461
	Gonçalves, Carvalho	2007	sacrifice ratio	4	-3.925	0.4535417	-4.44	-3.34
	Fang, Lee	2009	gdp growth rate	49	-0.1030596	1.07844	-2.1403	2.5402
	Naqvi,Rizvi	2009	gdp growth rate; Phillip curve co-efficient; short term interest rate variability	28	-2.172629	4.000264	-20.9801	0.6483
	Walsh	2009	gdp growth rate	14	0.0231429	0.4043281	-0.638	0.85
	Divino	2009	gdp growth rate; output gap; unemployment rate	18	-0.8977778	2.147139	-6.55	2.3
	Brito	2010	sacrifice ratio	11	3.19	2.701699	0.17	7.97
	Fang, Miller, Lee	2010	gdp growth rate	126	0.2488952	0.907032	-2.6803	3.1284
Group 2: *State of the Real Economy*	Flho	2010	gdp growth rate; industrial production; unemployment rate	19	-0.0161579	0.1981698	-0.72	0.343
	Brito, Bystedt	2010	gdp growth rate	24	-0.3916667	1.485942	-1.28	5.06
	Flood, Rose	2010	business cycle synchronization	130	0.0628316	0.0915608	-0.1	0.7
	Ball	2010	gdp growth rate; long term interest rate; long term interest rate variability	17	0.2747059	0.1860819	-0.01	0.65
	Huang, Yeh	2011	private credit	21	15.92751	7.954796	1.4701	29.0611
	Bousrih	2011	gdp growth rate	3	0.1513333	0.2465286	0.009	0.436
	Braeckman	2011	gdp growth rate	13	-0.2853846	0.9482406	-1.4	1.67
	Gemayel, Jahan, Peter	2011	gdp growth rate	16	-1.13625	0.9744597	-3.8	-0.13
	Mollick, Cabral, Carneiro	2011	log of gdp per capita	24	0.0689583	0.0374636	0.009	0.131
	Pourroy	2012	real interest rate	2	-0.4815	0.7247845	-0.994	0.031
	Inoue, Toyoshima, Hamori	2012	business cycle synchronization	8	0.0105	0.0100995	-0.001	0.028
	Chaouech	2012	gdp growth rate	2	-1.485	4.150717	-4.42	1.45
	Leonhard	2012	expected interest rate	6	0.1666667	0.1972477	-0.01	0.45
	Brito	2012	gdp growth rate; long term interest rate; long term interest rate variability	59	0.570339	0.9905832	-1.12	2.8
	Abo-Zaid, Tuzemen	2012	gdp growth rate	2	0.015	1.337846	-0.931	0.961
	Chu, Sek	2012	gdp growth rate; output gap	24	2.636417	4.046032	-0.002593	15.96246

Garcia-Solanes, Torrejon-Flores	2012	gdp growth rate; short term interest rate; short term interest rate variability	11	-0.6722727	2.853761	-7.29	2.78
Lucotte	2012	gdp growth rate	3	-2.236667	0.917864	-2.975	-1.209
Lin, Ye	2012	gdp growth rate	92	-0.1356087	0.5770924	-2.337	1.055
Souza$_a$	2013	gdp growth rate	769	0.0107765	0.0133102	-0.0204	0.0622
Montes	2013	Short-term interest rate; industrial entrepreneur confidence index	6	-3.689833	8.983159	-12.92	7.971
Amira, Mouldi, Feridun	2013	gdp growth rate	6	0.83	0.4597391	0.09	1.28
Fouejieu	2013	change in central bank reference rate; change in nominal interest rate; change in real interest rate	31	-2.68529	1.676315	-6.544	-0.422
Souza$_b$	2013	gdp growth rate	84	0.0120373	0.0043157	0.0028	0.0207
Puni, Osei, Barnor	2014	gdp growth rate	1	2.115329	.	2.115329	2.115329
Poon, Lee	2014	nominal interest rate	4	-0.045675	0.0038065	-0.05	-0.042
Ardakani, Kishor, Song	2014	interest rate volatility	12	-0.1864167	0.3117792	-0.67	0.39
Daboussi$_a$	2014	gdp growth rate; short term interest rate variability	4	-0.9225	0.8791805	-2.23	-0.34
Rose	2014	business cycle; real effective exchange rate	42	-23.52276	142.3979	-924	4.9
Fry-McKibbin, Wang	2014	gdp growth rate; unemployment rate	52	1.02725	2.484725	-2.249	8.993
Huang, Yeh	2014	unemployment rate	42	-0.1784762	1.900354	-5.8	3.4
Petreski	2014	gdp growth rate	13	-0.0426923	0.0404359	-0.171	0.002
Mazumder	2014	sacrifice ratio	24	0.575	0.8281619	-0.62	3.67
Daboussi$_b$	2014	gdp growth rate	10	-2.649	2.059479	-6.09	-0.06
Fouejieu	2014	financial instability	31	0.0763323	0.0162321	0.0555	0.135
Ayres, Belasen, Kutan	2014	gdp growth rate	75	-0.0028133	0.0772241	-0.46	0.111
Andersen, Moller, nordvig	2015	gdp growth rate	38	0.0162421	0.0074806	-0.0002	0.0348
Chong, Wong	2015	gdp growth rate	22	0.8408182	0.4042554	0.208	2.177
Kumo	2015	gdp growth rate	1	1.367311	.	1.367311	1.367311
		Total Group 2	2085				
Group 3: *Fiscal Performance and Credibility*	Miles	2007	government consumption; government revenue; overall budget surplus; taxes; total expenditures	20	-3.4107	3.809039	-9.42	2.33
	Lucotte	2012	level of public revenue	210	4.32	1.139303	1.05	7.4
	Minea, Tapsoba, Villieu	2012	institutional quality	228	0.3363851	0.1150669	0.0335	0.601
	Abo-Zaid, Tuzemen	2012	fiscal deficit; fiscal deficit volatility	4	0.59625	1.912895	-0.695	3.422
	Combes, Minea, Tapsoba	2012	primary fiscal balance; overall fiscal balance	7	2.368	0.3988713	1.996	3.005

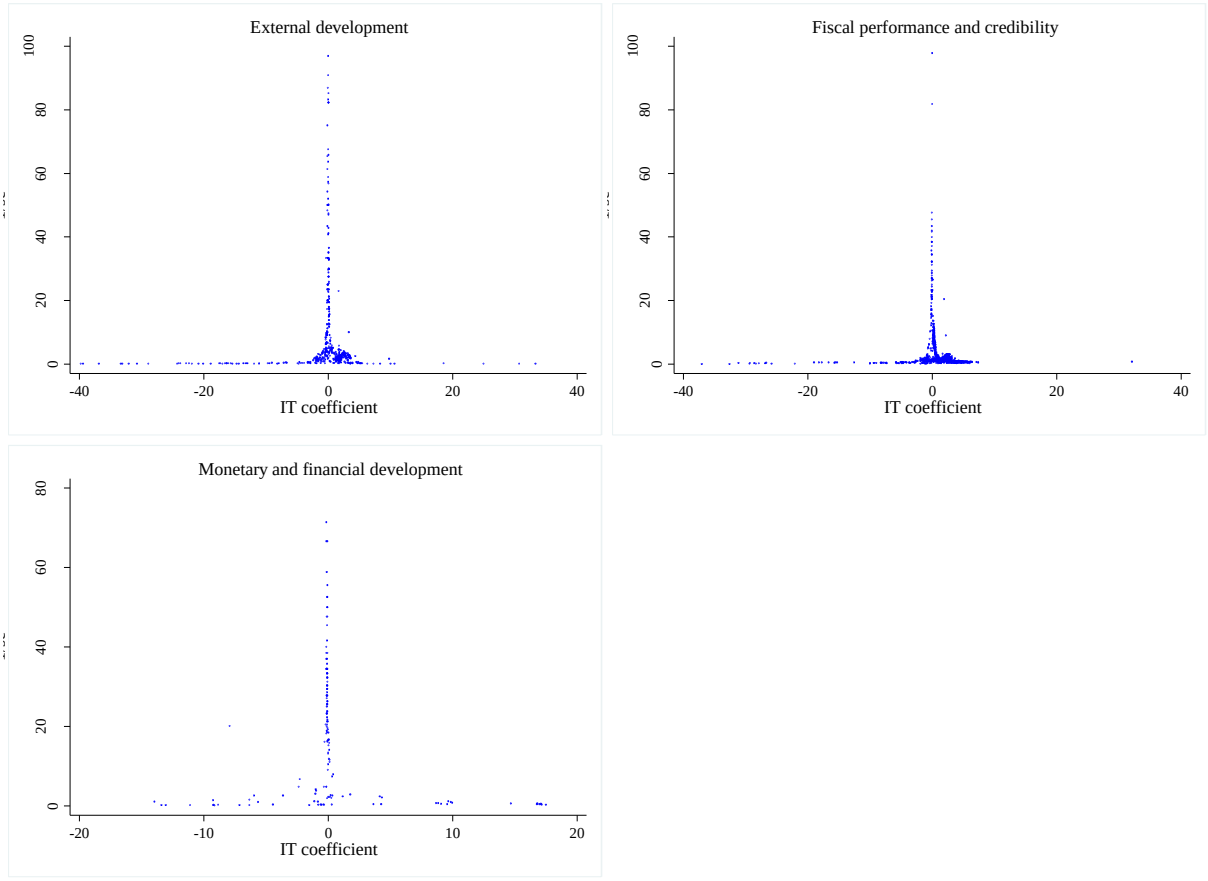
	Fouejieu, Roger	2013	sovereign bond yield spreads	17	-0.0113378	0.0163908	-0.0501	0.00804
	Lanzafame, nogueira	2013	long term nominal government interest rate	32	-0.7035625	0.2689322	-1.156	0.124
	Kadria, Aissa	2014	budget deficit	30	-1.5802	0.6202437	-2.983	-0.364
	Minea, Tapsoba	2014	cyclically-adjusted overall fiscal balance; cyclically-adjusted primary fiscal balance; overall fiscal balance; relative change in the debt-to-gdp	270	0.42409	0.6086787	-1.206	1.823
	Rose	2014	bond yields; change in budget; government budget	21	-0.6838095	2.511481	-10	1.2
	Fry-McKibbin, Wang	2014	government revenue to gdp; debt to gdp	52	-2.907327	15.8552	-29.362	55.709
	Ardakani, Kishor, Song	2014	government debt-gdp ratio	12	-20.55775	6.481907	-31.186	-12.57
	Balima, Combes, Minea	2015	sovereign bond yield spreads; sovereign bond yield spreads variability; sovereign rating	791	-109.1886	131.937	-644.42	4.715
	Kadria, Aissa	2015	primary budget deficit	6	-1.615	1.062101	-3.674	-0.789
			Total Group 3	1700				
	Kuttner, Posen	2001	volatility of nominal effective exchange rate	13	-4.053846	5.856992	-16.6	0.4
	Edwards	2006	volatility of nominal effective exchange rate	8	0.0000315	0.0008672	-0.001	0.002
	Batini, Laxtone	2006	reserves volatility; volatility of nominal effective exchange rate; exchange market pressure index	29	-8.614321	7.561725		
	Rose	2007	volatility of nominal effective exchange rate; volatility of real effective exchange rate	70	-0.0798714	0.1029763	-0.4	0.02
	Lin	2010	current account to gdp ratio; reserves to m2 ratio; reserves in months of imports; real exchange rate variability; nominal exchange rate variability	105	-1.286434	3.620987	-17.5393	1.3571
	Prasertnukul, Kim, Kakinaka	2010	volatility of nominal effective exchange rate	4	-0.0025562	0.0034155	-0.00754	-0.000236
Group 4: *External Development*	Tapsoba	2012	Foreign direct investment	240	2.177079	0.7001757	0.944	4.365
	Chu, Sek	2012	volatility of nominal effective exchange rate	14	4.938549	18.0111	-0.40381	67.50007
	Berganza, Broto	2012	exchange rate volatility	108	0.0187963	0.2830003	-0.94	1.02
	Lamouchi	2013	volatility of real effective exchange rate	3	0.0263333	0.0131592	0.0129	0.0392
	Daboussi	2014	exchange rate volatility	4	-1.46075	0.3289411	-1.86	-1.13
	Rose	2014	change in real effective exchange rate; Chinn-Ito capital mobility; current account; export growth; financial freedom change; gross capital inflows; gross capital inflows variability; gross capital outflows; gross capital outflows variability; import growth; international reserve growth; investment freedom change; net capital inflows	91	-0.1598242	14.45214	-131	25

	Fry-McKibbin, Wang	2014	current account	26	-16.22427	36.43104	-54.871	116.437
	Poon, Lee	2014	exchange rate volatility	2	-0.03585	0.0119501	-0.0443	-0.0274
	Ardakani, Kishor, Song	2014	exchange rate volatility	12	0.1245	1.728398	-1.817	2.274
	Chong, Wong	2015	volatility of nominal effective exchange rate	4	0.17275	0.2494051	-0.187	0.372
			Total Group 4	733				
Group 5: *Monetary and Financial Development*	Lin, Ye	2007	velocity variability	14	0.0434143	0.0468002	-0.0382	0.1124
	Huang, Yeh	2011	commercial central bank; liquid liabilities	42	1.930883	9.276633	-13.4322	17.5064
	Garcia-Solanes, Torrejon-Flores	2012	interest rate of bank deposits; interest rate of bank deposits variability	10	-5.079	4.156629	-13.97	-0.3
	Lin, Ye	2013	financial dollarization	87	-0.0828621	0.0346011	-0.197	-0.009
	Rose	2014	m2 growth-to-gdp	7	-0.0071429	0.0048795	-0.01	0
	Hale, Jones, Spiegel	2014	probability of home currency insurance; probability of increase in the ratio of home currency issuance	11	0.4510909	1.945848	-1.128	4.305
			Total Group 5	171				

Appendix 2. Variables used in the Meta-Regressions

Variable	Description
Dependent variable	
t-statistic	The t-statistic of the estimated effect of IT
|t-statistic|	The t-statistic of the estimated effect of IT in absolute terms
Stability of price and output	1 if favorable effect on group 1 at 10%, 0 otherwise.
State of the real economy	1 if unfavorable effect on group 2 at 10%, 0 otherwise.
Fiscal performance and credibility	1 if favorable effect on group 3 at 10%, 0 otherwise.
External development	1 if favorable effect on group 4 at 10%, 0 otherwise.
Monetary and financial development	1 if favorable effect on group 5 at 10%, 0 otherwise.
Genuine effect	
1/se	The precision of the estimated effect of IT.
Sample characteristics	
Developing	1 if developing countries, 0 otherwise.
Mixed	1 if developed and developing countries, 0 otherwise.
Estimation characteristics	
PSM	1 if PSM estimator, 0 otherwise.
GMM	1 if GMM estimator, 0 otherwise.
DD	1 if Difference-in-Differences estimator, 0 otherwise.
IV	1 if IV estimator, 0 otherwise.
Control variables characteristics	
Government debt	1 if government debt variable, 0 otherwise.
Fiscal balance	1 if fiscal balance variable, 0 otherwise.
Trade openness	1 if trade variable, 0 otherwise.
Exchange rate regime	1 if exchange rate regime variable, 0 otherwise.
Central bank autonomy	1 if central bank autonomy variable, 0 otherwise.
Financial development	1 if financial development variable, 0 otherwise.
GDP per capita	1 if GDP per capita variable, 0 otherwise.
Investment	1 if investment variable, 0 otherwise.
Government consumption	1 if government consumption variable, 0 otherwise.
Institution	1 if institution variable, 0 otherwise.
Financial openness	1 if financial openness variable, 0 otherwise.
GDP growth/variability	1 if GDP growth or variability variable, 0 otherwise.
Financial reform	1 if financial reform variable, 0 otherwise.
IT characteristics	
Conservative starting date	1 if conservative IT adoption date, 0 otherwise.
Benchmark Policy regime: IT	1 if IT is a benchmark monetary policy regime, 0 otherwise.
Study period characteristics	
Ratio targeters/non-targeters	Number of ITers divided by the number of non-ITers.
Post 1990 – Post 2007	1 if the study covers the period of 1990 to 2007, 0 otherwise.
Publication characteristics	
Journal	1 if published in journal, 0 otherwise.
Impact score	Impact score of a journal.
US-based co-author	1 if at least one us-based co-author, 0 otherwise.

Appendix 3. Funnel graphs



Notes: We plot the estimated coefficient of IT on the corresponding outcome variable on the horizontal scale, and the precision of the estimate (1/standard error) on the vertical axis.

Appendix 4. Publication Bias Test

	[1]	[2]	[3]
	External development	**Fiscal performance and credibility**	**Monetary and financial developments**
1/(standard error)	6.13e-10	0.011*	0.005
	(6.47e-09)	(0.003)	(0.023)
Publication bias			
Constant	2.473***	2.406***	4.207***
	(0.321)	(0.436)	(1.478)
Observations	695	1699	169
Studies	16	14	6

Notes: The Appendix presents results of the test for publication bias for *External development*, *Fiscal performance and credibility*, and *Monetary and financial developments* using the absolute value of the t-statistic of the IT estimate as dependent variable. All estimates are obtained using a mixed-effects multilevel model. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Part 2. Government Bond Markets Risk and Stability

Chapter 2. Sovereign Debt Risk in Emerging Market Economies: Does Inflation Targeting Adoption Make Any Difference?[20]

Abstract:

Based on a sample of 38 emerging economies, we find that inflation targeting (IT) adoption improves sovereign debt risk. Next, we show that this favorable effect is sensitive to several structural characteristics, and to the considered time span. Finally, the measure of sovereign risk (sovereign debt ratings or government bond yield spreads), and the IT form (full-fledged or partial), equally influence the effect of IT adoption on sovereign debt risk. Thus, our paper provides valuable insights regarding IT implementation as a device for improving emerging market economies' access to international financial markets.

Keywords: Inflation targeting; Sovereign debt ratings; Government bond yield spreads; Emerging markets; Propensity scores matching.

JEL codes: E44, E58, H63, F34, G15.

[20] A version of this paper is published in the *Journal of International Money and Finance* under the reference Balima, W.H., Combes, J-L., Minea, A. 2017. Sovereign Debt Risk in Emerging Market Economies: Does Inflation Targeting Adoption Make Any Difference? *Journal of International Money and Finance*, 70, 360-377.

In their quest to cement their victory over the scourge of inflation [...], central banks realized they need help [...], especially in the 1990s. Central banks heavily got into the business of influencing expectations and the deployment of other people's money. [...] Monetary policy steers the economy through its effect on sentiment as much as any financial channel such as interest rates.

— Mohamed A. El-Erian, *The Only Game In Town* (2016, p.18-19)

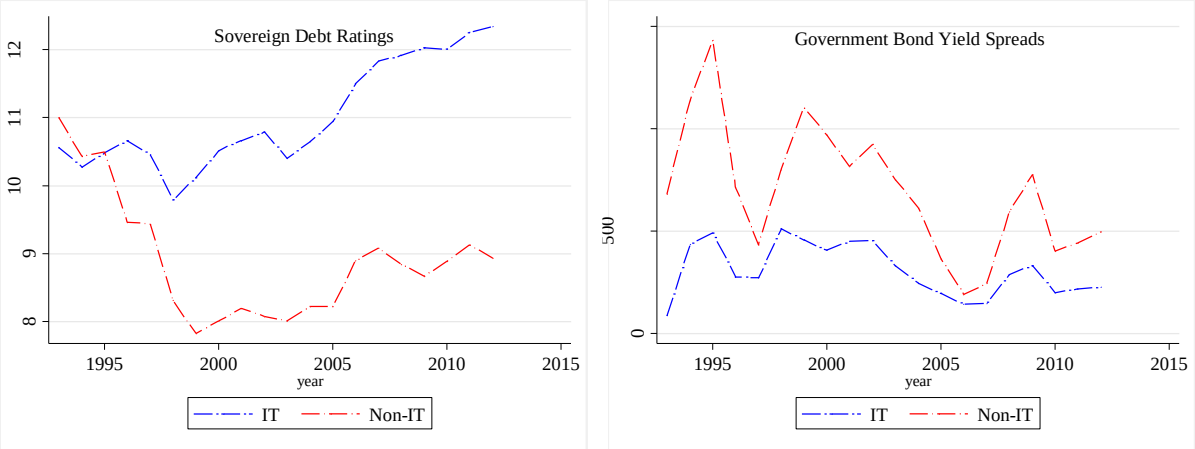
I. Introduction

The recent crisis engendered major macroeconomic imbalances, such as large unemployment, low economic growth, rapid expansion of government debts, and fiscal and current account deficits. This resulted in a worsening of access conditions to financial markets, and particularly in a sizeable increase of sovereign debt risk. According to Csonto & Ivaschenko (2013), the government borrowing cost of emerging markets, measured by the JP Morgan Emerging Market Bond Index, quadrupled from 200 (beginning of 2007) to more than 800 basis points (end of 2009). Consequently, the debate on the determinants of sovereign risk is currently into the spotlight.

An important literature focuses on the determinants of sovereign risk, especially in emerging countries. Risk is generally measured by (i) government debt ratings from notation agencies, (ii) yield spreads with respect to a country's sovereign bonds assumed as risk-free, or (iii) Credit Default Swaps (CDS) spreads. In one of the first contribution using measure (i), Cantor & Packer (1996) employ Moody's and Standard and Poor's ratings for 49 countries, and find that higher ratings are due to higher income per capita, rapid GDP growth, low inflation, low external debt, high economic development, and absence of default history. Capitalizing on these findings, subsequent studies unveiled additional determinants of ratings, such as exchange reserves or the current account balance (Afonso et al., 2011; Ratha et al., 2011), the fiscal balance, trade openness or institutions (Bario & Packer, 2004), the political business cycle (Block & Vaaler, 2004), or fiscal transparency (Hameed, 2005). Moreover, the major determinants of (ii) are domestic macroeconomic fundamentals (Edwards, 1984; Hilscher & Nosbusch, 2010; Baldacci et al., 2011; Eichler, 2014) and global conditions in financial markets and international factors (Arora & Cerisola, 2001; Sy, 2002), including GDP growth, public debt, exchange reserves, inflation, crisis, or the FED interest rate. Lastly, a recent literature using (iii) attributes high market default risks to weak macroeconomic fundamentals and global market factors (Longstaff et al., 2011; Aizenman et al., 2013).

In this paper, we analyze how notation agencies and bondholders perceive the sovereign risk of inflation targeting (IT) countries, compared to countries under money or exchange rate targeting. Indeed, simple charts in Figure 1 show that (i) IT countries experienced a substantial improvement in their debt ratings after the IT adoption period 1998-2000, and (ii) following this period, government bond yield spreads seem more stable in IT compared to non-IT countries. Building on this intuition, we develop a more formal analysis based on a recently-popular method used for macroeconomic policy evaluations,[21] namely the propensity score matching (PSM), in a sample of 38 emerging countries over 1993-2012.

Fig. 1. Evolution of Sovereign Debt Ratings and Bond Yield Spreads: IT vs Non-IT countries



We find that IT adoption significantly increases sovereign debt ratings and decreases government bond yield spreads in emerging countries. The magnitude of this favorable effect is economically meaningful, namely around 2 rating grades, and around 2-3 pp for spreads. Consequently, IT adoption can move emerging countries to investment grade status that can considerably increase and diversify their investors' portfolio. The strength of these baseline results is supported by post-estimation tests, and still holds when accounting for unobserved heterogeneity, altering the sample, controlling for additional covariates, or when using system-GMM estimates.

Moreover, we unveil interesting heterogeneities in the effect of IT adoption on sovereign debt risk. First, we find that, sometimes, full-fledged IT outperform partial IT in

[21] Indeed, Figure 1 only provides an unconditional comparison of ITers and non-ITers. Besides, previous work (see the next section) found that ITers outperform non-ITers in terms of several macroeconomic goals, and this seems also to be the case in our sample in terms of monetary (inflation) and fiscal (debt-to-GDP) outcomes, as suggested by Appendix S1 in the Supplementary Material (SM). For this reason, our formal analysis of IT performances in terms of sovereign debt risk will provide results conditional upon controlling for these macroeconomic variables.

reducing sovereign debt risk. Second, we emphasize the importance of structural characteristics, together with the retained measure of sovereign debt risk. Regarding ratings, IT adoption improves them more in the "good" phase of the business cycle, in a context of strong fiscal stance, and exclusively in upper-middle income emerging countries. Regarding spreads, IT adoption has no significant impact in "bad" times, under a loose fiscal stance, and in lower-middle income emerging countries. Third, accounting for dynamics in estimating the impact of IT adoption reveals yet again the importance of the retained measure of sovereign debt risk: (i) adopting IT significantly affects ratings, but not spreads, in the year of adoption; (ii) this positive effect on ratings increases in time and then stabilizes at levels comparable to baseline values; (iii) despite increasing in time, the favorable effect on spreads remains below baseline values.

Our findings suggest that the implementation of an IT monetary framework should be performed with caution. In several cases, IT adoption is not found to significantly reduce sovereign debt risk, irrespective of the way risk is measured (for example, in lower-middle income emerging countries). Next, notation agencies and markets do not identically value IT adoption in terms of risk. Finally, the form of IT is crucial, since only full-fledged IT strongly increase ratings in bad times, or significantly decrease spreads relative to emerging countries with exchange rate targeting.

Section II provides some theoretical considerations and discusses the related literature, Section III details the data and the methodology, Section IV presents the main results, Section V analyzes their robustness, Section VI deals with their sensitivity and Section VII concludes.

II. Theoretical considerations and testable predictions

Several theoretical arguments support the idea that IT countries could be treated differently by notation agencies and financial markets in terms of sovereign debt risk. First, due to the limits it imposes on seigniorage revenues, IT adoption improves fiscal discipline (Minea & Tapsoba, 2014), by reforming the tax system or rationalizing public expenditure (Rose, 2007; Freedman & Ötker-Robe, 2009; Lucotte, 2012).[22] Such efforts constitute significant progress towards achieving compliance with government's intertemporal budget constraint; in turn, better fiscal discipline may increase government's willingness and ability to repay debt and its burden on time. As shown by Heylen et al. (2013), a fiscal consolidation significantly

[22] For example, in Turkey, the reforms of the statutes of the central bank engendered by IT implementation in January 2006 (under the auspices of the IMF and in close coordination with the fiscal authorities), were accompanied by fiscal policy improvements, in the form of the announcement of annual primary surplus targets.

contributes to reducing debt in the long-run. Thus, we should expect a reduction in sovereign debt risk following IT adoption.

Second, monetary policy can have an indirect effect on fiscal efforts through inflation eroding the real value of taxes (the Keynes-Oliveira-Tanzi effect, Tanzi, 1992). Besides, since IT was found to be more effective than other monetary regimes in reducing the level and volatility of inflation (Gonçalves & Salles, 2008; Lin & Ye, 2009, 2012), it could mitigate the Keynes-Oliveira-Tanzi effect, and limit the uncertainty on tax revenues. This may ultimately increase government solvency, thereby reducing sovereign debt risk.

Third, the mere sustainability of IT is crucially related to central bank independence and transparency, which affect the credibility of monetary authorities. Besides, the credibility of fiscal and monetary authorities is a key discriminating factor to access international capital markets, as illustrated by the recent debt crisis in several Eurozone countries. Consequently, IT adoption can send a strong signal for macroeconomic reforms, with positive consequences on government debt risk.

Finally, two additional motives equally support a potential favorable effect of IT adoption on sovereign debt risk. On the one hand, according to the "Fisher effect" (coined by Irving Fisher, 1930), an increase in expected inflation erodes the real value of the return on government bonds, thus decreasing (increasing) the demand (supply) for bonds, and further increasing interest rates on bonds. Through involving low inflation rates, IT adoption cools down inflation expectations, and therefore reduces bonds yields. On the other hand, according to the theory of purchasing power parity (PPP), a rise in inflation, generating the depreciation of the domestic currency, negatively affects investors' expectations about a country's ability to repay its public foreign-currency debt, and thus can increase bond yield spreads. Given its performances in reducing inflation, IT adoption could affect notation agencies and investors' views on sovereign debt risk.

Despite a large literature evaluating the effects of IT on several macroeconomic variables,[23] no study has yet estimated the effect of IT adoption on sovereign debt risk, with the notable exception of Fouejieu & Roger (2013). Using a sample of 40 emerging and high-income countries over 1989-2010, the authors find that IT adoption reduces sovereign risk premium, through both the announcement effect, and the observed track record in stabilizing inflation. Capitalizing on this work, our study contributes to the literature on the determinants of sovereign debt risk on several grounds.

[23] For example, many studies, including Rose (2007), Lin & Ye (2007, 2009, 2012, 2013), Gonçalves & Salles (2008), Lin (2010), defend the merits of IT adoption for a wide range of monetary or real goals. Nevertheless, other studies emphasize negative (Brito & Bystedt, 2010) or inconclusive (Ball, 2010) effects of IT adoption.

First, in addition to government bond yield spreads, we use a second measure of sovereign debt risk, namely government debt ratings from notation agencies.[24] This allows distinguishing among sovereign debt risk from the perspective of notation agencies and investors, respectively. Indeed, while bond yield plays an important role in determining the cost of capital, debt ratings play a central role in determining both the cost of capital and the access to capital markets. Moreover, the direction of causality between ratings and spreads is subject to debate.[25] Finally, differences in the perception of risk by credit agencies and markets are supported by a simple illustrative comparison. Despite sharing the same rating grade in 2011-12 ("BBB", according to S&P), Brazil and Bulgaria displayed significantly different spreads during the same period. Therefore, it is vital to go beyond a unique measure of sovereign debt risk, in order to appropriately assess the consequences of IT adoption.

Second, IT adoption is subject to a self-selection bias. Following the literature on the effects of IT adoption, we consider IT as a natural experiment and draw upon recently-used propensity score matching (PSM) methods. In particular, PSM have the merit of properly identifying the control group through a list of well-identified observed variables.

Third, compared to Foujieu & Roger (2013), we made the choice of focusing our analysis exclusively on emerging countries, for the following reasons. Emerging countries are particularly concerned with the issue of sovereign debt risk, because of the large amount of capitals they must raise to further finance their economic development, and also given the large and rapidly expanding size of sovereign debt markets. Next, emerging markets generally display a large variation in the risk of sovereign insolvency, and are among the high-yield borrowers in the world, so the question of the drivers of sovereign risk is a crucial policy issue. Furthermore, since previous studies notably emphasized different effects of IT adoption in developing and developed countries (for example, in terms of fiscal discipline, see Minea & Tapsoba, 2014), it is more appropriate to perform estimations on the more homogenous sample of emerging countries. Lastly, we significantly enlarge the sample of emerging countries, from 18 in Foujieu & Roger (2013) to 38; more than doubling the number of countries is particular important for the robustness of our results, given the use of PSM.

Finally, we analyze the effect of IT adoption on spreads variability, and we extensively discuss potential heterogeneities in the effect of IT adoption on both measures of sovereign

[24] We abstract of CDS as a third measure of sovereign debt risk only because the largest majority of countries in our sample adopted IT previous to the publication of CDS data (for example, Bloomberg or Reuters report CDS starting only 2004).

[25] Contrary to Sy (2002), who finds that changes in ratings significantly impact spreads, Gonzalez-Rozada & Yeyati (2008) conclude that changes in ratings respond to, rather than influence, spreads. Other studies highlight that ratings have little market impact or fail to predict crisis episodes (Reinhart, 2002; IMF, 2010).

debt risk and considering both full-fledged and partial IT, conditional upon several key structural characteristics, and with respect to the time span.

III. Data and methodology

3.1. Data

We use an annual panel covering the period 1993-2012. Countries are exclusively selected based on the availability of government bond yield data, and are those composing the J.P. Morgan Emerging Markets Bond Index (EMBI) Global from Bloomberg. This dataset provides government bond yield spreads for 41 emerging economies until 2012. We dropped three countries because of missing data (Iraq, Serbia and Trinidad & Tobago), leading to a final sample of 38 emerging countries. For consistency, we stick to this same sample when constructing data for sovereign debt ratings.

Let us present our main variables. Regarding the treatment variable, we define inflation targeting (IT) as a dummy equal to 1 if country *i* at period *t* is under an IT regime, and to 0 otherwise. We compile data on IT using several sources (Batini et al., 2006; Rose, 2007; Roger, 2009; Warburton & Davies, 2012). Based on Rose (2007), we consider conservative starting dates or full-fledged IT. Out of the 38 emerging economies in our sample, 12 adopted IT by the end of 2012 (Appendices S2-3 display the list of IT countries and their starting dates, and the group of control countries, and Appendices S4-5 present descriptive statistics and sources and definitions of data).

Regarding the dependent variable, we measure sovereign debt risk in two ways. On the one hand, we use the yield spread between each emerging country and US sovereign bonds. As previously emphasized, data on spreads (in basis points) come from the J.P. Morgan EMBI, which includes Brady bonds, loans, and Eurozone bonds issued by sovereign countries with a minimum size of 500 millions USD and 12-years average maturity.

On the other hand, we employ long-term foreign-currency government debt ratings provided by notation agencies. Sovereign ratings capture the willingness and the ability of a government to repay its debt at the due date. Since they provide insights on the estimated probability of default, ratings are a decision support tool for investors. The international credit market rating is dominated by three main agencies, namely, Moody's, Standard & Poor's (S&P), and Fitch; the former two share 80% of the market, whereas Fitch covers around 15%. Agency grades range from AAA (highest credit quality) to C or D (highest vulnerability or default). Following Sy (2002), we use a linear transformation to convert ratings into a discrete variable, ranging from 0 to 20. For an aggregate representation of sovereign risks, we use

data from all three agencies to compute an arithmetic average rating per country, keeping in mind the following two issues. First, as in Chen et al. (2013), if a country experienced several rating changes during the same year, we consider only the first of them, to reduce potential problems due to overlapping data. Second, if no rating is provided for a country between two rating dates, we assume that this country did not experience a rating change, so we just consider the latest rating. Data on ratings are collected from the three notation agencies' websites, and Appendix S6 details the numerical transformation.

3.2. Methodology

We draw upon a variety of propensity score matching (PSM) to evaluate the impact of IT adoption on sovereign debt risk, compared to countries that did not adopt IT. Since several contributions already discuss in detail this methodology with respect to IT adoption (see, e.g. Lin & Ye, 2007), we only sketch here its main functioning.

The main idea is to estimate the average treatment effect on the treated (ATT), defined as the mean of the difference in sovereign debt risk for all IT countries in two scenarios: first, they adopted IT; second, they did not adopt IT. Of course, we cannot observe sovereign debt risk for IT countries should they have not adopted IT. Thus, we could compare risk in IT countries (the treated group) and in non-IT countries (the control group). However, this is not a viable strategy, since IT adoption is not a random decision, but depending on several observable variables. Following Rosenbaum & Rubin (1983), a convenient solution is to compare IT and non-IT countries based on propensity scores (PS), which summarize the probability to adopt IT based on a vector of observable variables. Under the conditional independence assumption (i.e. conditional to the vector of observable variables, IT adoption is independent of unobservables), differences in sovereign debt risk between IT and non-IT countries with "fairly close" PS are considered to be due to IT adoption (the treatment).[26]

Finally, several varieties of defining "fairly close" PS, i.e. of performing the PSM, appear in the literature (Caliendo & Kopeinig, 2008). First, under the N-nearest-neighbor matching, each IT is matched with non-IT with close PS. Following Lin & Ye (2007), we consider the nearest (N=1), the two-nearest (N=2), and the three-nearest neighbors (N=3). Second, we draw upon the radius method of Dehejia & Wahba (2002), which matches each treated with untreated located at some distance. Following the related literature, we use the PS to define a small (r=0.005), a medium (r=0.01), and a wide (r=0.05) radius. Third, we use the kernel matching coined by Heckman et al. (1998), which matches each treated with the

[26] According to the common support condition, there exist, for each IT country, some non-IT countries with fairly close PS, providing appropriate counterfactual.

distribution of untreated in the common support, with weights inversely proportional to the gap with respect to the PS of each treated (following the previous literature, we use an Epanechnikov kernel). Fourth, we employ the local linear matching, which is similar to the kernel matching but includes a linear term in the weighting function. Finally, similar to Minea & Tapsoba (2014), we perform the matching using a stratification method. Based on Cochran & Chambers (1965), we compute the ATT as the weighted (by the share of treated observations) mean of the estimated treatment effect from several equal strata, such as there are no statistical differences between PS of IT compared to non-IT countries.

IV. Results

This section presents the results of the effect of IT adoption on sovereign debt ratings and government bond yield spreads, respectively.[27]

4.1. Baseline results

We estimate PS using a probit model with IT adoption as the dependent variable. Following, e.g. Lin & Ye (2007), we consider two groups of control variables.[28] First, those highlighted by the literature as IT adoption preconditions, namely, lag inflation, lag public debt, lag public deficit, real GDP growth, and law & order. The former three variables are expected to be negatively correlated with IT; indeed, IT adoption is more likely after a successful period of disinflation, while high public debt or deficit can be a signal of fiscal dominance, thereby hindering IT adoption. Regarding the latter two variables, we equally expect a negative effect of real GDP growth and of law & order, as strong growth and institutional performances can be interpreted as the result of sound macroeconomic policies that do not require adopting alternative policies, such as IT.

The second group of variables captures the likelihood of adopting alternative monetary regimes, such as monetary or exchange rate (ER) targeting. We account for a dummy variable of fixed ER regime, and for the trade openness-to-GDP ratio. Since a flexible ER regime is considered as an initial condition for IT, a fixed ER and IT should be incompatible (Brenner & Sokoler, 2010). Besides, since emerging countries are relatively open to trade, they tend to adopt ER targeting, due, for example, to the "fear of floating" (Calvo & Reinhart, 2002).

[27] Prior to estimation, unit root tests (Pesaran, 2007) revealed the absence of a unit root for all variables, except for three control variables, for which we use the first-difference (results are available upon request).
[28] Most of these variables were also identified as determinants of sovereign risk by the existing literature, as discussed in introduction.

4.1.1. Inflation targeting and sovereign debt ratings

Appendix S7A presents the results of the estimation of PS using conservative IT starting dates. Let us focus on our baseline regression [1]. All parameters present the expected sign and, except for trade openness, are significant: lag inflation, lag public debt, lag deficit, lag real GDP growth, and the fixed ER dummy negatively affect IT adoption. The explanatory power of our model is fairly important, as emphasized by McFadden's pseudo R2.

Based on PS estimated from baseline regression [1], we define the common support ensuring that treated and control groups are comparable based on the "Min-Max" method.[29] The ATT of IT adoption on sovereign debt ratings is presented in Table 1A, along with standard errors based on bootstrap resampling with 500 replications. As illustrated by line [1], ATT are positive and statistically significant, irrespective of the matching method.[30] The estimated ATT varies between 2.216 (for radius matching, r=0.01) and 2.679 (for stratification matching), and is economically meaningful. Indeed, the average rating in no-IT emerging countries equals approximately 9, which is equivalent to Ba2, BB, and BB for Moody's, S&P, and Fitch rating symbols, respectively (see Appendix S6). Since this value roughly corresponds to the break-point between speculative and investment grades, IT adoption, through its favorable effect on sovereign debt ratings, shifts IT countries to investment grade status that can considerably increase and diversify their investors' portfolio.

4.1.2. Inflation targeting and government bond yield spreads

We now evaluate the effect of IT adoption on government bond yield spreads. According to Reinhart (2002), ratings play a crucial role in determining, in addition to rated countries' access to international capital markets, the terms of this access. Thus, since IT adoption was found to affect ratings, it may also influence spreads.

Analogous to our previous analysis, we first estimate PS. In addition to the covariates used for computing PS for ratings, we augment our baseline regression [1] in Appendix S7B with two additional variables, namely total exchange reserves and a dummy variable for sovereign debt crisis. As illustrated by regression [1], large exchange reserves positively affect IT adoption, contrary to the negative impact of sovereign debt crisis. Overall, McFadden's R2 show that our baseline model provides a reasonably good fitting.

[29] This method matches all treated and untreated observations except those untreated (treated) estimated PS that are less (more) than the minimum (maximum) estimated PS for treated (untreated) observations.

[30] In addition, following Abadie & Imbens (2008) criticism about the use of bootstrap without theoretical foundation, we computed standard deviations based on Abadie et al. (2004). For example, for the nearest neighbor matching method, ATTs (and their standard-errors) for N equal to one, two, and three, are, respectively: 2.651 (0.195), 2.324 (0.196), and 2.386 (0.221), consistent with our baseline results.

Based on these PS, we report in Table 1B the estimated ATT of IT adoption on government bond yield spreads. Baseline estimations in line [1] show that ATTs are negative and statistically significant;[31] thus, IT adoption is found to reduce risk premia on government debt in emerging countries. The size of this effect ranges from 226.54 (for stratification matching) to 454.45 (for a low radius, r=0.005) basis points, and is economically meaningful: IT emerging countries present lower government bond yield spreads between 2 and up to 4.5 pp on average, compared to countries under monetary or ER targeting.

4.2. Common support assumption

The literature suggests different methods for assessing the performance of estimated PS as balanced scores. Following, among others, Balima et al. (2016), we draw upon Sianesi (2004) and re-estimate PS on matched units using a probit model. For each estimated ATT, we report a pseudo-R2, defined as the difference between the pseudo-R2 for the matched and for the unmatched samples. A small pseudo-R2 signals that PS can be used as balanced scores. Since Tables 1A-B reveal pseudo-R2 fairly close to 0, our matching led to balanced scores for estimating the treatment effect of IT adoption on both debt ratings and bond yield spreads.

[31] In addition, ATT (and their standard errors) for the nearest neighbor matching method, using Abadie et al. (2004) to compute standard deviations, are consistent with baseline estimations, namely -223.69 (23.11), -204.30 (32.17), and -192.69 (29.96), for N equal to one, two, and three, respectively.

Table 1A. ATT of IT adoption (conservative IT starting dates) on Sovereign Debt Ratings

Dependent variable: Sovereign Debt Ratings		Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
		N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline results										
[1] **ATT**		**2.459****	**2.269****	**2.257****	**2.367*****	**2.216*****	**2.339*****	**2.410*****	**2.327*****	**2.679*****
		(0.560)	(0.532)	(0.453)	(0.519)	(0.458)	(0.363)	(0.354)	(0.334)	(0.558)
Treated/Untreated/Total Observations		147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/330/477
The common support assumption										
Pseudo-R2		0.047	0.008	0.011	0.007	0.010	0.013	0.015	0.013	0.004
Unobserved heterogeneity										
MH bounds	p-value=0.05	2.45	1.85	2.1	2	2	1.95	2.15	1.95	2.6
	p-value=0.10	2.5	1.9	2.1	2	2	2	2.2	2	2.7
Logit estimations with fixed effects										
[1A] Logit PSM: Baseline results		2.370***	2.275***	2.291***	1.990***	2.273***	2.415***	2.480***	2.442***	2.369***
		(0.568)	(0.522)	(0.482)	(0.541)	(0.469)	(0.365)	(0.336)	(0.371)	(0.439)
[1B] Logit PSM with country fixed effects		2.494***	2.126***	2.351***	2.493***	2.420***	2.388***	2.463***	2.376***	2.335***
		(0.567)	(0.493)	(0.476)	(0.535)	(0.430)	(0.372)	(0.357)	(0.349)	(0.432)
[1C] Logit PSM with country and time fixed effects		2.261***	2.639***	2.309***	2.305***	2.487***	2.489***	2.593***	2.491***	3.013***
		(0.660)	(0.565)	(0.527)	(0.566)	(0.494)	(0.429)	(0.495)	(0.482)	(0.423)

Note for All Tables: Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 1B. ATT of IT adoption (IT conservative starting dates) on Government Bond Yield Spreads

Dependent variable: GBY Spreads		N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
		N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result										
[1] **ATT**		**-380.29****	**-315.53****	**-274.75****	**-454.45*****	**-345.10*****	**-235.09***	**-271.24*****	**-244.61****	**-226.54*****
		(172.78)	(161.84)	(140.14)	(138.18)	(126.72)	(125.54)	(106.99)	(111.98)	(52.05)
Treated/Untreated/Total Observations		140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/255/395
The common support assumption										
Pseudo-R2		0.136	0.103	0.065	0.033	0.034	0.048	0.136	0.050	0.047
Unobserved heterogeneity										
MH bounds	p-value=0.05	2.7	2.85	2.35	3.85	3.35	3.25	3.7	3.25	3.55
	p-value=0.10	2.8	2.9	2.4	3.9	3.4	3.3	3.8	3.3	3.6
Logit estimations with fixed effects										
[1A] Logit PSM: Baseline results		-256.28***	-240.92***	-208.15***	-283.25***	-231.16***	-186.90***	-231.14***	-194.32***	-207.77**
		(93.72)	(95.67)	(79.15)	(64.41)	(71.21)	(70.26)	(75.23)	(68.87)	(102.36)
[1B] Logit PSM with country fixed effects		-201.62**	-160.94**	-162.14**	-170.84**	-151.11**	-155.15**	-190.71**	-161.26**	-185.23**
		(100.60)	(79.05)	(80.80)	(73.89)	(69.47)	(74.67)	(87.33)	(84.11)	(94.40)
[1C] Logit PSM with country and time fixed effects		-223.99***	-183.72***	-179.69***	-163.11**	-171.90**	-134.90***	-188.01**	-165.04***	-171.67***
		(80.05)	(74.19)	(72.34)	(84.96)	(74.24)	(43.03)	(97.88)	(50.55)	(30.15)

4.3. Unobserved heterogeneity

The validity of matching estimations is related to the potential influence of non-observables. Thus, we implement the test of Mantel & Hsenszel (MH, 1959),[32] which measures the magnitude of the bias generated by non-observables that could lead to a non-significant effect of IT adoption. We report the statistic for the upper bound under the assumption that the treatment effect has been overestimated. Based on the results of the test, together with 5 and 10% bounds, our findings may be questioned around an odds ratio between 1.85-2.7 for ratings (Table 1A), and between 2.35-3.9 for spreads (Table 1B). In other words, the estimated effect of IT adoption on ratings and spreads is robust provided that unobservables do not change the odds ratio between treated and control units by more than a factor around 2.5. In light of other studies (for example, the numbers are between 1.25-3 in Caliendo & Künn, 2011, and between 1.8-2.3 in Balima et al., 2016), our findings seem fairly vigorous with respect to the conditional independence assumption.

Capitalizing on the MH test, we further explore unobserved heterogeneity. To this end, we substitute the probit model from baseline estimations with a logit specification, which has the advantage of allowing controlling for unobserved heterogeneity through fixed effects. Lines [1A] in Tables 1A-B show that using a logit to compute PS leaves estimated ATT qualitatively unaffected.[33] Moreover, accounting for unobserved heterogeneity through country- (lines [1B]) and both country- and time-fixed effects (lines [1C]) leads to significant ATT that present the expected sign. Thus, except for some magnitude loss for spreads, results remain robust when tackling unobserved heterogeneity through fixed effects.

[32] The implementation of this test requires a binary outcome variable. Thus, we transform outcome variables to dichotomous variables, equal to 1 for a rating upgrade or a decrease in spreads for a given country between two periods, and to 0 otherwise. In addition, we re-estimate in each case the ATT with binary outcome variables (results are consistent with previous findings).

[33] The estimations of the logit equations used to compute PS are available upon request.

V. Robustness

Our main results show that IT adoption has a favorable effect on both sovereign debt ratings and government bond yield spreads in the emerging economies in our sample. In the following, we investigate the robustness of these findings.

5.1. Altering the sample

We alter our sample as follows. First, "dollarized" countries lose the control of their monetary policy, so we exclude them. Second, our results might be influenced by hyperinflation episodes; hence we drop inflation observations above 40%. Third, we abstract from major oil exporters.[34] Finally, we exclude the saving glut sample periods.[35] Based on PS computed in Appendices S7A-B, we report in Tables 2A-B ATT of IT adoption on sovereign debt ratings and government bond yield spreads, respectively. Regarding ratings, Table 2A shows that estimated ATT remain significant and of comparable magnitude with results for the baseline model [1]. In particular, excluding the saving glut period only decreases the size of the effect (which is still around 2 on average), but does not alter its significance. Regarding spreads, despite some significance loss when excluding dollarized economies (the ATT is significant in six out of nine cases, see Table 2B), the effect of IT adoption remains consistent with our baseline estimations. In particular, even if excluding the saving glut reduces the magnitude of the effect, IT adoption is still found to reduce spreads by at least 1pp.

5.2. Additional controls

We augment the baseline specification with additional groups of controls. These covariates were selected such as to cover different macroeconomic dimensions, namely: *Real Economy* state (real GDP per capita, unemployment, and the current account balance), *Monetary Conditions* (M2 to GDP ratio, and central bank independence), *Fiscal Conditions* (external debt, and the presence of a fiscal rule), *Macroeconomic Instability* (inflation variability, REER volatility, and crisis contagion[36]), and *Institutions* (government stability, corruption, and a dummy if a country has lending arrangements with the IMF). Results for the computation of

[34] We excluded OPEC and top 15 world oil net exporters from 2012 U.S. Energy Information Administration classification.

[35] The saving glut corresponds to the time leading to the global financial crisis, namely the period 2000-2006. We thank an anonymous Referee for suggesting this robustness check.

[36] Following Foujieu & Roger (2013), we divided our sample in regions using World Bank's classification. Then, we built a dummy variable for sovereign crisis contagion, equal to 1 for country i at period t if at least one of the countries in the same region faces a sovereign debt crisis, and to 0 otherwise.

PS and ATT are presented in Appendices S8A-B and S8C-D, respectively. According to Appendix S8C, IT adoption significantly improves ratings by around two rating grades in most specifications.[37] According to Appendix S8D, IT adoption significantly reduces spreads by roughly 2-3 pp. Consequently, accounting for these additional covariates leads to results consistent with those in the baseline specification.

5.3. Default IT starting dates

To test the sensitivity of our results to IT beginning dates, we follow Rose (2007) and Roger (2009) and distinguish between conservative starting dates or full-fledged IT, and default starting dates or partial IT.[38] Appendices S9A-B, S10A-B, and S11A-B report estimations for the computation of PS and the ATT, for ratings and spreads, respectively. Estimations point to the following. First, regarding ratings, considering default IT starting dates does not alter the significance and size of the effect of IT adoption. This holds for the baseline estimation, when altering the sample, or when adding covariates. Second, results are more mitigated for spreads. Indeed, some ATT are not significant in the baseline estimation, and the magnitude of significant ATT is lower. Such differences with respect to conservative dates are equally at work when excluding the saving glut period. Thus, if IT adoption fosters ratings and cuts spreads, we unveil that full-fledged IT sometime outperform partial IT regarding spreads: markets seem to be more sensitive than notation agencies when it comes to value the intrinsic degree of reforms related to IT adoption in terms of sovereign debt risk in emerging countries.

5.4. Using pretreatment characteristics

To select our counterfactual non-IT based on observable pretreatment characteristics, we employ all covariates as first-lagged. According to Appendices S12A-B, IT adoption significantly reduces sovereign debt risk, irrespective of its measure, consistent with baseline results. In addition, comparable results arise when using IT default starting dates, as illustrated by Appendices S13A-B.

[37] Comparable conclusions arise when alternatively converting ratings in numbers, using a linear transformation following Afonso et al. (2011), as illustrated by Appendix S6 (estimated ATT are available upon request).
[38] Contrary to default starting dates, conservative starting dates signal the achievement of the five conditions presented by Mishkin (2000).

Table 2A. Robustness of ATT of IT adoption on Sovereign Debt Ratings (conservative IT starting dates): Altering the sample

Dependent variable: Sovereign Debt Ratings	Nearest Neighbor Matching			Radius Matching			Local Linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**2.459****	**2.269****	**2.257****	**2.367*****	**2.216*****	**2.339*****	**2.410*****	**2.327*****	**2.679*****
	(0.560)	(0.532)	(0.453)	(0.519)	(0.458)	(0.363)	(0.354)	(0.334)	(0.558)
Treated/Untreated/Total Observations	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/330/477
Robustness: Altering the sample									
[2] Excluding dollarized countries	2.065***	2.439***	2.403***	1.921***	2.429***	2.413***	2.457***	2.424***	3.262***
	(0.550)	(0.523)	(0.450)	(0.493)	(0.464)	(0.327)	(0.360)	(0.364)	(0.943)
[3] Excluding hyperinflation episodes	2.459***	2.269***	2.257***	2.365***	2.213***	2.332***	2.402***	2.320***	2.332**
	(0.543)	(0.514)	(0.483)	(0.520)	(0.454)	(0.338)	(0.343)	(0.344)	(1.013)
[4] Excluding top oil net exporting countries	2.345***	2.073***	2.128***	2.171***	2.034***	2.084***	2.165***	2.070***	3.755
	(0.617)	(0.555)	(0.503)	(0.557)	(0.478)	(0.409)	(0.383)	(0.380)	(3.800)
[5] Excluding global saving glut	1.612**	1.688**	1.887***	1.944**	2.142***	2.174***	2.223***	2.129***	2.404***
	(0.766)	(0.674)	(0.654)	(0.859)	(0.638)	(0.545)	(0.568)	(0.562)	(0.536)

Table 2B. Robustness of ATT of IT adoption on Government Bond Yield Spreads (conservative IT starting dates): Altering the sample

Dependent variable: GBY Spreads	N Nearest Neighbor Matching			Radius Matching			Local Linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**-380.29****	**-315.53****	**-274.75****	**-454.45*****	**-345.10*****	**-235.09***	**-271.24*****	**-244.61****	**-226.54*****
	(172.78)	(161.84)	(140.14)	(138.18)	(126.72)	(125.54)	(106.99)	(111.98)	(52.05)
Treated/Untreated/Total Observations	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/255/395
Robustness: Altering the sample									
[2] Excluding dollarized countries	-202.94	-181.87	-254.65**	-177.38*	-184.23	-251.23**	-256.02***	-253.86**	-370.80***
	(143.715)	(155.32)	(127.47)	(109.83)	(125.59)	(112.30)	(108.98)	(116.06)	(105.87)
[3] Excluding hyperinflation episodes	-380.29**	-315.53*	-274.75**	-453.85***	-344.62***	-233.92***	-270.12**	-243.55*	-235.79***
	(176.59)	(177.09)	(137.49)	(119.38)	(134.12)	(99.99)	(118.44)	(134.32)	(21.67)
[4] Excluding top oil net exporting countries	-156.26***	-150.26***	-135.78***	-148.78***	-147.39***	-142.38***	-143.34***	-139.95***	-324.98*
	(56.24)	(53.15)	(50.01)	(63.38)	(52.09)	(45.38)	(42.57)	(48.18)	(195.57)
[5] Excluding global saving glut	-132.31**	-108.43*	-130.10***	-127.61*	-170.64***	-106.70**	-118.29***	-110.19***	-108.71*
	(57.63)	(57.69)	(49.58)	(78.41)	(57.38)	(44.04)	(43.79)	(42.69)	(64.19)

5.5. Alternative estimation methods: evidence from dynamic panel system-GMM

In addition to PSM, we also provide a dynamic perspective on the effect of IT adoption on sovereign debt risk using the dynamic panel system-GMM method. Indeed, while PSM is an appropriate technique to deal with the selection bias in IT adoption, dynamic panel system-GMM has the advantage of properly addressing the persistence of sovereign debt risk over time. In addition to the traditional system-GMM with internal instruments, we augment the model using the proportion of neighbor countries that adopted IT as an external instrument.[39] Using Ratha et al. (2011) control variables, results in Appendix S14A show that IT adoption has a significant and favorable effect on sovereign debt ratings; however, the magnitude of the effect is roughly half compared to baseline results. The same favorable impact of IT adoption is at work for government bond yield spreads, as illustrated by estimations reported in Appendix S14B, using Foujieu & Roger (2013) control variables. In addition, the effect is more pronounced for conservative than for default IT starting dates.

VI. Sensitivity

Previous results revealed that IT adoption reduces sovereign debt risk in emerging countries. In the following, we explore their sensitivity to several structural characteristics, and to the considered time perspective.

6.1. Structural characteristics

6.1.1. Sovereign debt ratings

First, as emphasized by Lin & Ye (2012), exchange rate (ER) targeting is a credible monetary strategy. To compare IT with ER targeting, we exclude fixed ER countries from the control group. As shown by line [16A] in Table 3A, IT adoption significantly increases sovereign debt ratings in emerging countries, compared to emerging countries under ER targeting.

Second, we account for the phase of the business cycle. On the one hand, some authors challenged the merits of IT, particularly during bad periods; for instance, Stiglitz (2008) argues that its narrow focus on inflation may blind monetary authorities from other worthwhile goals. On the other hand, other authors underscore that IT countries might outperform non-IT countries in bad times, due, for example, to better initial macroeconomic conditions, higher credibility and flexibility-enhancing properties of IT, or the shock-absorber properties provided by the flexibility of the ER regime (Fraga et al., 2003; Ghosh et al., 2009; De Carvalho Filho, 2011; Fouejieu, 2013). Thus, we distinguish between "good" and "bad"

[39] The construction of the IT instrument follows Miao (2009).

times, defined by a positive and a negative output gap, respectively.[40] Estimations in lines [17A]-[18A] show that IT adoption significantly improves ratings both in good and in bad times. However, estimated ATTs are stronger (and even by roughly 1 pp in five out of nine cases) in bad compared to good times, consistent with previous studies emphasizing IT performance in bad times (De Carvalho Filho, 2011; Fouejieu, 2013).

Third, we look at the fiscal stance. Indeed, in the presence of large public debt, the impossibility to resort to seigniorage because of IT can turn a loose fiscal policy into extremely damageable for public debt dynamics (Sargent & Wallace, 1981). Using the median level of total government debt, we distinguish between "strong" and "loose" fiscal stance. As emphasized by lines [19A]-[20A], IT adoption significantly increases ratings, irrespective of the fiscal stance. However, its effectiveness is more pronounced under strong fiscal stance (in eight out of nine cases), consistent with the conclusions of Lin & Ye (2009). Consequently, by strengthening IT credibility, better coordination between fiscal and monetary policies improves the effect of IT adoption on ratings.

Fourth, since emerging countries display substantial heterogeneity in their macroeconomic performances, we distinguish between "lower-middle income" and "upper-middle income" countries, based on World Bank's classification (see Appendices S2-3). Lines [21A]-[22A] show that, unlike its favorable effect in upper-middle income countries, IT adoption does not statistically affect ratings in lower-middle income countries. Thus, IT adoption perception differs with the level of economic development, suggesting that notation agencies attribute enough credibility to IT adoption to modify their rates only in relatively more developed emerging countries.

Finally, we performed this analysis on default, instead of conservative IT starting dates (see Appendix S14A). If most results are consistent with previous findings, accounting for IT default dates is no longer associated with important differences between good and bad times, as only in one out of nine cases the difference equals one rating grade.

6.1.2. Government bond yield spreads

First, we compare IT with ER targeting countries, by abstracting of the latter from the control group. As illustrated by line [16B] in Table 3B, IT adoption significantly decreases spreads, compared to emerging countries with ER targeting.

Second, lines [17B]-[18B] show that, if some effects are at work in good times, IT adoption has no significant effect on spreads in bad times. Thus, contrary to notation agencies

[40] Output gap is computed as the difference between actual and potential GDP; potential GDP is computed based on the Hodrick-Prescott filter, with a smoothing parameter of 6.25 (Ravn & Uhlig, 2002).

(line [18A] in Table 3A), markets do not see IT adoption as sufficiently binding on debt dynamics in bad times, and thus do not mirror this institutional change into significant spreads reductions.

Third, adopting IT significantly decreases spreads under a strong fiscal stance (line [19B]), consistent with its favorable effect on ratings. However, under a loose fiscal stance, IT has no significant impact on spreads (line [20B]), contrary to its favorable effect on ratings. Yet again, markets seem to be more sensitive than notation agencies to the joint behavior of fiscal and monetary policies, as poor fiscal policies inhibit IT credibility from the standpoint of risk-aversion investors.

Fourth, disaggregating the effect of IT adoption on spreads upon the level of economic development leads to findings comparable to its effect on ratings. Contrary to its lack of impact in lower-middle income countries (line [21B]), IT adoption is found to significantly decrease spreads in upper-middle income countries (line [22B]). Thus, similar to notation agencies, markets also value IT adoption in relatively more developed emerging countries.

Fifth, we estimate the impact of IT adoption on bond yield spreads variability, defined as the standard deviation of the thirty-six-months moving average of monthly yield spreads in levels. Given their still fragile integration into international capital markets, emerging countries have historically been subject to high financial stress, often resulting in a sudden massive capital withdrawal and high variability of government borrowing costs.[41] By reducing policy uncertainly, IT adoption could better anchor investors' expectations, thereby reducing the variability of spreads. Results in line [23] in Table 3B show that IT adoption significantly decreases the variability of spreads, between -55.50 (for stratification matching) and -83.62 (for kernel matching) basis points. Given an average spreads variability of 232 basis points in no-IT countries, IT adoption is found to reduce government borrowing cost variability by roughly 25 percent in the emerging countries in our sample.

Finally, evidence based on default IT starting dates is mostly consistent with results based on conservative dates (see Appendix S15A-B). However, there is an important exception: IT adoption no longer significantly decreases spreads compared to emerging countries under ER targeting. Corroborating previous results, this finding confirms the existence of cases in which full-fledged IT perform better than partial IT in terms of sovereign debt risk.

[41] For instance, during 1998-2002 Argentina's depression, government's borrowing cost increased dramatically from 476 (December 1997) to 1982 basis points (September 1998). At the end of 2002, Argentina borrowing cost was thirteen times larger than its level in December 1997.

6.2. The time perspective

To take a closer look at this later finding, we consider a time-varying treatment effect analysis (Fang & Miller, 2011; Kadria & Aissa, 2016). Indeed, it is well known in the macroeconomic literature that monetary policy could work with a lag, and this feature may be particularly true in emerging countries, which are generally characterized by important macroeconomic instability, and in which building credibility with financial markets may take time. We estimate ATT for the IT adoption year (t=0),[42] and for the following four years (t=1; 2; 3; 4).

Regarding ratings, Appendix S16A unveils a significant impact starting the year of adoption. Besides, this positive effect is increasing up until years two-three for most specifications, and then stabilizes at levels comparable to the ATT in our baseline specification. Regarding spreads, Appendix S16B reveals the absence of effect in the IT adoption year. Besides, if the favorable effect starting the second year increases in time, its magnitude in year four is still below its value in our baseline estimations, roughly by 0.5-1 pp depending on specifications. These findings corroborate previous sensitivity results (especially regarding bad times and a loose fiscal stance), related to differences in the way markets and notation agencies reverberate IT adoption into changes of their respective measures of sovereign debt risk.

[42] Following Ball and Sheridan (2004), the average adopting year, computed as the mean between the year of first IT and last IT adoption in our sample, is 2002.

Table 3A. Sensitivity of ATT of IT adoption on Sovereign Debt Ratings (conservative IT starting dates): Structural Characteristics

Dependent variable: Sovereign Debt Ratings	Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline results									
[1] **ATT**	**2.459****	**2.269****	**2.257****	**2.367*****	**2.216*****	**2.339*****	**2.410*****	**2.327*****	**2.679*****
	(0.560)	(0.532)	(0.453)	(0.519)	(0.458)	(0.363)	(0.354)	(0.334)	(0.558)
Treated/Untreated/Total Obs.	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/330/477
Comparing IT with Exchange Rate (ER) Targeting									
[16A] IT vs ER targeting	2.537***	2.601***	2.582***	2.750***	2.328***	2.420***	2.489***	2.395***	2.424***
	(0.594)	(0.509)	(0.487)	(0.583)	(0.495)	(0.385)	(0.368)	(0.397)	(0.713)
Phase of the business cycle									
[17A] Good times	1.758**	1.855***	2.172***	2.685***	2.449***	1.617***	1.828***	1.656***	2.007***
	(0.771)	(0.725)	(0.604)	(0.943)	(0.712)	(0.540)	(0.509)	(0.547)	(0.007)
[18A] Bad times	2.767***	2.738***	2.740***	2.858***	2.659***	2.532***	2.813***	2.554***	2.231*
	(0.693)	(0.660)	(0.619)	(0.879)	(0.739)	(0.544)	(0.482)	(0.538)	(1.356)
Fiscal stance									
[19A] Strong fiscal stance	2.566***	2.582***	2.565***	2.880***	2.512***	2.862***	2.618***	2.809***	2.974***
	(0.625)	(0.569)	(0.544)	(0.962)	(0.728)	(0.516)	(0.534)	(0.515)	(0.873)
[20A] Loose fiscal stance	1.935***	2.159***	1.986***	2.932***	2.509***	2.037***	2.177***	2.029***	2.732**
	(0.933)	(0.797)	(0.791)	(1.065)	(0.863)	(0.688)	(0.684)	(0.708)	(1.176)
Level of economic development									
[21A] Lower-middle income countries	1.214	1.023	1.182**	1.458	1.782	0.662	0.789	0.715	0.317
	(0.727)	(0.666)	(0.595)	(1.429)	(1.205)	(0.668)	(0.620)	(0.622)	(0.689)
[22A] Upper-middle income countries	1.181*	1.526***	1.794***	1.629***	1.796***	1.723***	1.870***	1.699***	1.926***
	(0.656)	(0.602)	(0.560)	(0.697)	(0.551)	(0.485)	(0.464)	(0.479)	(0.049)

Table 3B. Sensitivity of ATT of IT adoption on Government Bond Yield Spreads (conservative IT starting dates): Structural Characteristics

Dependent variable: GBY Spreads	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**-380.29****	**-315.53****	**-274.75****	**-454.45*****	**-345.10*****	**-235.09***	**-271.24*****	**-244.61****	**-226.54*****
	(172.78)	(161.84)	(140.14)	(138.18)	(126.72)	(125.54)	(106.99)	(111.98)	(52.05)
Treated/Untreated/Total Obs.	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/255/395
Comparing IT with Exchange Rate (ER) Targeting									
[16B] IT vs ER targeting	-308.96*	-252.60*	-290.63***	-194.39	-205.97*	-282.36**	-273.06***	-283.77***	-192.31***
	(164.92)	(151.86)	(124.38)	(137.50)	(127.24)	(122.32)	(101.34)	(107.28)	(61.20)
Phase of the business cycle									
[17B] Good times	-46.01	-55.94	-75.68**	-97.23	-108.90**	-73.38**	-64.41*	-51.13	-165.27***
	(49.67)	(44.59)	(38.97)	(69.85)	(52.48)	(37.09)	(35.05)	(33.37)	(56.73)
[18B] Bad times	-50.23	-56.05	-47.48	-32.61	-37.05	-118.87	-117.13	-112.98	-629.13
	(205.41)	(172.22)	(149.07)	(256.33)	(187.13)	(137.75)	(113.41)	(128.78)	(407.32)
Fiscal policy stance									
[19B] Strong fiscal stance	-78.83*	-72.97*	-71.24	-109.13*	-95.11**	-66.58*	-88.40***	-66.63*	-103.31**
	(46.53)	(41.30)	(40.88)	(68.81)	(49.97)	(35.74)	(34.60)	(37.47)	(42.24)
[20B] Loose fiscal stance	-185.95	-362.17	-274.68	-145.51	-214.97	-281.40	-280.45	-280.57	-549.80
	(264.52)	(243.88)	(207.61)	(299.39)	(229.68)	(214.21)	(222.62)	(221.25)	(493.35)
Level of economic development									
[21B] Lower-middle income countries	-85.48	-138.40	-109.85	-265.19	-255.51	-78.56	-143.04	-88.69	-594.40
	(188.94)	(161.45)	(148.63)	(335.47)	(303.95)	(186.35)	(182.64)	(191.41)	(557.12)
[22B] Upper-middle income countries	-239.43	-236.56	-315.98*	-259.04*	-252.97*	-357.23**	-346.57***	-357.23**	-188.84***
	(198.81)	(169.27)	(189.28)	(173.11)	(158.66)	(161.50)	(137.64)	(166.71)	(43.92)
Government Bond Yield Spreads Variability									
[23] GBY spreads variability	-56.85	-65.71*	-75.97**	-59.86*	-73.99**	-82.10***	-80.95***	-83.62***	-55.50***
	(44.92)	(36.04)	(33.88)	(37.32)	(31.79)	(28.77)	(28.70)	(31.52)	(15.58)

VII. Conclusion

We explored in this paper the potential impact of IT adoption on sovereign debt risk. We contribute to the scarce literature on this topic on several grounds, including (i) accounting for alternative measures of sovereign debt risk, (ii) using PSM to control for a self-selection bias in IT adoption, (iii) drawing upon a large sample of 38 emerging countries, and (iv) performing a wide analysis of the sensitivity of the effect of IT adoption on sovereign risk.

Our results are twofold. On the one hand, IT adoption significantly increases sovereign debt ratings and decreases government bond yield spreads. The magnitude of these effects is economically meaningful: an increase around two rating levels, and a decrease around 2-3 pp for spreads. These findings are robust to a wide set of alternative specifications. On the other hand, the effect of IT adoption on sovereign debt risk greatly depends on economic conditions. Regarding ratings, IT adoption increases them more during "bad" times and under strong fiscal stance, and significantly increases them only in upper-middle income countries. Regarding spreads, IT adoption has no significant effect during "bad" times, under loose fiscal stance, and in lower-middle income countries. Our estimations confirm that notation agencies and markets sometimes value differently IT adoption, and justify our choice of capturing the diversity of sovereign debt risk through several measures.

Consequently, this paper shows that adopting an IT monetary framework can provide benefits in terms of both higher ratings and lower spreads in emerging countries. In addition, our analysis reveals insightful evidence on the practical implementation of IT: the highest reduction of sovereign debt risk arises when combined with good fiscal stance and in relatively more developed emerging countries, provided that a full-fledged IT monetary regime is achieved. Under such conditions, IT adoption can improve emerging market economies' access to international financial markets, and provide an appropriate monetary strategy to finance long-term investment projects and support potential economic growth.

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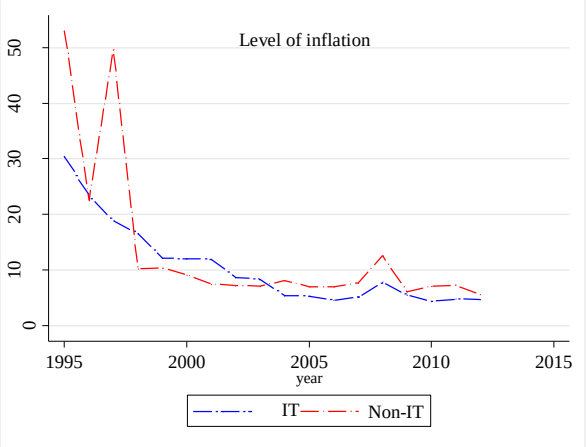
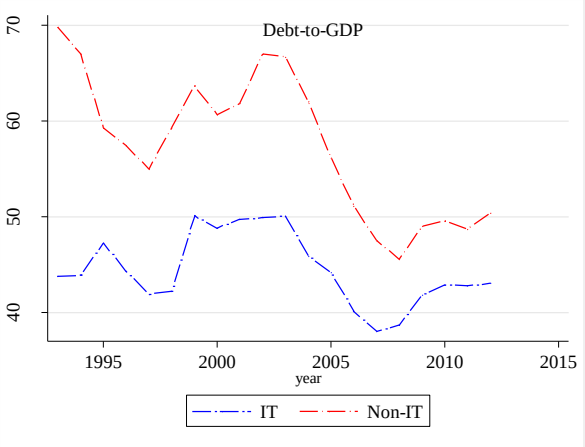
SUPPLEMENTARY MATERIAL

Appendix S1. Evolution of Inflation and Debt-to-GDP: IT vs Non-IT countries in our sample





Appendix S2. IT countries (treated group) and their IT starting dates.

Pays	Default starting dates	Conservative starting dates
Brazil[2]	June 1999	June 1999
Chile[2]	January 1991	August 1999
Colombia[2]	September 1999	October 1999
Ghana[1]	January 2007	January 2007
Hungary[2]	June 2001	August 2001
Mexico[2]	January 1999	January 2001
Peru[2]	January 2002	January 2002
Philippines[1]	January 2002	January 2002
Poland[2]	September 1998	September 1998
South Africa[2]	February 2000	February 2000
South Korea[2]	April 1998	April 1998
Turkey[2]	January 2006	January 2006

[1] Lower-middle-income economies. [2] Upper-middle-income economies.

Appendix S3. Non-IT countries (control group)

Argentina[2]	Georgia[1]	Panama[2]
Belize[2]	Indonesia[1]	Russian Federation[2]
Bulgaria[2]	Jamaica[2]	Sri Lanka[1]
China[2]	Kazakhstan[2]	Tunisia[2]
Dominican Republic[2]	Lebanon[2]	Ukraine[1]
Ecuador[2]	Malaysia[2]	Uruguay[2]
Egypt. Arab Republic[1]	Morocco[1]	Venezuela[2]
El Salvador[1]	Nigeria[1]	Vietnam[1]
Gabon[1]	Pakistan[1]	

[1] Lower-middle-income economies. [2] Upper-middle-income economies.

Appendix S4. Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
Ratings	Overall	9.525276	3.211126	1	17	N=633
	Between		2.751269	3.885417	4.75833	n=38
	Within		1.601458	2.100277	13.20861	T=16.66
Spread	Overall	496.9703	590.2867	0.9801	5779.666	N=515
	Between		324.9740	115.5654	1545.097	n=38
	Within		473.0044	-728.2618	4731.54	T=13.55
Spread Variability	Overall	182.1617	283.3154	0	2418.043	N=579
	Between		156.2299	36.43208	763.9998	n=38
	Within		229.0891	-484.6768	1836.205	T=15.23
Fullit	Overall	0.1894737	0.3921425	0	1	N=760
	Between		0.2936623	0	0.75	n=38
	Within		0.2640018	-0.5605263	0.8894737	T=20
Softit	Overall	0.2	0.4002634	0	1	N=760
	Between		0.3151576	0	1	n=38
	Within		0.2517397	-0.55	0.9	T=20

Appendix S5. Sources and Definitions of variables

Variables	Definitions	Sources
Full-fledged IT (conservative starting dates)	Dummy variable equal to 1 if a country is under IT regime in a given year; 0 otherwise. Conservative starting dates are related to full-fledged IT adoption	Batini et al. (2006), Rose (2007), Roger (2009), Warburton & Davies (2012)
Partial IT (default starting dates)	Dummy variable equal to 1 if a country is under IT regime in a given year; 0 otherwise. Default starting dates are related to partial IT adoption	
Sovereign debt ratings	Long-term foreign currency government debt ratings	Standard & Poor's, Moody's and Fitch websites
Government bond yield spread	Yield spread between each emerging country and United States sovereign bonds with a minimum size of 500 millions USD and an average maturity of 12 years	JP Morgan, Bloomberg
Government bond yield spread variability	Standard deviation of the thirty-six-months moving average of monthly yield spreads level	Authors' calculation based on government bond yield spread data
Inflation rate	Annual growth rate of average CPI	World Economic Outlook (2014)
Public debt	Gross general government debt to GDP	
Fiscal deficit	General government net lending/borrowing to GDP	
CA balance	Current account balance to GDP	
Real gdp growth	Annual growth rate of GDP	World Development Indicators (2014)
External debt	General government external debt to GNI	
Trade openness	Volume of imports and exports divided by GDP	
Total exchange reserves	Annual total exchange reserves	
Unemployment rate	Annual unemployment rate, in percent of total labor force	
Real gdp per capita	Gross domestic product per capita, constant prices USD	
M2 (% of GDP)	Money and quasi money (M2) to GDP	
Inflation variability	Standard deviation of the three-years moving average of annual growth rate of CPI	Authors' calculation based on inflation rate data
Governor turnover dummy	Dummy variable equal to 1 if a country experiences a turnover of central bank governor	Crowe & Meade (2008), updated
Central bank independence	De jure central bank independence index	
Government stability	Index measures the assessment both of the government's ability to carry out its declared program(s), and its ability to stay in office	International Country Risk Guide (ICRG)
Corruption	Index measures the assessment of corruption within the political system	
Law and order	Index measures the strength and impartiality of the legal system "law" and the assessment of popular observance of the law "order"	
Fixed exchange rate dummy	Dummy variable equal to 1 if a country is classified as having a de facto fixed exchange rate regime (hard or soft peg); 0 otherwise	Reinhart & Rogoff (2009), updated from IMF Annual Report on Exchange Arrangements and Exchange Restrictions (2011, 2012)
Fiscal rule	Dummy variable equal to 1 if a country had in place, at the national level, a numerical limit on fiscal aggregates (expenditure, revenue, budget balance, debt); 0 otherwise	IMF Fiscal Rules Dataset (2013)
Sovereign debt crisis	Dummy variable equal to 1 if a country experiences a domestic debt default or an external default; 0 otherwise	Reinhart & Rogoff (2009) updated from Laeven & Valencia (2013)
Sovereign debt crisis contagion	Dummy variable equal to 1 if at least one country in a same region faces a sovereign debt crisis; 0 otherwise. We use the World Bank country classification by region	Authors' calculations based on sovereign debt crisis data from Reinhart & Rogoff (2009) and Laeven & Valencia (2013)
Real Effective Exchange Rate volatility	Standard deviation of the three-years moving average of real effective exchange rate	Authors' calculations based on Real Effective Exchange Rate from CERDI database (2012)
IMF programme dummy	Dummy variable equal to 1 if IMF standby arrangement of IMF extended facility arrangement is in effect for at least 5 months in a particular year; 0 otherwise	IMF website

Appendix S6. Linear transformation of S&P, Moody's, and Fitch ratings for long-term debt

					Numerical values	
Rating Grade	Risk level	Moody's	S&P	Fitch	Baseline	Scale 1-17
Investment grade	Highest quality	Aaa	AAA	AAA	20	17
	High quality	Aa1	AA+	AA+	19	16
		Aa2	AA	AA	18	15
		Aa3	AA-	AA-	17	14
	Strong payment capacity	A1	A+	A+	16	13
		A2	A	A	15	12
		A3	A-	A-	14	11
	Adequate payment capacity	Baa1	BBB+	BBB+	13	10
		Baa2	BBB	BBB	12	9
		Baa3	BBB-	BBB-	11	8
Speculative grade	Likely to fulfill obligations, ongoing uncertainty	Ba1	BB+	BB+	10	7
		Ba2	BB	BB	9	6
		Ba3	BB-	BB-	8	5
	High credit risk	B1	B+	B+	7	4
		B2	B	B	6	3
		B3	B-	B-	5	2
	Very high credit risk with possibility of recovery	Caa1	CCC+	CCC+	4	1
		Caa2	CCC	CCC	3	1
		Caa3	CCC-	CCC-	2	1
		Ca	CC	CC	1	1
				C	0	1
		C	SD	RD	0	1
	Default	C	D	D	0	1

Appendix S7A. Estimation of PS for Sovereign Debt Ratings (conservative IT starting dates)

	[1]	[2]	[3]	[4]	[5]
VARIABLES	Baseline model	No dollarized	No Hyperinflation	No Top oil exp	No Saving glut
Lagged inflation	-0.128***	-0.128***	-0.128***	-0.103***	-0.155***
	(0.0186)	(0.0184)	(0.0190)	(0.0183)	(0.0292)
Lagged log total debt/gdp	-0.512***	-0.526***	-0.526***	-0.866***	-0.422***
	(0.114)	(0.113)	(0.115)	(0.144)	(0.148)
Lagged fiscal deficit	-0.071***	-0.067***	-0.072***	-0.094***	-0.0779***
	(0.020)	(0.019)	(0.020)	(0.024)	(0.0293)
Real gdp growth	-0.042**	-0.043**	-0.051**	-0.030	-0.0622**
	(0.021)	(0.021)	(0.022)	(0.023)	(0.0279)
Law and order	-0.231***	-0.272***	-0.240***	-0.170**	-0.237**
	(0.0691)	(0.0710)	(0.0696)	(0.0781)	(0.109)
Fixed exchange rate dummy	-1.888***	-1.638***	-1.909***	-1.707***	-2.618***
	(0.248)	(0.254)	(0.251)	(0.255)	(0.471)
Log trade openness/gdp	-0.317	-0.198	-0.204	0.358	-0.328
	(0.594)	(0.594)	(0.593)	(0.672)	(0.878)
Constant	3.677***	3.720***	3.648***	3.495***	3.628***
	(0.950)	(0.939)	(0.954)	(1.097)	(1.286)
Pseudo-R2	0.2965	0.2755	0.2935	0.2774	0.3352
Observations	601	544	587	505	364

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S7B. Estimation of PS for Government Bond Yield Spreads (conservative IT starting dates)

	[1]	[2]	[3]	[4]	[5]
VARIABLES	Baseline model	No dollarized	No Hyperinflation	No Top oil exp	No Saving glut
Lagged inflation	-0.115***	-0.116***	-0.115***	-0.080***	-0.121***
	(0.0193)	(0.0191)	(0.0192)	(0.0189)	(0.0286)
Lagged log total debt/gdp	-0.346**	-0.353**	-0.357**	-0.957***	-0.316*
	(0.142)	(0.141)	(0.143)	(0.180)	(0.170)
Lagged fiscal deficit	-0.082***	-0.079***	-0.083***	-0.136***	-0.0884***
	(0.0256)	(0.0256)	(0.0256)	(0.0311)	(0.0333)
Real gdp growth	-0.071***	-0.072***	-0.075***	-0.067***	-0.0798***
	(0.0211)	(0.0212)	(0.0213)	(0.0235)	(0.0287)
Law and order	-0.351***	-0.362***	-0.355***	-0.391***	-0.313***
	(0.0732)	(0.0742)	(0.0735)	(0.0831)	(0.108)
Fixed exchange rate dummy	-1.876***	-1.791***	-1.881***	-1.511***	-2.451***
	(0.293)	(0.314)	(0.292)	(0.317)	(0.472)
Log trade openness/gdp	0.606	0.602	0.700	0.246	0.638
	(0.684)	(0.675)	(0.685)	(0.786)	(0.964)
Log total exchange reserves	9.165***	8.794***	9.210***	14.20***	7.990***
	(1.144)	(1.221)	(1.151)	(1.600)	(1.562)
Sovereign debt crisis	-1.654*	-1.676*	-1.309	--	--
	(0.912)	(0.921)	(0.889)	(--)	(--)
Pseudo-R2	0.3998	0.3717	0.3951	0.4334	0.4020
Observations	601	544	587	480	348

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S8A. Estimation of PS for SD Ratings (conservative IT starting): additional controls

	[1]	[6]	[7]	[8]	[9]	[10]
VARIABLES	Baseline model	Adding *Real Economy*	Adding *Monetary Conditions*	Adding *Fiscal Conditions*	Adding *Macro Instability*	Adding *Institutions*
Lagged inflation	-0.128***	-0.134***	-0.133***	-0.115***	-0.0931***	-0.120***
	(0.0186)	(0.0190)	(0.0187)	(0.0177)	(0.0198)	(0.0185)
Lagged log total debt/gdp	-0.512***	-0.581***	-0.432***		-0.611***	-0.604***
	(0.114)	(0.118)	(0.114)		(0.128)	(0.148)
Lagged fiscal deficit	-0.071***	-0.0617***	-0.0435**	-0.0221	-0.0998***	-0.114***
	(0.020)	(0.0211)	(0.0212)	(0.0161)	(0.0230)	(0.0264)
Real gdp growth	-0.042**	-0.103***	-0.0441**	-0.0398*	-0.0708***	-0.0194
	(0.021)	(0.0370)	(0.0211)	(0.0216)	(0.0222)	(0.0246)
Law & order	-0.231***	-0.253***	-0.188**	-0.140**	-0.257***	-0.282***
	(0.0691)	(0.0693)	(0.0767)	(0.0679)	(0.0769)	(0.0819)
Fixed exchange rate dummy	-1.888***	-1.973***	-1.803***	-1.809***	-1.863***	-1.735***
	(0.248)	(0.243)	(0.305)	(0.231)	(0.274)	(0.270)
Log trade openness/gdp	-0.317	-0.424	-0.458	-0.393	0.222	-1.171*
	(0.594)	(0.594)	(0.706)	(0.583)	(0.615)	(0.642)
Log gdp per capita		5.732*				
		(3.057)				
Unemployment rate		0.0830				
		(0.122)				
Current account balance		-0.0338**				
		(0.0138)				
Log M2/gdp			0.116			
			(0.175)			
Central Bank independence			-2.551***			
			(0.588)			
Lagged log external debt/gni				-0.260		
				(0.321)		
Fiscal rule				0.337**		
				(0.142)		
Lagged inflation variability					-0.182***	
					(0.0365)	
REER volatility					0.00111	
					(0.00955)	
Sovereign debt crisis contagion					0.110	
					(0.103)	
Government stability						-0.224***
						(0.0442)
Corruption						0.341***
						(0.0955)
IMF programme dummy						-0.340**
						(0.165)
Constant	3.677***	4.077***	3.774***	1.788**	3.521***	6.208***
	(0.950)	(0.985)	(1.105)	(0.873)	(1.018)	(1.151)
Pseudo-R2	0.2965	0.3072	0.3316	0.2870	0.3169	0.3554
Observations	601	601	506	609	571	535

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S8B. Estimation of PS for GBY Spreads (conservative IT starting dates): additional controls

	[1]	[6]	[7]	[8]	[9]	[10]
VARIABLES	Baseline model	Adding *Real Economy*	Adding *Monetary Conditions*	Adding *Fiscal Conditions*	Adding *Macro Instability*	Adding *Institutions*
Lagged inflation	-0.115***	-0.118***	-0.138***	-0.102***	-0.0826***	-0.101***
	(0.0193)	(0.0210)	(0.0202)	(0.0185)	(0.0197)	(0.0181)
Lagged log total debt/gdp	-0.346**	-0.501***	-0.253*		-0.413***	-0.523***
	(0.142)	(0.143)	(0.142)		(0.155)	(0.181)
Lagged fiscal deficit	-0.082***	-0.0687***	-0.0687***	-0.0366*	-0.118***	-0.124***
	(0.0256)	(0.0264)	(0.0253)	(0.0190)	(0.0285)	(0.0299)
Real gdp growth	-0.071***	-0.0820**	-0.0713***	-0.0613***	-0.0851***	-0.0278
	(0.0211)	(0.0392)	(0.0217)	(0.0213)	(0.0241)	(0.0237)
Law & order	-0.351***	-0.387***	-0.183**	-0.328***	-0.318***	-0.405***
	(0.0732)	(0.0695)	(0.0809)	(0.0766)	(0.0777)	(0.0774)
Fixed exchange rate dummy	-1.876***	-2.063***	-1.769***	-1.749***	-1.881***	-1.346***
	(0.293)	(0.305)	(0.328)	(0.259)	(0.314)	(0.276)
Log trade openness/gdp	0.606	0.727	0.588	0.251	1.279*	-0.200
	(0.684)	(0.690)	(0.763)	(0.681)	(0.705)	(0.699)
Log total exchange reserves	9.165***	12.00***	10.40***	10.16***	9.745***	10.48***
	(1.144)	(1.394)	(1.457)	(1.241)	(1.287)	(1.618)
Sovereign debt crisis	-1.654*	-1.360*	-1.198	-1.886**	-0.898	-1.444**
	(0.912)	(0.802)	(0.844)	(0.737)	(0.557)	(0.721)
Log gdp per capita		1.759				
		(3.221)				
Unemployment rate		0.523***				
		(0.142)				
Current account balance		-0.0686***				
		(0.0153)				
Log M2/gdp			-0.593***			
			(0.216)			
Central Bank independence			-2.865***			
			(0.557)			
Lagged log external debt/gni				0.797**		
				(0.346)		
Fiscal rule				0.235		
				(0.150)		
Lagged inflation variability					-0.141***	
					(0.0350)	
REER volatility					-0.00853	
					(0.0120)	
Sovereign debt crisis contagion					0.405***	
					(0.119)	
Government stability						-0.173***
						(0.0474)
Corruption						0.498***
						(0.110)
IMF programme dummy						0.0995
						(0.178)
Pseudo-R2	0.3998	0.4368	0.4141	0.4025	0.4136	0.4494
Observations	601	601	506	609	571	535

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S8C. Robustness of ATT of IT adoption on Sovereign Debt Ratings (conservative IT starting dates): additional controls

Dependent variable: Sovereign Debt Ratings	Nearest Neighbor Matching			Radius Matching			Local Linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**2.459****	**2.269****	**2.257****	**2.367*****	**2.216*****	**2.339*****	**2.410*****	**2.327*****	**2.679*****
	(0.560)	(0.532)	(0.453)	(0.519)	(0.458)	(0.363)	(0.354)	(0.334)	(0.558)
Treated/Untreated/Total Observations	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/330/477
Additional controls									
[6] Adding *Real Economy*	2.263***	2.277***	1.714***	2.112***	2.148***	2.386***	2.442***	2.395***	2.408**
	(0.553)	(0.467)	(0.560)	(0.524)	(0.426)	(0.345)	(0.347)	(0.366)	(1.083)
[7] Adding *Monetary Conditions*	2.295***	1.857***	2.065***	1.954***	1.782***	2.211***	2.301***	2.206***	2.391**
	(0.597)	(0.534)	(0.512)	(0.542)	(0.501)	(0.375)	(0.348)	(0.374)	(0.960)
[8] Adding *Fiscal Conditions*	2.521***	2.636***	2.711**	2.265***	2.648***	2.668***	2.724***	2.649***	2.859***
	(0.535)	(0.466)	(0.442)	(0.444)	(0.414)	(0.339)	(0.334)	(0.334)	(0.674)
[9] Adding *Macro Instability*	1.311**	1.572***	1.801***	1.722***	1.968***	2.037***	2.070***	2.027***	1.972***
	(0.581)	(0.476)	(0.468)	(0.553)	(0.414)	(0.364)	(0.345)	(0.324)	(0.394)
[10] Adding *Institutions*	2.395***	2.282***	2.244***	2.277***	2.305***	2.376***	2.244***	2.355***	2.253***
	(0.584)	(0.549)	(0.505)	(0.560)	(0.462)	(0.378)	(0.402)	(0.373)	(0.416)

Appendix S8D. Robustness of ATT of IT adoption on Government Bond Yield Spreads (conservative IT starting dates): additional controls

Dependent variable: GBY Spreads	N Nearest Neighbor Matching			Radius Matching			Local Linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**-380.29****	**-315.53****	**-274.75****	**-454.45*****	**-345.10*****	**-235.09***	**-271.24*****	**-244.61****	**-226.54*****
	(172.78)	(161.84)	(140.14)	(138.18)	(126.72)	(125.54)	(106.99)	(111.98)	(52.05)
Treated/Untreated/Total Observations	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/255/395
Additional controls									
[6] Adding *Real Economy*	-394.28***	-343.69**	-134.20***	-326.74***	-287.49**	-246.61**	-270.76***	-247.59**	-331.29*
	(153.64)	(148.65)	(49.18)	(112.38)	(133.59)	(109.85)	(104.67)	(123.33)	(192.91)
[7] Adding *Monetary Conditions*	-265.52*	-332.90***	-179.63***	-300.96***	-299.84***	-244.36**	-265.42**	-260.08**	-399.63
	(149.02)	(131.14)	(52.35)	(106.11)	(100.39)	(106.96)	(123.05)	(111.85)	(511.07)
[8] Adding *Fiscal Conditions*	-211.40	-245.92**	-207.92**	-160.80*	-194.27**	-219.38***	-221.03***	-214.01***	-316.89**
	(144.83)	(118.39)	(100.75)	(100.71)	(102.23)	(81.52)	(83.63)	(89.88)	(151.52)
[9] Adding *Macro Instability*	-190.11***	-149.29**	-147.96***	-113.23*	-179.68***	-143.34***	-143.39***	-145.00***	-137.20***
	(73.46)	(60.73)	(52.01)	(67.65)	(54.50)	(47.11)	(41.51)	(44.74)	(47.47)
[10] Adding *Institutions*	-228.84	-251.01**	-211.88*	-182.39*	-207.21*	-265.42***	-246.83***	-262.91***	-162.99***
	(153.74)	(116.40)	(117.31)	(116.46)	(122.72)	(107.86)	(96.09)	(106.61)	(54.69)

Appendix S9A. Estimation of PS for Sovereign Debt Ratings (default starting IT dates)

	[1]	[2]	[3]	[4]	[5]
VARIABLES	Baseline model	No dollarized	No hyperinflation	No top oil exporters	No saving glut
Lagged inflation	-0.109***	-0.109***	-0.109***	-0.0896***	-0.125***
	(0.0157)	(0.0156)	(0.0161)	(0.0160)	(0.0234)
Lagged log total debt/gdp	-0.435***	-0.449***	-0.447***	-0.759***	-0.266*
	(0.110)	(0.110)	(0.110)	(0.141)	(0.141)
Lagged fiscal deficit	-0.0549***	-0.0517***	-0.0551***	-0.0683***	-0.0424
	(0.0195)	(0.0190)	(0.0196)	(0.0239)	(0.0290)
Real gdp growth	-0.0345*	-0.0355*	-0.0422**	-0.0220	-0.0454*
	(0.0198)	(0.0198)	(0.0204)	(0.0218)	(0.0257)
Law and order	-0.164**	-0.200***	-0.171**	-0.0830	-0.117
	(0.0670)	(0.0692)	(0.0674)	(0.0745)	(0.0991)
Fixed exchange rate dummy	-1.838***	-1.615***	-1.853***	-1.630***	-2.439***
	(0.230)	(0.238)	(0.232)	(0.233)	(0.421)
Log trade openness/gdp	-0.592	-0.478	-0.495	-0.0960	-0.794
	(0.580)	(0.580)	(0.580)	(0.649)	(0.813)
Constant	3.499***	3.528***	3.467***	3.437***	3.194***
	(0.904)	(0.897)	(0.906)	(1.052)	(1.183)
Pseudo-R2	0.2742	0.2496	0.2698	0.2604	0.2980
Observations	601	544	587	505	364

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S10A. Estimations of PS for SD Ratings (default starting IT dates): additional controls

	[1]	[6]	[7]	[8]	[9]	[10]
VARIABLES	Baseline model	Adding *Real Economy*	Adding *Monetary Conditions*	Adding *Fiscal Conditions*	Adding *Macro Instability*	Adding *Institutions*
Lagged inflation	-0.109***	-0.113***	-0.113***	-0.103***	-0.0713***	-0.101***
	(0.0157)	(0.0161)	(0.0160)	(0.0155)	(0.0173)	(0.0157)
Lagged log total debt/gdp	-0.435***	-0.489***	-0.324***		-0.528***	-0.545***
	(0.110)	(0.115)	(0.113)		(0.122)	(0.140)
Lagged fiscal deficit	-0.0549***	-0.0432**	-0.0306	-0.0157	-0.0876***	-0.0947***
	(0.0195)	(0.0207)	(0.0200)	(0.0158)	(0.0220)	(0.0250)
Real gdp growth	-0.0345*	-0.0822**	-0.0341*	-0.0331	-0.0585***	-0.0104
	(0.0198)	(0.0360)	(0.0199)	(0.0204)	(0.0217)	(0.0228)
Law & order	-0.164**	-0.186***	-0.0968	-0.105	-0.168**	-0.213***
	(0.0670)	(0.0674)	(0.0750)	(0.0661)	(0.0733)	(0.0785)
Fixed exchange rate dummy	-1.838***	-1.908***	-1.784***	-1.792***	-1.821***	-1.680***
	(0.230)	(0.227)	(0.275)	(0.221)	(0.255)	(0.248)
Log trade openness/gdp	-0.592	-0.761	-0.532	-0.613	0.000871	-1.409**
	(0.580)	(0.584)	(0.669)	(0.574)	(0.598)	(0.626)
Log gdp per capita		4.241				
		(2.964)				
Unemployment rate		0.0215				
		(0.122)				
Current account balance		-0.0359***				
		(0.0131)				
Log M2/gdp			0.0724			
			(0.159)			
Central Bank independence			-1.835***			
			(0.660)			
Lagged log external debt/gni				-0.233		
				(0.315)		
Fiscal rule				0.270*		
				(0.139)		
Lagged inflation variability					-0.187***	
					(0.0341)	
REER volatility					0.000406	
					(0.00927)	
Sovereign debt crisis contagion					0.225**	
					(0.0981)	
Government stability						-0.208***
						(0.0441)
Corruption						0.365***
						(0.0897)
IMF programme dummy						-0.324**
						(0.158)
Constant	3.499***	4.033***	3.114***	1.930**	3.084***	5.858***
	(0.904)	(0.960)	(1.099)	(0.858)	(0.975)	(1.085)
Pseudo R^2	0.2742	0.2840	0.2944	0.2706	0.2979	0.3304
Observations	601	601	506	609	571	535

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S11A. Robustness of ATT of IT adoption on Sovereign Debt Ratings (default starting IT dates): altering the sample and additional controls

Dependent variable: Sovereign Debt Ratings	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**2.768*** **	**2.213*** **	**2.332** **	**2.348*** **	**2.216*** **	**2.435*** **	**2.485*** **	**2.429*** **	**2.653** **
	(0.556)	(0.502)	(0.457)	(0.475)	(0.458)	(0.365)	(0.330)	(0.357)	(0.760)
Treated/Untreated/Total Observations	147/394/541	147/394/541	147/394/541	134/394/528	142/394/536	147/394/541	147/394/541	147/394/541	147/394/541
Robustness: altering the sample and additional controls									
[2] Excluding dollarized countries	2.328***	2.459***	2.394***	2.473***	2.403***	2.463***	2.513***	2.468***	2.962**
	(0.555)	(0.505)	(0.454)	(0.534)	(0.441)	(0.355)	(0.336)	(0.355)	(0.749)
[3] Excluding hyperinflation episodes	2.768***	2.229***	2.332***	2.359***	2.350***	2.428***	2.478***	2.422***	2.137*
	(0.530)	(0.505)	(0.458)	(0.479)	(0.464)	(0.356)	(0.349)	(0.355)	(1.105)
[4] Excluding top oil net exporting countries	2.345***	2.073***	2.128***	2.171***	2.034***	2.084***	2.165***	2.070***	4.212**
	(0.610)	(0.522)	(0.507)	(0.572)	(0.501)	(0.383)	(0.364)	(0.398)	(2.158)
[5] Excluding global saving glut	1.660**	1.918***	1.995***	1.471**	1.688***	2.109***	2.285***	2.123***	2.460***
	(0.808)	(0.705)	(0.687)	(0.728)	(0.620)	(0.564)	(0.580)	(0.533)	(0.535)
[6] Adding *Real Economy*	1.973***	2.150***	2.199***	2.009***	2.183***	2.343***	2.410***	2.334***	2.251***
	(0.577)	(0.493)	(0.463)	(0.501)	(0.436)	(0.349)	(0.360)	(0.367)	(0.407)
[7] Adding *Monetary Conditions*	2.570***	2.943***	2.745***	2.250***	2.438***	3.033***	3.264***	2.995***	2.810***
	(0.748)	(0.613)	(0.650)	(0.600)	(0.542)	(0.503)	(0.518)	(0.525)	(0.536)
[8] Adding *Fiscal Conditions*	2.090***	2.199***	2.324***	1.967***	2.180***	2.312***	2.494***	2.324***	2.471***
	(0.585)	(0.495)	(0.488)	(0.494)	(0.423)	(0.354)	(0.341)	(0.344)	(0.370)
[9 Adding *Macro Instability*	1.949***	1.946***	2.157***	2.521***	2.309***	2.105***	2.135***	2.119***	1.985***
	(0.524)	(0.437)	(0.431)	(0.475)	(0.392)	(0.332)	(0.311)	(0.319)	(0.405)
[10] Adding *Institutions*	2.315***	2.130***	2.151***	2.520***	2.245***	2.310***	2.435***	2.318***	2.409***
	(0.519)	(0.459)	(0.401)	(0.516)	(0.437)	(0.342)	(0.353)	(0.348)	(0.442)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S9B. Estimation of PS for Government Bond Yield Spreads (default IT starting dates)

	[1]	[2]	[3]	[4]	[5]
VARIABLES	Baseline model	No dollarized	No hyperinflation	No Top oil exp	No Saving glut
Lagged inflation	-0.0941***	-0.094***	-0.0939***	-0.0646***	-0.121***
	(0.0161)	(0.0160)	(0.0161)	(0.0164)	(0.0286)
Lagged log total debt/gdp	-0.241*	-0.249*	-0.250*	-0.757***	-0.316*
	(0.134)	(0.133)	(0.134)	(0.171)	(0.170)
Lagged fiscal deficit	-0.0604**	-0.0582**	-0.0608**	-0.0914***	-0.088***
	(0.0245)	(0.0244)	(0.0246)	(0.0303)	(0.0333)
Real gdp growth	-0.0596***	-0.060***	-0.0630***	-0.0481**	-0.079***
	(0.0203)	(0.0203)	(0.0207)	(0.0235)	(0.0287)
Law and order	-0.258***	-0.268***	-0.261***	-0.250***	-0.313***
	(0.0732)	(0.0742)	(0.0735)	(0.0815)	(0.108)
Fixed exchange rate dummy	-1.826***	-1.752***	-1.829***	-1.390***	-2.451***
	(0.271)	(0.289)	(0.269)	(0.270)	(0.472)
Log trade openness/gdp	0.233	0.232	0.306	-0.257	0.638
	(0.660)	(0.652)	(0.663)	(0.719)	(0.964)
Log total exchange reserves	8.688***	8.341***	8.716***	13.02***	7.990***
	(1.093)	(1.159)	(1.099)	(1.459)	(1.562)
Sovereign debt crisis	-1.548**	-1.563**	-1.282*	--	--
	(0.766)	(0.772)	(0.726)	(--)	(--)
Constant	-25.53***	-24.35***	-25.67***	-36.95***	-23.41***
	(3.759)	(3.954)	(3.781)	(4.669)	(5.490)
Pseudo-R2	0.3707	0.3398	0.3649	0.3967	0.3532
Observations	601	544	587	480	348

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S10B. Probit estimates of Propensity Scores for GBY Spreads (default starting IT dates): additional controls

	[1]	[6]	[7]	[8]	[9]	[10]
VARIABLES	Baseline model	Adding *Real Economy*	Adding *Monetary Conditions*	Adding *Fiscal Conditions*	Adding *Macro Instability*	Adding *Institutions*
Lagged inflation	-0.0941***	-0.0940***	-0.114***	-0.0903***	-0.0595***	-0.0831***
	(0.0161)	(0.0175)	(0.0169)	(0.0161)	(0.0174)	(0.0153)
Lagged log total debt/gdp	-0.241*	-0.373***	-0.128		-0.307**	-0.429**
	(0.134)	(0.136)	(0.134)		(0.146)	(0.172)
Lagged fiscal deficit	-0.0604**	-0.0442*	-0.0492**	-0.0289	-0.103***	-0.100***
	(0.0245)	(0.0255)	(0.0239)	(0.0187)	(0.0269)	(0.0293)
Real gdp growth	-0.0596***	-0.0555	-0.0571***	-0.0517**	-0.0696***	-0.0152
	(0.0203)	(0.0398)	(0.0204)	(0.0206)	(0.0240)	(0.0230)
Law & order	-0.258***	-0.291***	-0.0782	-0.276***	-0.217***	-0.318***
	(0.0732)	(0.0713)	(0.0786)	(0.0755)	(0.0758)	(0.0797)
Fixed exchange rate dummy	-1.826***	-2.000***	-1.753***	-1.750***	-1.863***	-1.308***
	(0.271)	(0.284)	(0.291)	(0.251)	(0.297)	(0.252)
Log trade openness/gdp	0.233	0.226	0.439	-0.0135	0.985	-0.542
	(0.660)	(0.673)	(0.717)	(0.661)	(0.692)	(0.689)
Log total exchange reserves	8.688***	11.37***	9.431***	9.896***	9.731***	10.30***
	(1.093)	(1.307)	(1.389)	(1.208)	(1.246)	(1.543)
Sovereign debt crisis	-1.548**	-1.278*	-1.262*	-1.800***	-1.175*	-1.364**
	(0.766)	(0.663)	(0.720)	(0.663)	(0.653)	(0.599)
Log gdp per capita		0.0503				
		(3.236)				
Unemployment rate		0.425***				
		(0.134)				
Current account balance		-0.0696***				
		(0.0149)				
Log M2/gdp			-0.571***			
			(0.193)			
Central Bank independence			-1.972***			
			(0.707)			
Lagged log external debt/gni				0.837**		
				(0.338)		
Fiscal rule				0.159		
				(0.147)		
Lagged inflation variability					-0.153***	
					(0.0351)	
REER volatility					-0.0103	
					(0.0131)	
Sovereign debt crisis contagion					0.536***	
					(0.129)	
Government stability						-0.160***
						(0.0464)
Corruption						0.521***
						(0.104)
IMF programme dummy						0.0809
						(0.169)
Constant	-25.53***	-34.39***	-26.28***	-30.95***	-29.93***	-29.05***
	(3.759)	(4.467)	(4.437)	(4.153)	(4.318)	(5.225)
Pseudo R^2	0.3707	0.4044	0.3705	0.3828	0.3957	0.4254
Observations	601	601	506	609	571	535

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S11B. Robustness of ATT of IT adoption on Government Bond Yield Spreads (default starting IT dates): altering the sample and additional controls

Dependent variable: GBY Spreads	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**-244.38**	**-218.21***	**-240.39***	**-182.08**	**-201.61***	**-276.36****	**-284.36*****	**-280.64*****	**-179.85*****
	(159.76)	(133.01)	(128.42)	(114.25)	(107.70)	(112.32)	(107.72)	(106.26)	(61.21)
Treated/Untreated/Total observations	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	140/255/395
Robustness: altering the sample and additional controls									
[2] Excluding dollarized countries	-300.73**	-283.59**	-343.97***	-289.30**	-214.54*	-257.97***	-248.44***	-255.86***	-220.09*
	(141.10)	(127.98)	(102.09)	(126.88)	(116.16)	(90.95)	(101.13)	(87.83)	(118.95)
[3] Excluding hyperinflation episodes	-317.19**	-339.50***	-304.35***	-268.79***	-259.35**	-246.75***	-241.55***	-239.94***	-234.78*
	(142.21)	(109.85)	(101.39)	(107.73)	(112.357)	(86.13)	(78.33)	(89.70)	(118.60)
[4] Excluding top oil net exporting countries	-181.01***	-129.79**	-122.05**	-119.59**	-141.94***	-138.82***	-139.43***	-137.61***	-197.71*
	(63.82)	(56.56)	(52.24)	(60.38)	(51.28)	(45.73)	(39.43)	(43.31)	(101.91)
[5] Excluding global saving glut	-76.15	-79.28	-106.82**	-139.03*	-92.93	-113.52***	-121.07***	-113.19***	-17.11
	(61.97)	(54.86)	(51.48)	(78.36)	(65.37)	(43.62)	(42.52)	(44.18)	(41.85)
[6] Adding *Real Economy*	-124.27	-413.79***	-350.18***	-135.09	-149.13	-206.22**	-292.50***	-298.65***	-113.48**
	(140.33)	(121.54)	(119.52)	(117.70)	(108.20)	(105.99)	(111.48)	(92.10)	(46.93)
[7] Adding *Monetary Conditions*	-72.00	-153.90	-203.00*	-229.57**	-204.46*	-216.71*	-200.51*	-214.48**	-202.76**
	(159.32)	(126.97)	(119.20)	(116.75)	(122.21)	(124.74)	(123.00)	(107.64)	(87.74)
[8] Adding *Fiscal Conditions*	-317.19**	-400.36***	-328.22***	-413.43***	-375.19***	-288.90***	-256.07***	-302.53***	-189.23**
	(165.99)	(137.46)	(132.65)	(104.57)	(118.69)	(101.80)	(91.72)	(103.45)	(75.72)
[9] Adding *Macro Instability*	-201.61***	-193.32***	-190.91***	-204.65***	-195.94***	-180.97***	-172.01***	-180.47***	-111.14***
	(72.51)	(57.22)	(53.35)	(65.04)	(56.04)	(44.80)	(39.58)	(43.93)	(40.15)
[10] Adding *Institutions*	-275.61**	-321.52***	-320.44***	-335.86**	-331.21***	-323.98***	-270.19***	-315.48***	-241.70**
	(137.35)	(124.55)	(118.12)	(143.43)	(120.33)	(92.63)	(84.67)	(87.93)	(111.62)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S12A. ATT of IT adoption on Sovereign Debt Ratings (conservative IT starting dates): lagged covariates

Dependent variable: Sovereign Debt Ratings	Nearest Neighbor Matching			Radius Matching			Local Linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**2.459****	**2.269****	**2.257****	**2.367*****	**2.216*****	**2.339*****	**2.410*****	**2.327*****	**2.679*****
	(0.560)	(0.532)	(0.453)	(0.519)	(0.458)	(0.363)	(0.354)	(0.334)	(0.558)
Treated/Untreated/Total Observations	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/394/541	147/330/477
Lagged covariates									
[11] Lagged values of all covariates	1.764***	2.159***	1.913***	1.584***	1.769***	2.128***	2.328***	2.142***	2.078***
	(0.561)	(0.485)	(0.435)	(0.555)	(0.463)	(0.359)	(0.330)	(0.372)	(0.451)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S12B. ATT of IT adoption on Government Bond Yield Spreads (conservative IT starting dates): lagged covariates

Dependent variable: Government Bond Yield Spreads	N Nearest Neighbor Matching			Radius Matching			Local Linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**-380.29****	**-315.53****	**-274.75****	**-454.45*****	**-345.10*****	**-235.09***	**-271.24*****	**-244.61****	**-226.54*****
	(172.78)	(161.84)	(140.14)	(138.18)	(126.72)	(125.54)	(106.99)	(111.98)	(52.05)
Treated/Untreated/Total Observations	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/316/456	140/255/395
Lagged covariates									
[11] Lagged values of all covariates	-120.06	-239.09**	-265.55**	-220.04*	-218.37*	-291.55**	-271.20**	-277.67**	-217.82**
	(173.83)	(122.94)	(140.49)	(133.59)	(132.39)	(128.85)	(123.67)	(131.37)	(104.09)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S13A. ATT of IT adoption on Sovereign Debt Ratings (default starting IT dates): lagged covariates

Dependent variable: Sovereign Debt Ratings	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**2.768*****	**2.213*****	**2.332****	**2.348*****	**2.216*****	**2.435*****	**2.485*****	**2.429*****	**2.653****
	(0.556)	(0.502)	(0.457)	(0.475)	(0.458)	(0.365)	(0.330)	(0.357)	(0.760)
Treated/Untreated/Total Observations	147/394/541	147/394/541	147/394/541	134/394/528	142/394/536	147/394/541	147/394/541	147/394/541	147/394/541
Lagged covariates									
[11] Lagged values of all covariates	2.261***	2.316***	2.242***	2.203***	2.222***	2.190***	2.347***	2.195***	2.071***
	(0.552)	(0.498)	(0.465)	(0.494)	(0.430)	(0.342)	(0.351)	(0.357)	(0.428)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S13B. ATT of Inflation Targeting on Government Bond Yield Spreads (default starting IT dates): lagged covariates

Dependent variable: Government Bond Yield Spreads	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**-244.38**	**-218.21***	**-240.39***	**-182.08**	**-201.61***	**-276.36****	**-284.36*****	**-280.64*****	**-179.85*****
	(159.76)	(133.01)	(128.42)	(114.25)	(107.70)	(112.32)	(107.72)	(106.26)	(61.21)
Treated/Untreated/Total Observations	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	140/255/395
Lagged covariates									
[11] Lagged values of all covariates	-191.26	-206.79**	-241.25*	-245.60**	-240.17*	-294.79**	-302.73**	-305.29***	-139.68***
	(200.06)	(106.87)	(132.19)	(121.68)	(141.51)	(133.26)	(138.97)	(119.17)	(52.04)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S14A. IT adoption on Sovereign Debt Ratings: System-GMM estimations

Dependent variable:	System GMM		System GMM-IV	
Sovereign Debt Ratings	[12]	[13]	[14]	[15]
Lagged ratings	0.753***	0.734***	0.891***	0.677***
	(0.0535)	(0.0550)	(0.0450)	(0.0497)
IT (conservative)	1.189***		1.072**	
	(0.310)		(0.482)	
IT (default)		1.312***		0.987***
		(0.310)		(0.289)
GDP growth	0.177***	0.176***	0.164***	0.0917
	(0.0463)	(0.0443)	(0.0551)	(0.0597)
Log of GNI per capita	0.337	0.528*	0.428	0.941***
	(0.310)	(0.305)	(0.293)	(0.251)
Reserve to imports	1.684***	1.665***	0.464**	1.313**
	(0.532)	(0.544)	(0.222)	(0.664)
External debt to exports	-0.199**	-0.259***	-0.0657	-0.301***
	(0.0843)	(0.0940)	(0.0724)	(0.102)
GDP volatility	-0.208***	-0.191***	-0.143***	-0.224***
	(0.0319)	(0.0286)	(0.0318)	(0.0501)
Government stability	0.0717	0.0857	0.00189	0.0999
	(0.0569)	(0.0567)	(0.0684)	(0.0699)
Constant	-2.337	-3.882	-2.725	-6.227***
	(2.628)	(2.543)	(2.272)	(2.166)
Number of observations/countries	548/38	548/38	548/38	548/38
Fixed effects	Yes	Yes	Yes	Yes
Wald test pvalue	0.000	0.000	0.000	0.000
AR(1)/AR(2) pvalue	0.004/0.644	0.005/0.652	0.006/0.213	0.009/0.413
Hansen test pvalue	0.132	0.602	0.264	0.386

We use Ratha et al. (2011) control variables and substitute their variable "rule of law" by "government stability" due to missing data. Standard errors reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S14B. IT adoption and Government Bond Yield Spreads: System-GMM estimations

Dependent variable:	System GMM		System GMM-IV	
Government Bond Yield Spreads	[12]	[13]	[14]	[15]
Lagged spreads	0.534***	0.515***	0.537***	0.522***
	(0.0428)	(0.0436)	(0.0432)	(0.0440)
IT (conservative)	-279.4***		-325.9***	
	(81.73)		(82.32)	
IT (default)		-235.4***		-251.9***
		(78.44)		(62.50)
External debt-to-GDP	3.459**	4.056***	2.804***	3.671**
	(1.679)	(1.500)	(0.918)	(1.630)
External reserves-to-GDP	-4.504*	-4.774*	-3.450*	-5.409*
	(2.766)	(2.579)	(2.009)	(2.924)
Exchange rate volatility	26.73***	24.44***	21.87***	28.31***
	(7.938)	(6.683)	(5.230)	(8.188)
Government stability	-58.87**	-68.61**	-81.34**	-63.68**
	(28.40)	(29.20)	(32.43)	(29.34)
Corruption	219.7***	194.9***	157.1***	222.8***
	(64.96)	(47.46)	(47.36)	(54.02)
Fiscal deficit	8.327	6.260	7.742	6.445
	(8.520)	(9.062)	(7.062)	(9.334)
Current account surplus	-3.944	-5.320	-1.602	-5.223
	(6.832)	(6.720)	(5.021)	(8.446)
Constant	-1.022	-557.2	34.83	-1,120
	(869.3)	(422.0)	(375.2)	(1,104)
Number of observations/countries	425/38	425/38	425/38	425/38
Fixed effects	Yes	Yes	Yes	Yes
Wald test pvalue	0.000	0.000	0.000	0.000
AR(1)/AR(2) pvalue	0.016/0.698	0.013/0.615	0.034/0.522	0.004/0.730
Hansen test pvalue	0.453	0.419	0.752	0.480

We use Fouejieu & Roger (2013) control variables. Standard errors reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S15A. ATT of IT adoption on Sovereign Debt Ratings (Default IT starting dates): Sensitivity

Dependent variable: Sovereign Debt Ratings	Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**2.768*** **	**2.213*** **	**2.332** **	**2.348*** **	**2.216*** **	**2.435*** **	**2.485*** **	**2.429*** **	**2.653** **
	(0.556)	(0.502)	(0.457)	(0.475)	(0.458)	(0.365)	(0.330)	(0.357)	(0.760)
Treated/Untreated/Total Observations	147/394/541	147/394/541	147/394/541	134/394/528	142/394/536	147/394/541	147/394/541	147/394/541	147/394/541
Heterogeneity in treatment effects									
Comparing IT with Exchange Rate Targeting									
[16A] IT vs Exchange rate targeting	2.949***	2.816***	2.810***	2.821***	2.777***	2.508***	2.626***	2.563***	2.193***
	(0.559)	(0.547)	(0.494)	(0.519)	(0.450)	(0.368)	(0.383)	(0.390)	(0.111)
Phase of the business cycle									
[17A] Good times	2.065***	2.383***	2.168***	2.066**	1.825***	2.255***	2.118***	2.253***	3.412***
	(0.747)	(0.643)	(0.632)	(0.830)	(0.613)	(0.480)	(0.479)	(0.542)	(1.284)
[18A] Bad times	2.485***	2.181***	2.311***	3.019***	2.443***	2.383***	2.696***	2.393***	3.876***
	(0.778)	(0.718)	(0.653)	(0.919)	(0.758)	(0.585)	(0.602)	(0.612)	(4.716)
Fiscal stance									
[19A] Strong fiscal stance	3.130***	2.866***	2.856***	3.556***	2.954***	2.665***	2.614***	2.684***	2.669**
	(0.598)	(0.523)	(0.488)	(0.866)	(0.661)	(0.465)	(0.441)	(0.470)	(1.204)
[20A] Loose fiscal stance	2.678***	2.028***	2.152***	2.432***	2.048***	2.244***	2.468***	2.319***	3.482
	(0.997)	(0.936)	(0.797)	(1.437)	(1.034)	(0.851)	(0.871)	(0.851)	(2.326)
Level of economic development									
[21A] Lower-middle income countries	1.214*	1.023	1.182**	1.458	1.782	0.662	0.789	0.715	0.281
	(0.722)	(0.625)	(0.601)	(1.456)	(1.246)	(0.691)	(0.642)	(0.690)	(0.726)
[22A] Upper-middle income countries	1.401**	1.583***	1.928***	2.322***	1.928***	2.018***	2.178***	1.996***	1.653***
	(0.624)	(0.605)	(0.548)	(0.637)	(0.580)	(0.469)	(0.443)	(0.451)	(0.307)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S15B. ATT of IT adoption on Government Bond Yield Spreads (Default IT starting dates): Sensitivity

Dependent variable: Government Bond Yield Spreads	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Baseline result									
[1] **ATT**	**-244.38**	**-218.21***	**-240.39***	**-182.08**	**-201.61***	**-276.36****	**-284.36*****	**-280.64*****	**-179.85*****
	(159.76)	(133.01)	(128.42)	(114.25)	(107.70)	(112.32)	(107.72)	(106.26)	(61.21)
Treated/Untreated/Total Observations	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	142/314/456	140/255/395
Heterogeneity in treatment effects									
Comparing IT with Exchange Rate Targeting									
[16B] IT vs Exchange rate targeting	-42.07	-80.47	-114.93	-99.76	-131.12	-177.70*	-208.01**	-171.32	-409.32*
	(167.03)	(112.34)	(107.58)	(133.41)	(104.18)	(95.74)	(85.76)	(117.38)	(240.16)
Phase of the business cycle									
[17B] Good times	-161.93**	-115.09*	-128.32**	-188.53**	-169.83***	-105.21**	-110.51*	-103.15*	-160.88***
	(72.69)	(65.05)	(62.08)	(84.00)	(68.05)	(53.84)	(57.98)	(56.42)	(45.03)
[18B] Bad times	-203.00*	-229.24**	-204.81**	-118.07	-126.24	-181.51*	-176.63*	-192.15**	-401.38
	(118.86)	(105.63)	(101.14)	(218.39)	(142.72)	(95.61)	(90.63)	(79.90)	(367.25)
Fiscal policy stance									
[19B] Strong fiscal stance	-40.87	-62.93*	-72.00*	-57.17	-25.86	-69.44*	-82.93**	-70.74*	-98.61**
	(46.91)	(38.62)	(37.45)	(68.70)	(51.78)	(32.96)	(34.16)	(31.98)	(50.21)
[20B] Loose fiscal stance	-185.95	-362.17	-274.68	-145.51	-214.97	-281.40	-280.45	-280.57	-549.80
	(268.12)	(255.73)	(173.80)	(303.26)	(211.65)	(195.63)	(209.20)	(232.08)	(493.35)
Level of economic development									
[21B] Lower-middle income countries	-395.59**	-182.88	-170.86	-283.56	-67.39	-399.09**	-381.52**	-315.71**	-644.42
	(181.55)	(146.19)	(143.45)	(380.75)	(352.61)	(183.63)	(166.53)	(158.42)	(561.06)
[22B] Upper-middle income countries	-272.51	-238.61*	-299.86**	-312.82**	-227.99	-288.52*	-298.76**	-289.74**	-211.98***
	(187.09)	(146.17)	(134.23)	(140.38)	(149.92)	(156.20)	(126.76)	(129.21)	(14.55)
Government Bond Yield Spreads Variability									
[23] Government Bond Yield Spreads Variability	-80.72*	-95.30**	-82.75**	-82.10**	-87.81***	-99.66***	-99.67***	-95.29***	-122.49*
	(41.51)	(37.34)	(33.51)	(34.42)	(32.06)	(27.00)	(31.22)	(25.91)	(73.34)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S16A. Short and medium ATT of Inflation Targeting on Sovereign Debt Ratings: conservative starting IT dates

Dependent variable: Sovereign Debt Ratings	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
[24A] ATT_0	0.865**	1.772**	1.814**	1.514***	1.095***	1.820***	1.832**	1.880**	1.603
	(0.442)	(0.710)	(0.864)	(0.549)	(0.392)	(0.461)	(0.734)	(0.777)	(0.261)
[25A] ATT_1	1.799*	1.882**	2.168***	3.459***	2.046**	2.031***	2.155***	2.020***	1.388*
	(1.113)	(0.896)	(0.866)	(1.225)	(0.958)	(0.706)	(0.741)	(0.758)	(0.817)
[26A] ATT_2	2.153***	2.363***	2.291***	2.837***	2.380***	2.250***	2.179***	2.171***	1.194
	(0.924)	(0.824)	(0.827)	(0.993)	(0.879)	(0.705)	(0.651)	(0.639)	(0.760)
[27A] ATT_3	2.364***	2.146***	1.757***	3.144***	2.627***	2.065***	2.173***	2.122***	1.408*
	(0.882)	(0.773)	(0.740)	(0.929)	(0.734)	(0.671)	(0.606)	(0.657)	(0.741)
[28A] ATT_4	2.055***	2.262***	2.079***	2.227***	1.922***	2.132***	2.361***	2.127***	1.511**
	(0.766)	(0.733)	(0.664)	(0.809)	(0.687)	(0.528)	(0.513)	(0.551)	(0.623)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix S16B. Short and medium ATT of Inflation Targeting on Government Bond Yield Spreads: conservative starting IT dates

Dependent variable: GBY Spreads	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
[24B] ATT_0	-181.13	-175.47	-173.39	-216.82	-113.20	-223.37	-245.04	-189.92	-185.19
	(273.97)	(249.89)	(272.69)	(430.60)	(240.79)	(288.39)	(184.58)	(185.72)	(154.93)
[25B] ATT_1	-126.19*	-169.33*	-155.59**	-144.14**	-174.70**	-175.98**	-161.25**	-180.89**	-61.39*
	(73.74)	(95.32)	(69.14)	(72.40)	(84.52)	(86.20)	(70.64)	(89.88)	(35.44)
[26B] ATT_2	-154.30***	-180.50**	-161.37***	-204.56**	-181.31**	-176.01**	-178.42***	-182.28**	-118.47***
	(46.27)	(70.92)	(62.03)	(89.49)	(89.30)	(81.25)	(37.38)	(74.22)	(20.29)
[27B] ATT_3	-147.87***	-217.82**	-178.29**	-363.69***	-227.82**	-204.57***	-190.53***	-181.48***	-139.00***
	(48.49)	(95.70)	(76.93)	(56.87)	(95.57)	(44.18)	(51.00)	(54.49)	(37.36)
[28B] ATT_4	-203.36***	-243.08***	-206.96**	-374.34**	-250.71**	-188.19***	-215.92***	-154.45***	-147.03**
	(71.22)	(52.50)	(87.43)	(156.43)	(117.43)	(48.32)	(70.82)	(54.99)	(59.85)

Bootstrapped standard errors based on 500 replications reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Chapter 3. Do Wealth Transfers Capital Inflows Help Reduced Bond Yield Spreads In Emerging Market Economies?[43]

Abstract:

This paper tests whether wealth transfers capital inflows (remittances and official development aid) reduce bond yield spreads in emerging countries. Drawing upon instrumental variables techniques, it unveils that remittances inflows significantly reduce bond yield spreads, while official development aid does not. These results are fairly robust to several specifications, alternative instrumentation techniques, additional control variables, and the use of Credit Default Swaps (CDS) spreads rather than bond spreads. In addition, it finds that the effect of remittances on spreads (i) is larger in less developed financial system, (ii) increases with the degree of trade openness, (iii) is larger in low fiscal space regime, and (iv) is larger in no-remittances dependent countries.

Keywords: Government bond yield spreads; Fiscal policy; Remittances; Official development assistance; Emerging markets.

JEL codes: E44, E62, F24, F35, G15.

[43] A version of this paper is under review in the *Review of International Economics*.

The relatively stable nature of remittances suggests that countries with access to significant remittance inflows may be less prone to damaging fluctuations [...]. In extreme cases, remittances might reduce the probability of financial crises.

— IMF, *World Economic Outlook* (April 2005, Chapter II, p.73)

I. Introduction

The 2008-2009 financial crisis has deteriorated many countries' access conditions to international capital markets, and particularly for emerging countries. According to Arellano (2008), emerging countries generally tend to have more volatile and highly countercyclical borrowing costs compared to developed countries, due to the cyclical changes in the access to international credit. The countercyclical nature of interest rates means that they raise in time of recession and decrease in time of expansion. This cyclical change poses significant challenges for policymakers, leading many academic researchers to investigate the determinants of sovereign bond yield spreads.

There is an important literature on the determinants of government bond yield spreads. Bond spreads are generally associated with two main drivers: (i) domestic macroeconomic fundamentals [Edwards (1984), Baldacci & Kumar (2010), Arezki & Brückner (2010), Hilscher & Nosbusch (2010), Baldacci et al. (2011), Hatchondo et al. (2012), Comelli (2012), Aizenman et al. (2013), Eichler (2014), Costantini et al. (2014)], and (ii) global conditions on financial market and international factors [Arora & Cerisola (2001), Sy (2002), Bellas et al. (2010), Jaramillo & Tejada (2011), Arslanalp & Poghosyan (2014)]. The list of factors considered as important determinants of spreads include GDP growth, fiscal space, public debt, foreign exchange reserves, inflation, crisis episodes, the VIX index or the FED policy rate.

Despite the important literature on the determinants of bond spreads, little attention has been given with respect to the potential impact of wealth transfers capital inflows, namely remittances and official development aid (ODA), with the notable exception of Ratha (2007). In a survey, this author defines a standard country creditworthiness model, and shows that including remittances in the debt-to-export ratio can result in spread reduction of 130 to 334 basis points for Lebanon and Haiti. Apart from this stylized fact, no empirical study has, to the best of our knowledge, examined the effect of remittances or ODA on spreads. This is somewhat surprising since the empirical literature on capital flows suggests that some forms of capital are more countercyclical than others. More specifically, it has been pointed that

remittances and ODA inflows may be countercyclical, increasing during crisis and time of hardship for the recipient country.[44] Given the countercyclical nature of emerging countries borrowing costs, it begs the following question: are remittances and ODA reliable stabilizers on government bond market? In this paper, we contribute to the literature on the determinants of government bond yield spreads by analyzing the effects of remittances and ODA inflows on bond spreads in emerging countries.

There are several mechanisms through which remittances and ODA can affect emerging countries borrowing cost. Regarding remittances, first, remittances increase the receiving country fiscal space. Indeed, by increasing households' consumption or investment, remittances can raise the receiving country revenue base, and then reduce the marginal cost of raising revenue (Chami et al., 2008). In that vein, remittances improve the receiving countries' creditworthiness in the international capital market. Second, previous studies highlight the countercyclical behavior of remittances with respect to the economic conditions in migrants' country of origin (Frankel, 2011). Consequently, this countercyclical nature of remittances can play as an insurance mechanism by absorbing negative shocks, particularly those affecting receiving countries bond markets. Third, remittances can act through securitization of future remittance flows, by helping the borrowing country to mitigate its currency convertibility risk and to establish a credit history.[45] The fourth channel is the diaspora bonds channel. Originally used by Japan and China in the early 1930s, and then by Israel (since 1951) and India (since its balance of payment crisis in 1991), a diaspora bond can serve as stable and cheap source of financing, especially during bad times. Indeed, compared to other foreign investors who are more concerned about the borrowing country's creditworthiness, members of the diaspora can accept lower interest rates on their home country government bond because of "patriotism act", or home bias, or solely by the satisfaction obtained from contributing to the development of their country of origin.[46] Consequently, diaspora bonds can increase bond market liquidity and then reduce bond spreads. We should therefore expect a reduction in sovereign bond spreads with inflows of remittances.

[44] The countercyclical or procyclical behavior of ODA is discussed in the empirical literature. However, Banerjee (2009) shows that developing countries with good institutions received acyclical or countercyclical ODA. We assume that this would be the case in the present study since our sample is consisted of emerging countries.

[45] Even if remittances securitization is quite recent, it allowed many countries to raise cheaper and long-term funds in the financial market. For instance, Ratha (2007) suggests that remittances securitization allowed Brazil to raise 4 billion USD during the election period in 2002 with a spread saving of over 700 basis points. In the case of African countries, Ghana and Nigeria also raised respectively 40 and 50 million USD in the bond markets by using flows of remittances (Shimeles, 2010).

[46] For instance, in 2011, Greek government used this funding mechanism when its borrowing conditions in the financial market became very costly.

Regarding the mechanisms through which ODA can affect sovereign bond spreads, the existing literature provides rather controversial standpoints. A recent study by Morrissey (2015) provides an update of aid impacts on recipient country's fiscal behavior. Generally, most of aid is allocated to government finance (budget support) or to financing the provision of services. As a general budget support, aid should alleviate the recipient country's budget constraint, thus improving the country's credit quality in the financial market, provided aid is used efficiently, and without any political, strategic or commercial considerations. However, several studies highlight that aid is fungible and not additional (McGillivray & Morrissey, 2004), and this fungibility might compromise its effectiveness on fiscal policy. Other studies suggest that even if aid is fungible, this does not impact its effectiveness [Pettersson (2007), Wagstaff (2011)]. Moreover, a literature focusing on the determinants of "donor generosity" shows that aid is often used to satisfy commercial, strategic and political interests of donors [Wang (1999), Alesina & Dollar (2000), Gates & Hoeffler (2004), Dreher & Sturm (2012), Dreher et al. (2015)]. In such circumstances, assuming bondholders' rational expectations, we believe that aid should not have any effect on spreads. In addition, the debate on the effect of aid on a recipient country's fiscal policy also addresses its effect on domestic tax revenues mobilization, albeit with mixed results. For instance, Gupta et al. (2003) find that aid, and in particular grants, induce lower tax effort in the recipient country. Clist & Morrissey (2011) and Carter (2013) use similar data as Gupta et al. (2003) but they do not find a robust effect of aid on tax effort. These controversial results have led Clist & Morrissey (2011) to conclude that the negative effect of aid on tax performance should reflect the periods of economic reforms, which are generally associated with aid episodes and lower tax ratio. Lastly, one might also think that bondholders are more concerned with borrowing countries endogenous capacities when taking their investment decisions rather than resources derived from foreign aid. Given these conflicting evidences, we expect an ambiguous effect of ODA on bond yield spreads.

To investigate the role of remittances and ODA on bond spreads, we rely on 38 emerging countries annual data over the period 1993 to 2012. We tackle the potential endogeneity issues of remittances and ODA by using an instrumental variables (IV) strategy. Our results are as follow. First, remittances significantly reduce bond spreads in emerging market. The magnitude of this favorable effect is economically meaningful, namely a spread saving of 3 basis points following an increase of 1 percentage point of remittances-to-GDP ratio. Second, ODA has no insignificant effect on spreads. These two results are insensitive to several robustness checks including alternative specifications, alternative instrumentation techniques, additional control variables, and the use of Credit Default Swaps (CDS) spreads

rather than bond spreads. Third, we examine the potential heterogeneity of the estimated effect of remittances. We provide evidence that the effect of remittances on spreads (i) is larger in less developed financial system, (ii) increases with the degree of trade openness, (iii) is larger in low fiscal space regime, and (iv) is larger in no-remittances dependent countries.

The rest of this paper is organized as follows. Section II presents the data, the empirical model and the identification strategy. Section III discusses the baseline results and the different robustness tests. Section IV addresses the potential heterogeneity of the effect of remittances on bond spreads. Conclusions and discussion are offered in section V.

II. Data, Empirical Model and Identification Strategy

2.1. Data and Empirical Model

Based on the availability of government bond yield spreads data, our sample consists of annual unbalanced panel data on 38 emerging markets for the period 1993-2012. We measure government borrowing cost using JP Morgan Emerging Market Bond Index Global (EMBIG). The EMBIG measures the yield spread between each emerging country and the United States (US), assuming that US sovereign bonds are risk-free. EMBIG tracks total return for traded external debt instruments, and includes Brady bonds, loans, and Eurobonds with a minimum size of 500 million of dollars and an average maturity of 12 years.

Our main variables of interest are remittances and official development aid (ODA) inflows. Regarding the former, the literature usually distinguishes three different items reported in the statistic of the balance of payment: workers' remittances, compensation of employees, and migrants' transfers. Workers' remittances refer to current transfers by employed migrants, who do not reside in their countries of origin. Compensation of employees includes income of border, seasonal, and other short-term workers who work away from their usual residence, as well as earnings provided by non-resident entities to residents. Migrants' transfers represent contra-entries, flows of goods, and changes in financial items resulting from inter-country migration of individuals. A common approach in the empirical literature was to sum the three components (see Guiliano & Ruiz-Arranz, 2009; Aggarwal et al., 2011). However, as discussed in Chami et al. (2008), the measurement of remittances matters when assessing their macroeconomic implications, as, in particular, workers' remittances is the most periodic, unrequired, and non-market transfer between residents of different countries, and corresponds to the item that researchers and policymakers have in mind when discussing remittances flows. As such, they argue that the inclusion of compensation of employees and

migrants' transfers can "pollute" the database with "non-remittance" behavioral characteristics, and recommend the use of workers' remittances alone (see Chami et al., 2008, for a discussion). Following their recommendation, we use workers' remittances in our baseline analysis, and then compile the three elements as a robustness check. Data on workers' remittances comes from World Bank's development indicator.

The second variable of interest, ODA, comes from the Query Wizard for International Development Statistics of OECD. ODA captures total disbursement to all sectors provided by bilateral donors and multilateral agencies. In our sample of emerging economies, four countries (Poland, Russia, Hungary, and Bulgaria) did not received aid over the study period. In addition, South Korea stopped receiving aid in 2000, and Ukraine began receiving in 2005. One possibility in such cases consists of excluding these countries from the sample. Our preferred approach is to keep them, and thus to include periods where zero aid was received. This avoids the sample selection bias (Rajan & Subramanian, 2008; Askarov & Doucouliagos, 2015), and allows keeping the initial sample size. As a robustness check, we will provide estimations excluding no-recipient ODA countries.

The empirical model is:

$$Spread_{it} = \alpha + \beta_1 R_{it} + \beta_2 ODA_{it} + \sum_k \lambda_k X_{k,it} + \eta_i + \varepsilon_{it}, \qquad (1)$$

where $Spread_{it}$ is the sovereign bond yield spread for country i in year t, R_{it} is the amount of worker's remittances received (in % of GDP), ODA_{it} is the bilateral and multilateral official development aid received (in % of GDP), $X_{k,it}$ is the matrix of k control variables, and α, η_i and ε_{it} are the constant, country-fixed-effects, and the error term, respectively. To facilitate the interpretation, the variables $Spread_{it}$, R_{it} and ODA_{it} are expressed in logs.[47]

The matrix of control variables contains the following 11 items. *Real GDP growth* is expected to improve public debt sustainability in terms of market access due to potential higher public revenues, thus decreasing yield spread. *Total government debt* (% of GDP) should increase yield spread, as higher public debt raises the concerns about government's ability to serve its debt. *Government's fiscal deficit* (% of GDP) is expected to increase bond spread. Indeed, a large fiscal deficit may reduce national saving and raise aggregate demand (Elmendorf & Mankiw, 1999), then translating into an excess supply of government bond and thus increasing bond spread. *Total external reserves* should reduce bond spread, since higher

[47] For instance, Brückner (2011) uses the same transformation when studying the effect of aid on economic growth.

reserves strengthen government's credibility to repay public debt and its burden. The *institutional quality index* is also expected to reduce bond spread, as sound institutions should enhance the sustainability of public finances.[48] The *current account balance* (% of GDP; we exclude remittances) is expected to decrease risk premium, since a higher current account surplus improves government's ability to repay its external debt. The *real effective exchange rate* (REER) can affect a country's borrowing cost through trade performance, and domestic and external balance sheets. On the one hand, an exchange rate appreciation lowers trade competitiveness but, on the other hand, it also reduces the stock of external and domestic dollar-denominated debt. As such, the effect of REER on risk premium is ambiguous. *Sovereign debt crisis* and *banking crisis* dummies may positively affect bond spread, since government's borrowing cost should increase in time of financial stress. The *inflation rate* is expected to increase bond spread, because high inflation rates might signal unhealthy macroeconomic fundamentals and a higher economic uncertainty. *Trade openness*, (measured as the sum of exports and imports in % of GDP) could decrease the probability of external default. Finally, *Sovereign debt rating* (computed as the average of long-term foreign currency debt rating provided by Standard and Poor's, Moody's, and Fitch) may reduce risk premium, since higher rating grades usually signal better macroeconomic performances. Appendix 1 presents the sources and definitions of variables.

2.2. Identification strategy

The main challenge of this study is to identify the appropriate parameters of interest β_1 and β_2 in equation (1) above, given the potential issue of endogeneity. Indeed, remittances and ODA may be endogenous for a number of reasons. Regarding remittances, first, there may be a simultaneity bias running from remittances to bond spread and vice versa. For instance, if remittances can reduce bond spread as discussed in the introduction, worsening conditions of access to financial markets can also affect fiscal policy management, for example through a reduction of social transfers or operating expenditures. More generally, a tightening of government's borrowing constraint can lead to procyclical fiscal policy (Galvin & Perotti, 1997). In such circumstances, one would thing that migrants can remit more money in order to support their families back home, and this raises the issue of simultaneity bias. Second, data on remittances suffer from measurement errors, with unrecorded remittances accounting for 20 to 200% of recorded remittances (Freund & Spatafora, 2008). Besides, as recently pointed

[48] Following Frankel et al. (2013), we build an index of institutional quality equal to the average of four normalized variables, namely investment profile, corruption, law & order and bureaucratic quality.

out by Clemens & McKenzie (2014), much of the recent rise in measured remittances may be illusory, arising from changes in measurement rather than changes in real financial flows. Third, there may be an omitted variable bias since it is not sure that we control for all factors that affect both remittances and bond spreads.

Regarding ODA, endogeneity may arise from simultaneity bias or measurement errors. First, bilateral and multilateral donors can increase their development aid effort to support a recipient country that faced difficulties in gaining access to international capital market, raising the issue of simultaneity bias. For instance, the euro area member States and the International Monetary Fund (IMF) have been providing financial support to the Greek government since 2010, in a context of sharp deterioration in Greece's market financing conditions. Second, as explicitly recognized by the OECD, despite an improvement in donors' ODA data reporting during the last two decades, the problem of measurement errors still subsists.

Our strategy to mitigate these endogeneity issues is to identify some external instruments for remittances and ODA. In our benchmark analysis, we consider two instruments for remittances. First, we compute the (i) *potential earning in migrants' host countries*, proxied by real GDP per capita of each destination country weighted by the share of emigrants of each recipient country. The underlying idea is that remittances sent home are positively related to the economic conditions in the countries of residence of migrants. However, there is no reason to suspect a direct link between (i) and bond spreads in the country of origin, after controlling for international business cycle transmission through the variables of trade openness, capital account openness, and financial crises. Second, we use the (ii) *share of young population* (0-14 years) in the recipient country as a second external instrument. This variable is expected to be positively correlated with remittances. The underlying ideas is that the presence of young family members may trigger additional remittances especially on health spending and education (Beine et al., 2012). However, there is no reason to believe that (ii) can impact debt cost, once its potential effect on public debt trajectory is ruled out.

Regarding ODA, we instrument it using the (i') *average voting similarity index at the United Nations (UN) general assembly*, the (ii') *average linguistic proximity*, and the (iii') *infant mortality rate in the recipient country.*[49] (i') is computed using bilateral ODA from 22 OECD

[49] Prior to using these variables as external instrument, we followed Tavares (2003) and instrumented ODA using a bilateral distance variable, a common land border dummy, a dummy for sharing a same major religion, and average donors' budget. However, we report that this strategy lead to weak instrumentation in most cases (results are available upon request).

donor countries, and as the sum of the share of ODA received by each recipient from each donor per year weighted by the annual voting similarity index.[50] The relevance of this instrument is supported by previous research showing that bilateral and multilateral aid are generally used to "buy" political support from recipient countries. In particular, the UN voting index has been widely accepted in the related literature as a reliable indicator of the political motivation of aid (Wang, 1999; Alesina & Dollar, 2000; Alesina & Weber, 2002; Gates & Hoeffler, 2004; Fink & Redaelli, 2011; Dreher & Sturm, 2012; Dreher et al., 2015). For instance, Alesina & Dollar (2000) use bilateral aid data and find that recipient countries received more aid from all major donors when voting in line with the donor country at the UN general assembly. Dreher & Sturm (2012) focus on multilateral grants and conclude that countries receiving large non-concessional loans from IMF and the World Bank voted more frequently in line with G7 countries. Following these empirical findings, we expect a positive relationship between the UN voting index and the volume of aid received.

We follow the same logic and compute (ii') using the linguistic proximity. Our linguistic proximity variable differs from traditional binary variables, such as common official language or common native language, employed in previous literature (see for instance Tavares, 2003; Rajan & Subramanian, 2008). It is a continuous variable builds on the basis of ethnologists' classification of language family trees provided by CEPII. As such, it captures the historical, commercial, and cultural patterns of aid.[51]

Finally, we employ (iii') as an indicator of poverty to capture the recipient country need for aid. Data on (iii") are taken from the world development indicators and correspond to the number of infants dying before reaching one year of age per 1,000 births in a given year.

III. Results

We begin by presenting our baseline results of the effect of remittances and ODA on sovereign bond yield spreads, and then we explore the robustness of our findings.

3.1. Baseline results

Table 1 presents the baseline results based on instrumental variables approach. We initially introduce remittances and ODA separately in the regressions (see columns [1]-[2], and [4]-

[50] Data on the voting similarity index come from Strezhney & Voeten (2013), and equals the ratio between the total of votes where both states agree, and the total of joint votes.
[51] For instance, France focuses its development aid on the International Organization of La Francophonie members, while the US provides relatively more aid to English-speaking countries.

Table 1. Remittances, ODA, and Sovereign Bond Yield Spreads (IV-FE results)

	[1]	[2]	[3]	[4]	[5]	[6]
Log Remittance-to-GDP	**-0.322****		**-0.298*****	**-0.276****		**-0.186***
	(0.135)		**(0.110)**	**(0.117)**		**(0.104)**
Log ODA-to-GDP		**-0.077**	**-0.268**		**-0.482**	**-0.427**
		(0.360)	**(0.409)**		**(0.385)**	**(0.410)**
Log Trade openness-to-GDP	-0.378	-0.554**	-0.381	0.176	0.00709	0.124
	(0.319)	(0.248)	(0.282)	(0.303)	(0.255)	(0.274)
Real GDP growth	-0.0483***	-0.0528***	-0.0462***	-0.0468***	-0.0539***	-0.0510***
	(0.00876)	(0.00737)	(0.00973)	(0.00770)	(0.00728)	(0.00805)
Log Total government debt-to-GDP	0.631***	0.646***	0.657***	0.240**	0.234**	0.222**
	(0.115)	(0.112)	(0.127)	(0.0993)	(0.0978)	(0.102)
Government fiscal deficit-to-GDP	-0.00143	0.000425	-0.00257	-0.00829	-0.00600	-0.00735
	(0.0148)	(0.0136)	(0.0141)	(0.0132)	(0.0127)	(0.0131)
Log Total external reserves-to-GDP	-0.221**	-0.352***	-0.248***	-0.0317	-0.147**	-0.0520
	(0.0889)	(0.0725)	(0.0838)	(0.103)	(0.0727)	(0.0959)
Institutional quality	-1.659*	-0.475	-1.543**	-0.491	0.519	-0.142
	(0.872)	(0.620)	(0.761)	(0.817)	(0.625)	(0.757)
Current account balance-to-GDP	-0.00121	0.00826	-0.000124	-0.00498	0.00573	-0.00215
	(0.0128)	(0.0109)	(0.0116)	(0.0129)	(0.0110)	(0.0122)
Log Real effective exchange rate	-0.588***	-0.412**	-0.503**	0.266	0.228	0.184
	(0.205)	(0.198)	(0.236)	(0.241)	(0.245)	(0.263)
Sovereign debt crisis	0.499***	0.400***	0.481***	0.371***	0.266**	0.328***
	(0.113)	(0.107)	(0.111)	(0.124)	(0.120)	(0.124)
Banking crisis	0.399***	0.387***	0.385***	0.189***	0.230***	0.216***
	(0.0879)	(0.0805)	(0.0875)	(0.0670)	(0.0657)	(0.0694)
Inflation rate	8.62e-05	0.000101	9.49e-05	3.55e-06	2.15e-05	5.98e-06
	(0.000216)	(0.000125)	(0.000211)	(0.000173)	(0.000109)	(0.000150)
Sovereign debt rating				-0.212***	-0.189***	-0.207***
				(0.0316)	(0.0236)	(0.0275)
First stage regressions for instrumentation						
Log Real GDP per capita in host countries	3.886***		3.740***	3.485***		3.506***
	(0.9259)		(0.8925)	(0.9717)		(0.9210)
Share young population	0.0456*		0.0832***	0.0112		0.0255
	(0.0257)		(0.0257)	(0.0283)		(0.0303)
Average voting similarity		0.0034***	0.0034***		0.0033***	0.0032***
		(0.0005)	(0.0005)		(0.0005)	(0.00052)
Infant mortality rate		0.0054*	0.0023		0.0126***	0.0125***
		(0.0031)	(0.0038)		(0.0035)	(0.0053)
Average linguistic proximity		0.0034***	0.0486***		0.0472***	0.0502***
		(0.0005)	(.0161)		(0.0172)	(0.0172)
Observations	440	440	440	430	430	430
R-squared	0.371	0.452	0.382	0.472	0.502	0.489
F-stat remittance instrumentation [p-value]	9.33 [0.00]		13.62 [0.00]	11.31 [0.00]		7.96 [0.00]
F-stat ODA instrumentation [p-value]		21.15 [0.00]	13.38 [0.00]		23.77 [0.00]	15.57 [0.00]
Hansen J statistic (p-value)	0.63	0.35	0.63	0.55	0.17	0.12
Number of countries	38	38	38	38	38	38
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

[5]) and then simultaneously (columns [3] and [6]). At the outset, it is worth noting that sovereign debt rating is highly correlated with most of the country macroeconomic variables. For this reason, we present the results with and without credit rating (columns [1]-[3], and [4]-[6], respectively) and consider the regression in column [3] as our benchmark specification.

In all the estimations, we report the first stage regressions of the instrumental variables approach. It appears clearly that our instruments are statistically highly significant and with the expected signs (except for the share of the very young people in two out of four cases). In particular, GDP per capita in host countries and the share of the young population in remittance-recipient countries are positively correlated with remittances inflows. Similarly, average voting similarity, average linguistic proximity and infant mortality rate are positively associated with ODA. In addition, the F-tests of the first stage regressions for remittances and ODA are higher than 10, with respect to the golden rule of Staiger & Stock (1997), except for remittances IV equations in columns [1] and [6]. This may indicate that instrumenting remittances by the share of the very young population does not work well. Consequently, we re-estimate the remittances' IV regressions in columns [1], [3], [4] and [6] in Table 1 with just potential earning of migrants as an instrument for remittances. The results of these new regressions reported in Table 2 are conclusive: all the instruments are significant with the expected signs, and the first stage F-test statistics are larger than 10. We can then conclude that our instruments for remittances and ODA are relevant. Moreover, we report in Tables 1 and 2 the Hansen test for over-identification restrictions. As it clearly appears, the p-values of the Hansen test are larger than the conventional level—meaning that the over-identification restrictions are valid. We now turn to the results for our main variables of interest.

In columns [1], [3], [4], [6] of Table 1 and columns [1]-[4] of Table 2, all the estimated coefficients of remittances are negative and statistically significant. The size of these coefficients lies between -0.40 and -0.19 percent and is economically meaningful. Indeed, a 1 percentage increase in remittances-to-GDP leads to 0.19 to 0.40 percentage fall in bond yield spreads. Given that the average borrowing cost for our sample of emerging countries is approximately 500 basis points (see Appendix 2), in concrete terms, that means that an increase of 1 percent of remittances-to-GDP inflows decreases sovereign debt risk premia of about 3 basis points. The results for ODA are also reported in columns [2]-[3], [5]-[6] (in Table 1), and [2], [4] (in Table 2). We find that the estimated coefficients are statistically insignificant in all cases, meaning that ODA does not have any effect on government bond yield spreads in our sample of emerging countries.

To sum up, the empirical results reported in Tables 1 and 2 suggest that remittances negatively impact bond yield spreads, while ODA does not. Regarding the control variables, most of them are statistically significant with the expected signs. However, some variables lose their statistical significance once sovereign debt rating is introduced in the regressions, probably due to multicollinearity. Consistent with early studies, we find that higher GDP growth, higher exchange reserves, sound institutions and real effective exchange rate

Table 2. Remittances, ODA, and Sovereign Bond Yield Spreads (IV-FE results)

	[1]	[2]	[3]	[4]
Log Remittance-to-GDP	**-0.395*** **	**-0.371*** **	**-0.322*** **	**-0.249** **
	(0.131)	**(0.125)**	**(0.115)**	**(0.105)**
Log ODA-to-GDP		**-0.257**		**-0.380**
		(0.396)		**(0.411)**
Log Trade openness-to-GDP	-0.313	-0.311	0.231	0.202
	(0.303)	(0.281)	(0.296)	(0.272)
Real GDP growth	-0.0482***	-0.0463***	-0.0468***	-0.0507***
	(0.00977)	(0.0106)	(0.00837)	(0.00867)
Log Total government debt-to-GDP	0.614***	0.637***	0.222**	0.200**
	(0.116)	(0.127)	(0.0977)	(0.100)
Government fiscal deficit-to-GDP	-0.00416	-0.00527	-0.0123	-0.0114
	(0.0143)	(0.0139)	(0.0128)	(0.0126)
Log Total external reserves-to-GDP	-0.188**	-0.215**	-0.00266	-0.0193
	(0.0955)	(0.0938)	(0.110)	(0.101)
Institutional quality	-1.877**	-1.756**	-0.590	-0.286
	(0.814)	(0.747)	(0.801)	(0.747)
Current account balance-to-GDP	-0.00412	-0.00304	-0.00739	-0.00517
	(0.0116)	(0.0106)	(0.0123)	(0.0118)
Log Real effective exchange rate	-0.634***	-0.551**	0.250	0.180
	(0.198)	(0.231)	(0.245)	(0.267)
Sovereign debt crisis	0.529***	0.511***	0.391***	0.355***
	(0.116)	(0.115)	(0.126)	(0.126)
Banking crisis	0.400***	0.386***	0.182***	0.204***
	(0.0929)	(0.0913)	(0.0693)	(0.0718)
Inflation rate	8.57e-05	9.41e-05	2.48e-06	4.30e-06
	(0.000235)	(0.000229)	(0.000183)	(0.000162)
Sovereign debt rating			-0.217***	-0.213***
			(0.0336)	(0.0298)
First stage regressions for instrumentation				
Log Real GDP per capita in host countries	3.487***	3.126***	3.486***	3.421***
	(0.7751)	(0.8325)	(0.7775)	(0.6139)
Average voting similarity		0.0034***		0.0032***
		(0.0005)		(0.0005)
Infant mortality rate		0.0052*		0.0132***
		(0.0031)		(0.0023)
Average linguistic proximity		0.0426***		0.0496*
		(0.0158)		(0.0266)
Observations	450	450	440	440
R-squared	0.330	0.345	0.454	0.473
F-stat remittance instrumentation [p-value]	20.24 [0.00]	13.25 [0.00]	20.10 [0.00]	10.06 [0.00]
F-stat ODA instrumentation [p-value]		15.53 [0.00]		24.64 [0.00]
Hansen J statistic (p-value)		0.45		0.11
Number of countries	38	38	38	38
Country fixed effects	Yes	Yes	Yes	Yes

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

appreciation are negatively correlated with bond yield spreads, while higher government debt, banking and debt crises are positive determinants of spreads. The negative coefficient for real effective exchange rate suggests that the balance sheet effect may dominate the competitiveness effect.

3. 2. Robustness tests

We test the robustness of our findings in different ways. The results are presented in Table 3, and Annexes 1 and 2. Let us begin with the results in Table 3. First, since we use the share of the very young people and infant mortality rate as external instruments, one can suspect a relationship between the age structure of the population or the infant mortality rate, and the structure of the government spending. Suppose, for example, a benevolent social planner whose goal is to maximize the total utility of the society. The social planner would spend more money on priority sectors where the marginal benefit from additional expenditure is higher. This may be the health sector if infant mortality rate is higher, or the educational sector if the share of the very young population is important. Such allocations of public spending may improve the efficiency of the public sector and thus lower bond spreads. This possibility could jeopardize the external validity of our two instruments mentioned above. We solve this potential puzzle by controlling in a first step for total government expenditure (see column [1]), and then by making a disaggregation between health and education expenditures (see column [2]). The new results are very similar to the benchmark findings, both in significance and magnitude, suggesting that our results are fairly robust to this potential violation of the exclusion restriction.

Second, we replicate our baseline estimation by replacing the ratios of remittances and ODA over GDP by their per capita values.[52] The underlining idea is to capture the potential variation in intensity of the receiving country fiscal space resulting from these two types of capital flows. The results reported in column [3] are conclusive, confirming the robustness of our baseline results.

Next, we look for a potential role of time-specific factors. For this purpose, we include in the regression time dummies to account for common shocks across countries.[53] The results are reported in column [4] of Table 3. We find that the effects of remittances and ODA on bond yields are not driven by time specific factors.

In column [5], we use an alternative proxy of government borrowing cost, namely credit default swap (CDS) spreads. Indeed, if bond market and CDS market are fully integrated, and arbitrage takes place, the price of the credit risk in the two markets should follow the similar patterns (see Zhu, 2006, for an empirical comparison of credit spreads

[52] We also use other alternative definitions of the two principal variables of interest. More precisely, we first replace remittances flows by the sum of workers' remittances, compensation of employee and migrant's transfers. Second, we define ODA excluding debt relief, substitute disbursement with commitments. Overall, the results, available upon request, are consistent with our findings in the baseline specification.

[53] Including time dummies remove US bond yield from the left hand side of the estimated equation. As a result, the dependent variable in column [4] is no longer bond yield spread but rather bond yield.

between bond market and CDS market). Despite a significant reduction in the number of observations due to the limitation of CDS spreads data availability, our results are remarkably robust to the use of CDS spreads. We find that remittances significantly reduce CDS spreads, while the effect of aid remains statistically insignificant.

Fifth, we consider a possible inertia in the evolution of government risk premium and employ a system-GMM estimator. In addition to the traditional system-GMM, we also propose an augmented system-GMM using our external instruments to increase the efficiency of the estimates. The results are presented in columns [6] and [7] of Table 3 for traditional system-GMM and augmented system-GMM-IV, respectively. Before going to the interpretation of the estimated coefficients, we submit the estimations to the traditional three diagnostic tests–the Hansen test for overidentifying restrictions and the Arellano-Bond tests for first and second order serial correlation. The results of the Hansen and serial correlation tests are conclusive—we find a first order serial correlation but no second one, and the overidentifying restrictions are also valid. More importantly, the estimated coefficients associated to remittances remain remarkably significant and of comparable magnitude compared to the benchmark results in Table 1. However, the coefficients for ODA remain no statistically different from zero. Consequently, we find that the effects of remittances and ODA on government borrowing cost are robust to the use of alternative estimation techniques.

The next step consists of controlling for other determinants of spreads to make sure that our results are not driven by the specific choice of the control variables introduced in the regressions. To do so, we consider other relevant determinants of bond yield spreads found in previous literature. These additional factors include real GDP per capita (a proxy for the level of economic development), capital account openness (measured by the Chinn-Ito Index), unemployment rate (in % of labor force), currency crisis dummy, IMF lending program dummy, credit to private sector (in % of GDP, as a measure of the level of financial development), stock of immigrants, and monetary damage from natural disasters. The results are reported in Annex 1 in which the additional control variables are introduced sequentially—columns [1]-[8], and then simultaneously—column [9]. Irrespective of the specification, the results remain consistent, adding to the robustness of the benchmark results.

We finally provide additional robustness checks in Annex 2. In column [1], we exclude no-receiving ODA countries (as discussed in section 2.1). In column [2], we test whether the results are robust to different sample periods by excluding the period post-2006 to isolate the potential influence of the 2007 crisis, the well-known global saving glut, and the recent post-crisis quantitative easing measures. In column [3], we examine the sensitivity of the results to different sample size by excluding top oil exporting countries to isolate the

specific impact of these countries. The results of these additional robustness checks in Annex 2 are consistent with our previous findings. We find that remittances flows lower bond yield spreads in emerging countries, while aid flows do not.

All in all, we find that our results are robust to a wide set of robustness checks. In the following section, we focus particularly on the potential heterogeneity of the estimated effect of remittances on bond spreads.[54]

IV. Heterogeneity in the effect of remittances

Our analysis presented so far shows that remittances significantly reduce bond yield spreads in emerging countries. But is this effect similar to all emerging countries, regardless of these countries structural characteristics? To answer this question, we condition the effect of remittances on the degree of financial development, trade openness and fiscal space. To do so, we employ both an endogenous and an exogenous threshold models to split the sample into two groups, depending on the degree of financial development, trade openness and fiscal space. We also test for potential heterogeneity in remittance-dependent countries.

4.1. Remittances and financial development

We first condition the effect of remittances to financial development. More specifically, we estimate equation (1) for two groups of countries: (i) high degree of financial development; and (ii) low degree of financial development. We proxied the level of financial development by the ratio of domestic credit to private sector over GDP. As stated before, we split the sample in two ways in order to evaluate the consistency of results obtained. As a first step, the median level of financial development is used as an exogenous threshold value. In a second step, we follow Hansen (2000) and estimate an endogenous threshold value of financial development of 20.63%. This endogenous threshold is fairly close to the estimated value of Guiliano & Ruiz-Arranz (2009) and Combes et al., (2011).

There are three main reasons explaining why the degree of financial development may affect differently the effect of remittances on sovereign risk premia. First, existing studies suggest that the countercyclical nature of remittances depends on the degree of financial development. More specifically, remittances are more countercyclical in countries with less developed financial systems. Indeed, because of credit market failures in their

[54] Following the existing literature on the effectiveness of aid, we condition the effect of aid on the institutional structure (Burnside & Dollar, 2000) and the effectiveness of public expenditure programs (Roberts, 2003). However, this effort leads to insignificant results of the effect of aid.

Table 3. Robustness tests (IV-FE and, System-GMM results)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
	Potential violations of exclusion restriction		Rem & ODA per capita	Time dummies	CDS Spreads	System GMM	System GMM-IV
Log Remittance-to-GDP	**-0.301****	**-0.421*****	**-0.3736*****	**-0.475****	**-0.436****	**-0.373****	**-0.330****
	(0.124)	**(0.129)**	**(0.115)**	**(0.238)**	**(0.202)**	**(0.188)**	**(0.159)**
Log ODA-to-GDP	**-0.309**	**-0.201**	**-0.0125**	**-0.783**	**-0.731**	**-0.199**	**-0.307**
	(0.418)	**(0.473)**	**(0.0598)**	**(0.537)**	**(0.987)**	**(0.379)**	**(0.282)**
Log Trade openness-to-GDP	-0.388	-0.203	-0.185	-0.554**	1.396**	0.0831	-0.0206
	(0.263)	(0.316)	(0.330)	(0.223)	(0.677)	(0.655)	(0.336)
Real GDP growth	-0.0472***	-0.0516***	-0.0463***	-0.0234**	-0.0766***	-0.0342	-0.0447**
	(0.00956)	(0.0122)	(0.00936)	(0.0109)	(0.0147)	(0.0237)	(0.0224)
Log Total government debt-to-GDP	0.734***	0.780***	0.685***	0.685***	0.701***	0.199	0.290
	(0.158)	(0.185)	(0.128)	(0.111)	(0.240)	(0.258)	(0.273)
Government fiscal deficit-to-GDP	-0.00291	-0.0188	0.000252	0.00759	-0.0565**	0.0262	0.0439
	(0.0143)	(0.0184)	(0.0143)	(0.0112)	(0.0239)	(0.0470)	(0.0348)
Log Total external reserves-to-GDP	-0.253**	-0.104	-0.161	-0.337***	0.00667	-0.201	-0.160
	(0.0992)	(0.121)	(0.104)	(0.110)	(0.216)	(0.348)	(0.232)
Institutional quality	-1.115	-1.459*	-0.723	-1.871*	-2.951	-1.687	-2.118
	(0.719)	(0.809)	(0.616)	(1.007)	(2.035)	(2.260)	(1.577)
Current account balance-to-GDP	0.00551	-0.0170*	-0.00377	-0.00101	0.00295	-0.0461	-0.0392
	(0.0108)	(0.0102)	(0.0118)	(0.00980)	(0.0163)	(0.0447)	(0.0421)
Log Real effective exchange rate	-0.465*	-0.780***	-0.176	-0.821***	-0.951	0.348	0.296
	(0.247)	(0.293)	(0.213)	(0.280)	(0.632)	(0.562)	(0.567)
Sovereign debt crisis	0.366***	0.569***	0.548***	0.534***	0.362	1.273**	0.908*
	(0.119)	(0.167)	(0.115)	(0.159)	(0.302)	(0.539)	(0.521)
Banking crisis	0.388***	0.594***	0.419***	0.378***	0.795***	0.0234	0.0570
	(0.0944)	(0.110)	(0.0937)	(0.114)	(0.251)	(0.368)	(0.342)
Inflation rate	0.00765**	0.00883	0.000154	0.000236	0.0279	0.00288	0.00263
	(0.00377)	(0.00627)	(0.000275)	(0.000260)	(0.0182)	(0.00444)	(0.00303)
Public expenditure	0.0044						
	(0.0193)						
Public health expenditure		-0.0618**					
		(0.0268)					
Public expenditure on education		-0.0112					
		(0.0176)					
Lag Sovereign bond yield spreads						0.460**	0.4388*
						(0.233)	(0.246)
Observations/R-squared	430/0.382	289/0.392	421/0.380	450/0.344	137/0.559	410/-	410/-
F-stat remittance instrumentation [p-value]	15.16 [0.00]	6.89 [0.00]	8.65 [0.00]	5.15 [0.00]	9.28 [0.00]		
F-stat ODA instrumentation [p-value]	13.97 [0.00]	9.39 [0.00]	10.67 [0.00]	17.25 [0.00]	12.14 [0.00]		
Hansen J statistic (p-value)	0.60	0.16	0.53	0.58	0.49	0.71	0.72
AR(1)/AR(2)						0.06/0.22	0.07/0.19
Number of countries/instruments	38/-	36/-	38/-	38/-	17/-	38/26	38/31
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

countries of origin, migrants worry more about protecting their families left behind, particularly when they face negative shocks. Consequently, remittances can insure against different types of macroeconomic shocks and most importantly if financial development is low. Second, existing studies also suggest that remittances are substitutes for promoting economic activities in countries where credit market is inefficient or inexistent (Guiliano & Ruiz-Arranz, 2009). By doing so, remittances increase a country's fiscal space and thereby raise government potential tax revenues. Third, the bond market can serve as a safe investment for migrants in countries with a lower level of financial development. In this later case, the bond purchase by migrants enhances bond market liquidity with potential beneficial effect on liquidity premium.

The results are reported in Table 4—column 1 and 4 using exogenous and endogenous threshold values respectively. As expected, there is strong evidence that the effect of remittances on government risk premia depends on the level of financial development. On the one hand, the marginal impact of remittances is not statistical different from zero in the high financial development regime, independently of the type of threshold used. On the other hand, remittances have a positive and significant effect in the low financial development regime.

On balance, the result suggests that the beneficial effect of remittances on a sovereign bond market is obvious in less financial developed countries. Our finding is in line with the work of Guiliano & Ruiz-Arranz (2009).

4.2. Remittances and trade openness

In this sub-section, we explore the heterogeneity of the response of bond yield spreads to an increase in remittances by splitting our sample in two groups depending on the level of trade openness: (i) high degree of openness; (ii) low degree of openness. The main reason is that countries that are more open to trade are relatively more vulnerable to external shocks and also receive more remittances. We believe that remittances would be beneficial in countries with higher openness to international trade. In those countries, remittances can play an insurance role against external and internal negative shocks and help mitigating the potential adverse effect on bond market. As it is standard in the literature, we proxy trade openness by the ratio of imports plus exports over GDP and then, estimate an endogenous threshold value of 50.5%.

The results of the estimation for the two regimes are reported in Table 4—column 2 for exogenous threshold and column 5 for endogenous one. As expected, the beneficial effect of remittances on government borrowing cost occurs in countries with high degree of trade

openness. For countries in the lower regime, remittances do not seem to have a significant effect on the cost of the debt.

4.3. Remittances and fiscal space

We also condition the effect of remittances to fiscal space. We proxy fiscal space by the ratio of government debt over total tax revenue (Aizenman et al., 2013).[55] It is obvious that remittances increase the fiscal space in the receiving economy, whether they are used for current consumption or for investment. Furthermore, previous studies found that remittances inflows are higher in high indebted countries (i.e. in countries with lower fiscal space). By increasing fiscal space, we believe that remittances can mitigate the notion of fiscal fatigue particularly when the ability of the government to raise the primary surplus is restricted. More precisely, we test the hypothesis that the market response to remittances inflows may be apparent only when the country is close to its fiscal capacity. Consequently, we estimate equation (1) for two sub-samples: (i) low fiscal space; and (ii) high fiscal space, using both an exogenous and an endogenous threshold values.[56]

The results are reported in Table 4—column 3 for exogenous threshold and column 6 for endogenous threshold. Our findings are in line with our expectation: remittances have a significant effect in reducing bond yield spreads when the government ability to collect tax in the future is limited, but not any significant effect in high fiscal space stand. More importantly, the magnitude of the estimated coefficient in (i) is more important than in the total sample meaning than market attaches great importance to remittances inflows in this group. Specifically, a 1 percent increase of remittances received over GDP reduces bond spreads by 1 percent in lower fiscal space countries.

4.4. Do Remittance-dependent countries behave differently?

In this sub-section, we question whether market will react differently in remittance-dependent countries. This is a relevant question, since remittance-dependent countries may be highly vulnerable to global economic turmoil. In some sense, a high dependency could reflect a non-diversification of the economy. We think that bondholders can be more-risk averse in these countries. Moreover, large flows of remittances can have a negative effect on fiscal space though the reduction of labor supply of recipient households. Furthermore, previous studies

[55] What might be of more value is to measure country's fiscal space by the distance between current debt levels and the debt limit à la Ostry et al. (2010). However, this is far from the primary interest of this paper.
[56] We estimate an endogenous fiscal space (debt/tax) value of 3.69.

find that a high level of remittances can lead to more corruption (Chami et al., 2008), or Dutch Disease (Acosta et al., 2009; Bourdet & Falck, 2006) or diminished the stabilizing effect of remittances on consumption and output instabilities (Combes & Ebeke, 2011; Chami et al., 2009). To test this potential heterogeneity, we divide our sample by quartile depending on the level of remittances received.[57] We then estimate equation (1) for two sub-samples: (i) the top third quartiles; and (ii) the fourth quartile. The average level of remittances received is 3 percent of GDP in the first group, and 10 percent in the second.[58]

The results reported in Annex 3 are as follow. In the first group, remittances flows significantly reduce bond yield spreads. However, no statistically significant effect occurred in larger dependency countries.

[57] We first performed an endogenous threshold model depending on the level of remittances. Unfortunately, this initiative did not lead to interesting results.

[58] We are aware that this approach is arbitrary. However, we believe that the average level of remittances of 10 percent of GDP in the second group is a good proxy for larger remittances dependency countries. Indeed, Combes & Ebeke (2011) estimated an endogenous threshold value of 6 percent of GDP when studying the effect of remittances on household consumption instability in developing countries.

Table 4: Heterogeneity in the effect of remittances (IV-FE results)

	Exogenous Threshold estimation						Endogenous Threshold estimation					
	[1] Financial development		[2] Trade openness		[3] Fiscal space		[4] Financial development		[5] Trade openness		[6] Fiscal space	
	Below	Above	Below	Above	Below	Above	<20.64	>=20.63	<50.52	>=50.52	<3.69	>=3.69
Log Remittance-to-GDP	**-0.368****	**-0.426**	**-0.128**	**-0.524*****	**-0.344**	**-1.002****	**-0.381****	**-0.479**	**-0.142**	**-0.344*****	**-0.315**	**-0.921***
	(0.151)	**(0.259)**	**(0.141)**	**(0.128)**	**(0.211)**	**(0.428)**	**(0.153)**	**(0.296)**	**(0.148)**	**(0.127)**	**(0.215)**	**(0.474)**
Log ODA-to-GDP	**-1.155**	**0.854**	**-1.141**	**0.573**	**-1.515**	**1.465**	**-1.375**	**0.390**	**-0.139**	**0.512**	**-1.311**	**1.324**
	(0.846)	**(0.960)**	**(0.700)**	**(0.527)**	**(1.314)**	**(0.981)**	**(1.324)**	**(0.611)**	**(0.763)**	**(0.469)**	**(1.136)**	**(1.066)**
Log Trade openness-to-GDP	-0.670	-0.845			-0.390	-0.945	0.625	-0.544			-0.316	-0.729
	(0.529)	(0.853)			(0.370)	(0.576)	(0.596)	(0.453)			(0.430)	(0.556)
Real GDP growth	-0.0567***	-0.0566***	-0.0407***	-0.0642***	-0.0837***	-0.0261	-0.0214	-0.0613***	-0.0332***	-0.0599***	-0.0757***	-0.0300
	(0.0160)	(0.0134)	(0.0107)	(0.0115)	(0.0200)	(0.0194)	(0.0209)	(0.0183)	(0.0126)	(0.00916)	(0.0185)	(0.0189)
Log Total government debt-to-GDP	0.434	0.675**	0.630***	0.637***			1.151*	0.631**	1.237***	0.651***		
	(0.352)	(0.343)	(0.164)	(0.186)			(0.597)	(0.296)	(0.300)	(0.165)		
Government fiscal deficit-to-GDP	-0.0110	0.0205	-0.0264**	-0.00186	-0.00654	-0.0280	-0.0292	0.0172	-0.0184	0.00698	-0.0106	-0.0303
	(0.0226)	(0.0371)	(0.0108)	(0.0160)	(0.0290)	(0.0244)	(0.0247)	(0.0281)	(0.0184)	(0.0180)	(0.0230)	(0.0218)
Log Total external reserves-to-GDP	-0.556***	-0.0893	-0.406***	0.244	0.0286	-0.626***	-0.597	-0.118	-0.916***	-0.200*	0.0541	-0.625***
	(0.158)	(0.165)	(0.113)	(0.153)	(0.177)	(0.200)	(0.522)	(0.109)	(0.221)	(0.110)	(0.155)	(0.203)
Institutional quality	-1.286	-2.358	0.286	-2.512*	-2.127	-4.016***	-0.430	-2.017*	0.680	-1.308	-1.887	-3.579**
	(1.076)	(1.575)	(0.815)	(1.362)	(1.434)	(1.483)	(1.945)	(1.102)	(1.037)	(1.356)	(1.427)	(1.431)
Current account balance-to-GDP	0.0158	0.00807	-0.00906	-0.00686	-0.00311	0.0264	0.00598	-0.00870	-0.0124	0.00463	5.59e-05	0.0371
	(0.0164)	(0.0194)	(0.0136)	(0.0140)	(0.0131)	(0.0253)	(0.0151)	(0.0139)	(0.0215)	(0.0156)	(0.0154)	(0.0278)
Log Real effective exchange rate	-1.462***	0.393	-0.764***	0.274	-1.529***	-0.456	-0.301	-0.476	-0.710***	0.156	-1.583***	-0.299
	(0.348)	(0.505)	(0.243)	(0.499)	(0.347)	(0.476)	(0.379)	(0.360)	(0.256)	(0.436)	(0.283)	(0.505)
Sovereign debt crisis	0.551***	1.022	0.412***	0.0950	0.282	0.629**	0.245	0.420**	0.448***	0.383**	0.377**	0.610**
	(0.155)	(0.898)	(0.140)	(0.205)	(0.226)	(0.291)	(0.289)	(0.183)	(0.152)	(0.161)	(0.177)	(0.264)
Banking crisis	0.205	0.550***	0.317***	0.690***	0.453***	-0.127	0.176	0.377***	0.251***	0.497***	0.425***	-0.0542
	(0.147)	(0.123)	(0.0956)	(0.133)	(0.141)	(0.213)	(0.229)	(0.109)	(0.0945)	(0.110)	(0.150)	(0.225)
Inflation rate	0.00110***	0.000167	0.000258**	0.000492*	0.000276	-0.000941	0.000910**	0.000341**	0.000337**	0.000480*	0.000226*	-0.000516
	(0.000397)	(0.000433)	(0.000100)	(0.000288)	(0.000294)	(0.000633)	(0.000420)	(0.000151)	(0.000134)	(0.000256)	(0.000127)	(0.000631)
Observations	193	255	210	241	199	258	85	363	116	334	212	241
R-squared	0.481	0.174	0.529	0.357	0.228	0.100	0.551	0.104	0.674	0.408	0.218	0.027
F-stat remittance instrumentation (p-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F-stat ODA instrumentation (p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hansen J statistic (p-value)	0.19	0.62	0.82	0.14	0.24	0.26	0.28	0.99	0.017	0.25	0.49	0.18
Number of countries	22	28	23	29	22	35	14	34	15	33	22	33
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

V. Conclusion and discussion

A number of studies examined the determinants of bond yield spreads in emerging countries. However, these studies failed to take into account the potential effects of wealth transfers and countercyclical capital flows, especially remittances and official development aid inflows on bond spreads. In this paper, we contribute to fill the gap by examining the impact of the two wealth transfers foreign capital flows on sovereign bond spreads. Using a panel data of 38 emerging countries over the period 1993-2012 and after controlling for endogeneity issues of remittances and ODA, we contribute to the existing literature on spreads determinants in several grounds.

First, we find that remittances inflows significantly reduce bond spreads in emerging countries. The magnitude of the estimated effect is economically meaningful: a 1 percent increase of remittances-to-GDP inflows results in spreads saving of approximately 3 basis points. We provide several possible interpretations of this finding. Given the fact that remittances increase the fiscal space in recipient country and are countercyclical in nature, we believe that remittances reduce the government marginal cost of raising revenue and act as an insurance mechanism against negative shocks which affect bond markets. We also think that remittances securitization and diaspora bonds play some part in explaining this beneficial effect. Second, the empirical analysis suggests that official development aid does not have a significant impact on bond spreads, which could perhaps be attributed to the motivations for aid, or the specific behavior of bondholders, or the mismanagement of ODA. Since our sample consists of emerging countries, we believe that the first two explanations are more plausible. Indeed, we find that the average UN voting similarity index and the average linguistic proximity are positively related to ODA received, suggesting that donor interests may play an important role in aid allocation in emerging countries. A second plausible explanation of the insignificant effect of ODA on spreads would be to say that the major concern of bondholders is related to the endogenous capacity of fiscal policy to fulfill public finances transversality condition rather than external aid. Our findings are robust to a wide set of alternative specifications including the use of additional control; alternative definitions of sovereign risk premium, remittances and ODA; change in sample definition or time horizon; and the use of alternative instrumentation techniques. Third, we explore the heterogeneity of the estimated effect of remittances. We find that remittances reduce bond spreads in countries with lower developed financial system, higher degree of trade openness or a lower fiscal space. We also find that the beneficial effect of remittances disappears for remittance-dependent countries. These findings confirm that there is a fiscal space channel through which

remittances can reduce government borrowing cost. However, we do not explore all possible channels mentioned in the first section of this paper. In particular, the lack of appropriate data does not allow us to test remittances securitization channel and diaspora bonds channel.

Our results have policy implications. The evidence that remittances reduce bond spreads suggests that emerging countries should increase their efforts to improve measurement of remittances inflows and reduce transfer costs. Indeed, a recent study by Clemens & McKenzie (2014) estimates that "*79% of the growth in remittances received by developing countries over the 1990 to 2010 period reflect changes in measurement, with only 21% representing changes that can be attributable to the growth in the migrant stock and to the incomes these migrants are likely to be earning*". If this report is correct, we believe that policy-makers would gauge properly the remittances effect on bond markets from improving remittances measurement and reducing transfer costs. Adequate policies and strategies to enable the development of remittances' securitization and diaspora bonds are also very encouraging. Lastly, the biggest challenge for remittance-dependent countries is to put in place concrete policy measures to leverage remittances for international capital market access.

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SUPPLEMENTARY MATERIAL

Annex 1. Robustness tests (IV-FE results)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Log Remittance-to-GDP	**-0.294*** **	**-0.310*** **	**-0.285*** **	**-0.296*** **	**-0.296*** **	**-0.246*** **	**-0.375** **	**-0.361*** **	**-0.245***
	(0.110)	**(0.113)**	**(0.110)**	**(0.114)**	**(0.113)**	**(0.0891)**	**(0.161)**	**(0.109)**	**(0.139)**
Log ODA-to-GDP	**-0.246**	**-0.309**	**-0.240**	**-0.242**	**-0.298**	**-0.180**	**-0.361**	**-0.331**	**-0.371**
	(0.418)	**(0.414)**	**(0.416)**	**(0.392)**	**(0.386)**	**(0.348)**	**(0.435)**	**(0.437)**	**(0.398)**
Log Trade openness-to-GDP	-0.356	-0.337	-0.370	-0.379	-0.379	-0.0939	-0.448*	-0.332	-0.223
	(0.289)	(0.295)	(0.279)	(0.287)	(0.284)	(0.272)	(0.234)	(0.289)	(0.259)
Real GDP growth	-0.0289	-0.0464***	-0.0457***	-0.0472***	-0.0459***	-0.0581***	-0.0446***	-0.0457***	-0.0325
	(0.0191)	(0.00984)	(0.00956)	(0.00892)	(0.00955)	(0.00834)	(0.0119)	(0.0107)	(0.0209)
Log Total government debt-to-GDP	0.653***	0.651***	0.637***	0.654***	0.638***	0.552***	0.669***	0.644***	0.552***
	(0.129)	(0.128)	(0.135)	(0.125)	(0.168)	(0.111)	(0.133)	(0.130)	(0.136)
Government fiscal deficit-to-GDP	-0.00187	-0.00126	-0.00332	-0.00248	-0.00304	-0.00929	-0.00226	-0.00527	-0.00566
	(0.0140)	(0.0143)	(0.0140)	(0.0141)	(0.0147)	(0.0126)	(0.0137)	(0.0137)	(0.0126)
Log Total external reserves-to-GDP	-0.239***	-0.239***	-0.244***	-0.259***	-0.247***	-0.158*	-0.278***	-0.218**	-0.200**
	(0.0851)	(0.0853)	(0.0845)	(0.0812)	(0.0835)	(0.0837)	(0.0941)	(0.0864)	(0.0854)
Institutional quality	-1.579**	-1.537**	-1.485**	-1.501**	-1.587**	-1.507**	-1.572*	-1.766**	-1.467*
	(0.760)	(0.758)	(0.749)	(0.763)	(0.799)	(0.734)	(0.865)	(0.770)	(0.866)
Current account balance-to-GDP	-0.000507	-0.000906	-0.000641	-0.000228	-8.37e-05	-0.00655	-0.00254	-0.00233	-0.00674
	(0.0116)	(0.0118)	(0.0116)	(0.0119)	(0.0116)	(0.0116)	(0.0135)	(0.0117)	(0.0150)
Log Real effective exchange rate	-0.533**	-0.458*	-0.509**	-0.529**	-0.498**	-0.181	-0.637**	-0.541**	-0.268
	(0.242)	(0.241)	(0.235)	(0.236)	(0.231)	(0.254)	(0.284)	(0.238)	(0.276)
Sovereign debt crisis	0.479***	0.477***	0.477***	0.493***	0.476***	0.474***	0.527***	0.509***	0.479***
	(0.111)	(0.113)	(0.111)	(0.115)	(0.111)	(0.116)	(0.121)	(0.114)	(0.127)
Banking crisis	0.385***	0.386***	0.380***	0.398***	0.374***	0.462***	0.420***	0.384***	0.483***
	(0.0877)	(0.0881)	(0.0865)	(0.0919)	(0.0923)	(0.0855)	(0.108)	(0.0916)	(0.110)
Inflation rate	9.75e-05	7.17e-05	0.000108	0.000105	0.000108	0.000152	0.000110	8.36e-05	0.000171
	(0.000209)	(0.000215)	(0.000206)	(0.000217)	(0.000222)	(0.000275)	(0.000234)	(0.000223)	(0.000292)
Real GDP per capita	-1.736								-2.277
	(1.648)								(1.725)
Capital account openness (KOAPEN)		-0.0346							-0.00860
		(0.0322)							(0.0397)
Unemployment rate			0.0090						0.00161
			(0.0152)						(0.0160)
Currency crisis				-0.0688					0.0622
				(0.1162)					(0.107)
IMF lending program					0.0527				0.0665
					(0.1513)				(0.135)
Log Financial development						-0.440***			-0.490***
						(0.1254)			(0.136)
Log Stock of immigrant							0.636		0.814
							(0.7880)		(0.808)
Log Damage natural disasters								0.007	0.00728
								(0.0067)	(0.00525)
Observations	439	440	440	440	440	450	450	450	449
R-squared	0.386	0.376	0.389	0.384	0.383	0.428	0.343	0.352	0.435
F-stat remittance instrumentation [p-value]	15.32 [0.00]	15.92 [0.00]	15.15 [0.00]	11.56 [0.00]	13.32 [0.00]	17.17 [0.00]	13.89 [0.00]	14.92 [0.00]	14.48 [0.00]
F-stat ODA instrumentation [p-value]	13.43 [0.00]	13.51 [0.00]	14.00 [0.00]	13.48 [0.00]	13.79 [0.00]	12.61 [0.00]	13.67 [0.00]	13.45 [0.00]	12.59 [0.00]
Hansen J statistic (p-value)	0.71	0.68	0.60	0.62	0.52	0.31	0.26	0.68	0.12
Number of countries	38	38	38	38	38	38	38	38	38
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Annex 2. Robustness tests (IV-FE results)

	[1]	[2]	[3]
	No-receiving ODA countries	Before 2007	No top oil exporters
Log Remittance-to-GDP	**-0.362*** **	**-0.459*** **	**-0.283** **
	(0.121)	**(0.103)**	**(0.141)**
Log ODA-to-GDP	**-0.176**	**-0.436**	**-0.399**
	(0.484)	**(0.561)**	**(0.520)**
Log Trade openness-to-GDP	-0.466	-0.565	-0.504
	(0.347)	(0.379)	(0.345)
Real GDP growth	-0.0435***	-0.0203	-0.0477***
	(0.0123)	(0.0138)	(0.0126)
Log Total government debt-to-GDP	0.759***	0.916***	0.618***
	(0.200)	(0.224)	(0.149)
Government fiscal deficit-to-GDP	-0.0200	0.00877	0.00118
	(0.0126)	(0.0193)	(0.0230)
Log Total external reserves-to-GDP	-0.370***	-0.236*	-0.146
	(0.0909)	(0.126)	(0.125)
Institutional quality	-0.679	-1.454*	-0.962
	(0.807)	(0.846)	(0.909)
Current account balance-to-GDP	-0.00257	-0.00355	0.00149
	(0.0141)	(0.0104)	(0.0149)
Log Real effective exchange rate	-0.944***	-1.485***	-0.535*
	(0.227)	(0.336)	(0.275)
Sovereign debt crisis	0.464***	0.430***	0.652***
	(0.111)	(0.128)	(0.186)
Banking crisis	0.237***	0.293***	0.472***
	(0.0906)	(0.0936)	(0.112)
Inflation rate	0.000353***	2.56e-05	-0.000495
	(9.73e-05)	(0.000268)	(0.000366)
Observations	388	260	339
R-squared	0.300	0.471	0.285
F-stat remittance instrumentation [p-value]	19.32 [0.00]	11.83 [0.00]	10.50 [0.00]
F-stat ODA instrumentation [p-value]	12.38 [0.00]	5.95 [0.00]	17.19 [0.00]
Hansen J statistic (p-value)	0.21	0.11	0.23
Number of countries	34	31	38
Country fixed effects	Yes	Yes	Yes

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Annex 3. Heterogeneity in the effect of remittances (IV-FE results)

	[1]	[2]
	Top third quartiles	Fourth quartile
Log Remittance-to-GDP	**-0.291*** **	**-2.160**
	(0.100)	**(1.743)**
Log ODA-to-GDP	**-0.127**	**-2.731**
	(0.521)	**(2.809)**
Log Trade openness-to-GDP	0.0147	-3.182
	(0.264)	(2.112)
Real GDP growth	-0.0492***	0.0291
	(0.00982)	(0.0562)
Log Total government debt-to-GDP	0.475***	0.821
	(0.100)	(0.744)
Government fiscal deficit-to-GDP	-0.0137	0.0355
	(0.0116)	(0.0720)
Log Total external reserves-to-GDP	-0.162*	-0.883***
	(0.0865)	(0.339)
Institutional quality	-1.908***	6.009
	(0.732)	(6.122)
Current account balance-to-GDP	-0.00886	0.0167
	(0.00813)	(0.0455)
Log Real effective exchange rate	-0.774***	-0.742
	(0.201)	(1.747)
Sovereign debt crisis	0.487***	-0.249
	(0.124)	(0.525)
Banking crisis	0.482***	-0.987
	(0.100)	(0.641)
Inflation rate	0.000149	0.0287**
	(0.000140)	(0.0137)
Observations	347	102
R-squared	0.476	0.084
F-stat remittance instrumentation (p-value)	0.00	0.00
F-stat ODA instrumentation (p-value)	0.00	0.07
Hansen J statistic (p-value)	0.65	0.71
Number of countries	29	15
Country fixed effects	Yes	Yes

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Appendix 1. Sources and definitions of variables

Variables	Definitions	Sources
Government bond yield spread	Yield spread between each emerging country and United States sovereign bonds with a minimum size of 500 million USD and an average maturity of 12 years	JP Morgan, Bloomberg
CDS spreads	Spread between each emerging country and United States credit default swaps with a maturity of 10 years	Bloomberg
ODA	Total Disbursement of bilateral and multilateral official development assistance to all sectors, in share of GDP	Query Wizard for International Development Statistics (QWIDS), OECD
Inflation rate	Annual growth rate of average CPI	World Economic Outlook (2014)
Total government debt	Gross general government debt to GDP	
Government fiscal deficit	General government net lending/borrowing to GDP	
Current account balance	Current account balance to GDP	
Remittances	Workers remittances receipts in percentage of GDP	World Development Indicators (2014)
Real GDP growth	Annual growth rate of GDP	
Trade openness	Volume of imports and exports divided by GDP	
Total external reserves	Annual total external reserves in percentage of GDP	
Public expenditure	Total public expenditure in percentage of GDP	
Public health expenditure	Total public spending on health in percentage of GDP	
Public expenditure on education	Total public spending on education in percentage of GDP	
Unemployment rate	Annual unemployment rate, in percent of total labor force	
Real GDP per capita	Gross domestic product per capita, constant prices USD	
Financial development	Credit to private sector in percentage of GDP	
Share young population	Population between the ages 0 to 14 as a percentage of the total population	
Infant mortality rate	Number of infants dying before reaching one year of age, per 1,000 births in a given year	
Institutional quality index	Average of fourth normalized variables: investment profile, corruption, law and order, and bureaucratic quality	Author's calculation using International Country Risk Guide (ICRG) database
Real Effective Exchange Rate	Real effective exchange rate, with 2010 as a base year	Database from CERDI (Centre d'Etudes et de Recherche sur le Développement International)
Sovereign debt ratings	Long-term foreign currency government debt ratings	Standard & Poor's, Moody's and Fitch websites
Sovereign debt crisis	Dummy variable equal to 1 if a country experiences a domestic debt default or an external default; 0 otherwise	Reinhard & Rogoff (2010) updated from Laeven & Valencia (2012)
Currency crisis	Dummy variable equal to 1 if a country experiences a currency crisis; 0 otherwise	
Banking crisis	Dummy variable equal to 1 if a country experiences a banking crisis; 0 otherwise	
Capital account openness	Chinn-Ito financial openness index	Chinn & Ito (2013)
IMF lending program	Dummy variable equal to 1 if IMF standby arrangement of IMF extended facility arrangement is in effect for at least 5 months in a particular year; 0 otherwise	IMF website
Stock of immigrants	Total immigrant stock	Ozden et al. (2011)
Damage natural disasters	Estimated damage from natural disasters in US dollars	Centre for Research on the Epidemiology of Disasters (CRED) database
Real gdp per capita in host countries	Real gdp per capita of each destination country weighted by the share of emigrant of each recipient country	Author's calculation using WDI and QWIDS databases
Average voting similarity	Annual voting similarity index weighted by the share of ODA received by each recipient from each 22 OECD donors' per year. Voting similarity index correspond to the total of votes where both states agree over total of joint votes.	Author's calculation using CEPPI and QWIDS databases
Average linguistic proximity	Linguistic proximity weighted by the share of ODA received by each recipient from each 22 OECD donors' per year. Linguistic proximity is built on the basis of the ethnologists' classification of language family trees.	Author's calculation using Strezhney & Voeten (2013), and QWIDS databases

Appendix 2. Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
Log Bond yield spreads	overall	5.790603	0.9228914	-0.0200407	8.662101	N = 515
	between		0.6252163	4.661024	7.030361	n = 38
	within		0.6532552	0.5507621	7.972609	T-bar = 13.5526
Bond yield spreads	overall	496.9703	590.2867	0.9801587	5779.666	N = 515
	between		324.974	115.5654	1545.097	n = 38
	within		473.0044	-728.2618	4731.54	T-bar = 13.5526
Log Remittances-to-gdp	overall	0.1889022	1.839784	-10.45195	3.284018	N = 709
	between		1.814664	-5.097254	3.027993	n = 38
	within		0.7377654	-8.409686	2.487105	T-bar = 18.6579
Log ODA-to-gdp	overall	0.5120786	0.5995637	-1.019416	2.831664	N = 760
	between		0.5562696	-0.0051412	2.218116	n = 38
	within		0.240389	-0.6953865	2.036172	T = 20

References for Supplementary Material

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Chapter 4. The "Dark Side" of Credit Default Swaps Initiation: A Close Look at Sovereign Debt Crises[59]

Abstract:

We examine the effect of sovereign CDS trading initiation on the occurrence of sovereign debt crises (SDC). Estimations on a large sample of 141 countries for 1980-2013 reveal that CDS trading initiation significantly increases the probability of SDC in CDS compared to non-CDS countries. This result holds for different robustness tests, and depends of CDS countries' characteristics, and the time span. In the context of a remarkably scarce literature on debt financing for *sovereign* entities, our results are a direct complement of existing studies emphasizing a favorable effect of CDS trading (Ammer & Cai, 2011; Ismailescu & Phillips, 2015), by unveiling, for the first time, that CDS trading can also have *adverse* effects, by increasing SDC occurrence. These opposite effects should fuel the literature on measuring the consequences of CDS trading initiation, and its design and implementation from a policy perspective.

Keywords: Credit Default Swaps, Sovereign Debt Crises, Sovereign Bonds.

JEL codes: F34, G01, G23, H63.

[59] A version of this paper is under review in *Macroeconomic Dynamics*.

One of the big problems with debt markets is that, especially during times of stress, they become very illiquid. Many bankers have spent many hours trying to explain to emerging-market finance ministers that just because their bonds are trading at a certain level in the secondary market, that doesn't mean they can issue new bonds at that level, or even at all. But it turns out that a liquid CDS market is a great way of enabling countries to access the primary markets even when the secondary markets are full of uncertainty and turmoil. Which is yet another reason to laud the notorious buyers of naked CDS, rather than demonizing them.

— Felix Salmon, Reuters (March 2010)

Some derivatives ought not to be allowed to be traded at all. I have in mind credit default swaps. The more I've heard about them, the more I've realized they're truly toxic.

— George Soros, Financial Times (June 2009)

I. Introduction

Credit Default Swaps (CDS) are one of the most important and controversial financial innovation of the past decades, disparaged by some and extolled by others (Buiter, 2009; Soros, 2009; Jones, 2010; Portes, 2010; Salmon, 2010; Stultz, 2010). Recently, some observers highlighted the prominent role of CDS in the emergence of the Greek debt crisis, and its spread toward other peripheral Eurozone countries. In May 2010, this concern led German regulators to prohibit naked CDS trading on the bond market, and the European Union Parliament voted in July 2011 for their exclusion from Eurozone debt market.

Despite these criticisms, some industrial and academic experts argue that CDS trading should not affect bond markets, due to their relative small proportion compared to debt outstanding (Pickel, 2009; Stultz, 2010). Others insist that the presence of CDS yields better aggregation of information and beliefs, more complete markets, and greater bond market liquidity, making it easier for distressed borrowers to issue bonds (Greenspan, 2004; Salmon, 2010).

Previous research focused mainly on the impact of *corporate* CDS trading on the (i) supply and (ii) pricing of debt, and reported mixed results. Bolton & Oehmke (2011) built a limited-commitment model of credit, and showed that (i) debt supply can increase because of bondholders having more bargaining power in debt renegotiation when they use CDS to protect their exposure. This theoretical prediction is empirically confirmed by Saretto & Tookes (2013): firms with CDS transactions on their debt present higher leverage ratios and longer debt maturities. However, focusing on the effect of CDS on equilibrium debt contracts

in the presence of investors with heterogeneous beliefs, Che & Sethi (2012) argued that CDS may crowd-out lending, since bondholders might be tempted to trade CDS instead of bonds.

Regarding (ii) debt pricing, Ashcraft & Santos (2009) evaluated the impact of CDS trading on the spreads paid by firms to increase funding in the corporate and syndicated loan markets. They found that credit spreads increase (decrease) for low- (high-) quality firms, following CDS initiation. At a more aggregate level, Shim & Zhu (2014) established that CDS lowered the cost of issuing bonds, and enhanced liquidity in Asian bond markets. On the contrary, Das et al. (2014) concluded that CDS trading reduces the efficiency of corporate bond markets, without decreasing pricing errors or enhancing liquidity. Finally, beyond these studies on debt supply and cost, looking at North American corporate issuers, Subrahmanyam et al. (2014) revealed an increase in the likelihood of a credit rating downgrade and bankruptcy, following CDS trading initiation.

However, at odds with the passionate public debate and financial regulators' initiatives, and also with the research on corporate CDS, the literature on the effects of *sovereign* CDS trading is surprisingly sparse. Indeed, only few recent studies analyzed debt financing for sovereign entities (Ammer & Cai, 2011; Ismailescu & Phillips, 2015). Focusing on the access to bond markets and on their depth, these authors notably found that CDS trading improves price discovery and efficiency, and reduces bond yield spreads.

In this paper we extend the nascent literature on the effect of *sovereign* CDS trading by looking at their effect on the stability of bond markets. Using primary data from Markit Group Limited, a leading CDS data vendor, to identify CDS trading countries, we examine the impact of CDS initiation on the occurrence of sovereign debt crises (SDC), in a large sample of 141 countries over 1980-2013. Since we focus on *sovereign* CDS, our analysis complements the recent work of Subrahmanyam et al. (2014) on corporate CDS. Indeed, as stressed by Ismailescu & Phillips (2015), the two markets differ in various ways. First, contrary to corporate issuers, countries in financial difficulties do not go bankrupt and their assets are not liquidated: in the event of sovereign default, debt is generally rescheduled or restructured, making the risk on sovereign bonds different from corporates. Second, CDS trading is particularly active on sovereign debt markets, making them more liquid compared to corporate bond markets (Ammer & Cai, 2011); thus, the effect of CDS trading, if any, may be different in government bond markets. Finally, while corporate debt is mostly owned by insurance companies (Massa & Zhang, 2012), sovereign debt is held by a large set of investors, including central banks, commercial and investment banks, pension, insurance and hedge funds, and other governments (Acharya et al., 2014). Since these investors may differently

react to the presence of CDS markets, the potential effect of CDS trading on debt crises might equally differ between corporate and sovereign issuers.

From an empirical perspective, a challenging task is to identify a causal relationship running from CDS trading to SDC, due to the endogeneity of CDS trading initiation. Indeed, potential differences between CDS and non-CDS countries regarding their (un)observable characteristics may exacerbate a selection bias. Besides, CDS trading initiation may occur more likely when market participants are relatively pessimistic about borrowing governments' ability to repay the debt and its burden on time. To address these concerns, we combine the bias-corrected matching estimator of Abadie & Imbens (2006) with the entropy balancing approach of Hainmueller (2012), and we alternatively rely on instrumental variable and Heckman two-stage estimations.

Our benchmark finding is that CDS trading initiation significantly increases the probability of SDC in CDS compared to non-CDS countries. The magnitude of the estimated effect is economically meaningful, namely around 1.5 pp. This result holds for alternative specifications (such as altering the sample or adding covariates), is robust to the use of alternative methods (namely, entropy balancing, instrumental variables, or Heckman two-stage estimations), and is supported by the conclusions of a falsification test.

In addition, we unveil that the impact of CDS trading initiation on SDC occurrence is sensitive to countries' characteristics and to the considered time span. Regarding the former, the effect is (i) larger for developing, compared to developed countries, (ii) significant for CDS countries with speculative debt rating grades at the time of CDS initiation but not for countries with investment grades, (iii) larger for countries with "low" degree of public sector transparency, and (iv) larger for countries with lower Central Bank independence. Regarding the later, the adverse cumulative effect of CDS trading on SDC occurrence becomes significant only starting 2005, and converges towards its benchmark magnitude over time.

The merit of our analysis is twosome. First, in the context of a remarkably scarce literature on debt financing for sovereign entities, we show that CDS initiation increases SDC occurrence. Second, our results are a direct complement of existing studies emphasizing a *favorable* effect of CDS trading on price discovery and efficiency, and bond yield spreads (Ammer & Cai, 2011; Ismailescu & Phillips, 2015), by unveiling, for the first time, that CDS trading can also have *adverse* effects, by increasing SDC occurrence. Taken together, these opposite effects should fuel the literature on measuring the consequences of CDS trading initiation, and its design and implementation from a policy perspective.

The rest of the paper is organized as follows. Section 2 discusses theoretical arguments motivating a potential effect of CDS trading on SDC occurrence, Section 3 presents the data

and the methodology, Section 4 reports the main results, Section 5 explores their robustness, and Section 6 concludes.

II. Theoretical considerations

CDS trading can affect the occurrence of debt crises in many ways. First, evidence on corporate bond markets suggests that firm leverage increases after CDS initiation, due to larger credit supply and lower debt financing costs (Ashcraft & Santos, 2009; Saretto & Tookes, 2013). This is because CDS help lenders hedge their underlying exposure to borrowers, and enhance price discovery process through increasing available information on traded entities.[60] Therefore, if the sovereign debt stock increases following CDS trading initiation, default risk may correspondingly increase.

Second, due to the crowding-in of new investors, CDS trading amplifies creditors' coordination failure. Indeed, since CDS allow better mitigating risks, more investors are willing to lend (Bolton & Oehmke, 2011). Thus, CDS introduction may trigger a larger number of bondholders, making creditors' coordination more difficult when the borrower faces financial distress, and default more likely (Gilson & al., 1990; Brunner & Krahnen, 2008; Subrahmanyam & al., 2014).

Third, the CDS introduction can generate an "empty-creditors problem" or moral hazard on the bond market.[61] Empty creditors have greater stake to push a borrowing government into default if their total payoffs, including CDS payments, would be boosted by this event (Bolton & Oehmke, 2011). These authors stress that, even if CDS sellers can anticipate and incorporate the credit risk related to the empty-creditor hypothesis, they cannot directly intervene in the debt renegotiation process. Moreover, they point that the likelihood of empty creditors increases with the number of lenders; since CDS initiation attracts new entrants, this could amplify the strategic behavior of empty-creditors, thereby increasing the occurrence of debt crises.

Fourth, CDS trading can negatively affect bond markets through the presence of naked CDS. Indeed, if protection against sovereign default can be purchased by investors that do not hold the underlying sovereign bonds (naked CDS), investors who are pessimistic about a borrowing government's fiscal sustainability can exploit the implicit leverage that derivatives provide. This can increase the level and volatility of bond yields, and raise spreads in a

[60] For instance, Salmon (2010) reports that the presence of CDS market enabled the Greek government to access the primary bond market with rather affordable yield spreads, when its secondary market was in turmoil and uncertainty.

[61] Empty creditors are bondholders that hold both loans and CDS contracts.

damaging manner for the sovereign borrower. In other words, the presence of naked CDS can turn the fears about borrower's ability to repay its debt into self-fulfilling, making default more likely to occur (Soros, 2009; Buiter, 2009; Münchau, 2010; Portes, 2010).

Fifth, studies on corporate debt market highlight the potential indirect adverse effect of CDS contracts on credit crises, through the reduction of ex-post monitoring (Ashcraft & Santos, 2009). Indeed, by providing bondholders a new mechanism to lay off their credit exposures, CDS initiation also furnishes them a new way to sever their credit links to borrowers. In other words, bondholders without direct exposure to borrower's default can reduce their incentives to monitor them. For instance, bondholders with CDS protection can voluntarily lower their political pressure on a borrowing government, even if its fiscal policy follows an unsustainable trend; this can reduce government's incentives to engage in positive net-present-value projects, and consequently lower its likelihood to repay the debt and its burden on time. As such, CDS initiation could increase the likelihood of crises.

Finally, CDS markets can crowd-out bond markets. As stressed by Stein (1987), the entry of new speculators into a market can deteriorate the informational content of prices, and reduce the ability of pre-existing investors to properly infer assets' value; thus, CDS trading can cause a negative externality on the bond market. More importantly, for existing investors, there are potential advantages of trading in the CDS market as opposite to the bond market, notably because of the opacity of over-the-counter CDS markets (Acharya & Johnson, 2007). Through diverting investors off the bond market, CDS trading could lower their participation and bond liquidity, and therefore increase the likelihood of default.

Based on these arguments, the hypothesis (**H**) we aim testing is

(**H**): **CDS trading initiation increases the occurrence of sovereign debt crises (SDC).**

Since there is, to the best of our knowledge, no previous work on this issue, we will draw upon a several alternative econometric techniques and specifications to test this hypothesis.

III. Data and methodology

3.1. Data

Our sample consists of 141 developing and developed countries over 1980-2013. We identify the CDS trading initiation date as the first appearance of sovereign CDS spreads in the primary data of Markit Group Limited, a leading global provider of financial information services.[62] The Markit initiation date is also used by Ismailescu & Phillips (2015) to identify sovereign CDS introduction; and Massa & Zhang (2012), and Das et al. (2014) to identify CDS trading availability for corporate entities. CDS contracts in Markit are available in different currencies and maturities, and begin at different dates; however, comparing CDS trading beginning dates by issuing currencies reveals that USD-denominated contracts generally appear prior to all other currencies. Consequently, we focus on USD-denominated contracts with a maturity of 5-years (the benchmark in derivative markets), to identify the first sovereign CDS trading event. The final CDS sample consists of 74 countries,[63] of which 46 developed and 28 developing, called the treatment group (see Appendix 1 for the list of CDS countries, and their starting dates).

Regarding the outcome variable, we identify SDC using the database of Laeven & Valencia (2013). The authors define a debt crisis as the period when a borrowing government fails to meet principal or interest payments on the due date, or when debt repayment is rescheduled. Given the aim of our analysis, we also consider episodes of debt restructuring as debt crises, because markets relate them to credit worthiness.[64] Using this definition, our SDC dummy variable equals one if a country experiences a debt crisis or debt restructuring *à la* Laeven & Valencia (2013) in a year, and zero otherwise. Based on the 105 SDC experienced by the 141 countries in our sample during 1980-2013, Figure 1 suggests that, contrary to the period prior to CDS trading initiation, SDC occur more frequently in CDS countries after CDS introduction.

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[62] Since CDS transactions occur in an over-the-counter (OTC) market, and not as centralized exchanges, we compare Markit initiation date with concurrent data sources, including GFI, Fenics, Reuters, CMA, and JP Morgan. Initiation dates usually appear earlier in the Markit dataset.

[63] CDS data from Markit begins in January 2001 and includes 79 developed and developing CDS countries. Out of these, we exclude the three countries (China, Greece and Mexico) present in Markit database at the start of CDS trading in January 2001, as we are not able to infer initiation dates for them. Moreover, we follow Ismailescu & Phillips (2015) and compare Markit database initiation dates with the International Financing Review (IFR), which reports weekly CDS prices for 1998-2000, namely prior to the Markit dataset. Since Brazil and Hungary appear in the IFR database, suggesting that CDS trading began prior to the Markit introduction date, we equally exclude them from our sample.

[64] Besides, the International Swaps and Derivatives Association considers debt restructuring as a credit event leading to CDS payments.

3.2. Methodology

To test our hypothesis (**H**), we compare the effect of CDS trading initiation on SDC occurrence in CDS countries, compared to no-CDS countries. Following the treatment effect literature, we use a matching approach, in which the introduction of CDS contracts is the treatment, and SDC occurrence is the outcome variable. The units of analysis are country-year observations, and observations with (without) CDS trading in place represent the treatment (control) group.

The matching method is performed in two steps. First, we estimate the likelihood of CDS trading, conditional on observable covariates correlated with both SDC and CDS trading. Second, the likelihood of CDS trading is used to pair CDS trading observations with no-CDS observations. In this second step we compute the impact of CDS trading on SDC occurrence, namely the so-called average treatment effect on the treated (ATT), as the mean difference between the matched groups of treated and untreated.

Previous studies drawing upon matching methods generally use simple covariate matching (e.g. Lin & Ye, 2007; Forbes & Klein, 2015). However, Abadie & Imbens (2006) stress that the simple covariate matching estimator may be biased in finite samples if matching variables are continuous, because of the resulting bias due to matching discrepancies. They suggest a bias-corrected matching estimator that relies on estimating a regression function only on the control group to predict the missing potential outcomes. Their approach has the advantage of combining matching, which compares each treated observation with control observations with comparable covariates, and regression, which reduces potential remaining biases from covariates imbalances (for more details, see Abadie & Imbens, 2006, 2011).

In line with their recommendation, we examine the link between CDS trading and SDC using bias-corrected matching. Moreover, following Imbens (2004), we use pre-treatment characteristics as matching variables to circumvent potential reverse causality problems; capitalizing on the literature on SDC determinants and CDS initiation, we select the first-lag of the following matching variables: government debt-to-GDP, fiscal balance-to-GDP, inflation rate, current account balance-to-GDP, reserve-to-GDP, private credit-to-GDP, GDP growth rate, executive constraint, and financial openness index (Kaopen).[65] Finally, we also include year and regional fixed effects, to control for time- and regional-specific characteristics that may affect SDC occurrence.[66]

[65] Appendix 2 presents definitions and data sources of all variables.

[66] Since some countries did not experience any crisis in the study period, including country fixed-effects would lead to loss of information by dropping these non-crisis countries from the estimations.

IV. Results from bias-corrected matching

This section presents the results of the effect of CDS trading on SDC occurrence. We first report benchmark results from bias-corrected matching, and then account for alternative specifications.

4.1. Benchmark results

We compute the average treatment effect of CDS trading on SDC occurrence using the bias-corrected matching estimator. We start by estimating a logit model, in which we explain the dummy variable of CDS trading initiation by the matching variables previously emphasized, together with year and regional fixed-effects. Column [0] of Appendix 3 shows that countries with better fiscal and current account balances are less likely to introduce CDS contracts, contrary to countries with higher inflation rates, private credit-to-GDP ratios, and executive constraints. Based on the logit regression, we compute propensity scores (i.e. the probability of adopting CDS). Under the common support condition, which ensures that treated and control groups are fairly comparable, we use the bias-corrected matching to estimate the ATT of CDS trading initiation on SDC occurrence.

Table 1 reports benchmark results. ATTs on line [0] are statistically significant at the 5% level and positive, irrespective of the number of matched n, considered between 1 and 10. Thus, between two countries with comparable characteristics, the one with CDS trading is

Table 1: The impact of CDS trading on SDC using Bias-Corrected Matching

Dependent variable:	Bias-corrected matching estimators				
Sovereign Debt Crisis (SDC)	n=1	n=2	n=3	n=4	n=5
[0]ATT	0.0140**	0.0147***	0.0165***	0.0162***	0.0170***
	(0.0069)	(0.0048)	(0.0043)	(0.0039)	(0.0038)
Z-statistic/Observations	2.02/2386	3.06/2386	3.83/2386	4.16/2386	4.46/2386
	n=6	n=7	n=8	n=9	n=10
[0]ATT	0.0165***	0.0157***	0.0155***	0.0160***	0.0159***
	(0.0037)	(0.0039)	(0.0042)	(0.0044)	(0.0044)
Z-statistic/Observations	4.47/2386	4.03/2386	3.62/2386	3.58/2386	3.58/2386

Note for Tables 1-3: Heteroskedasticity-consistent standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

more prone to SDC. In addition, the estimated treatment effect is economically meaningful: the presence of CDS trading increases by around 1.6 percentage points (hereafter pp) the probability of SDC compared to countries without CDS contracts.

4.2. Alternative specifications: altering the sample

We alter the sample as follows.[67] First, we take a closer look at CDS trading initiation dates: when CDS initiation occurs during the last three months of a given year t, we attribute the initiation date to the following year $t+1$. ATTs based on these initiation dates reported in line [1] of Table 2 are all statistically significant (except for n=1), and quantitatively in line with benchmark results.

Next, we extend the sample to countries for which the identification of CDS trading initiation dates is less clear-cut, namely Brazil, China, Greece, Hungary, and Mexico, using the beginning date in Markit as first date of appearance of CDS trading. ATTs in line [2] are yet again consistent with benchmark findings.

Moreover, we account for the fact that CDS traders can anticipate the occurrence of SDC, and accordingly initiate CDS contracts for potential distressed countries. Thus, we exclude from the treated group countries that experienced at least one SDC episode in the first three years following their CDS initiation, namely Argentina, Dominican Republic, Indonesia, and Uruguay. Despite some magnitude loss compared with the benchmark (the effect is around 1.3 pp), most ATTs in line [3] are positive and significant.

In addition, since the 74 CDS trading countries are relatively rich, we improve the comparability of treated and control observations by excluding in line [4] of Table 2 control countries with real GDP per capita below that of the poorest CDS trading country. In the same vein, in line [5] we exclude African countries with nascent stages of development of bond markets. Corresponding ATTs remain statistically significant, and the effect is even stronger when excluding African countries (around 1.7 pp) compared to the benchmark.

Furthermore, given that CDS contracts were invented in 1994, we exclude pre-1994 country-year observations. Alternatively, we drop the post-2008 period to abstract of the recent financial crisis and the restriction period imposed by the European Union Parliament in June 2011 in the Eurozone debt market. Results reported in lines [6]-[7] are consistent with benchmark findings. In particular, we unveil a strong effect climbing even up to 2.1 pp, when excluding post-2008 observations.

Finally, we want to know if our results are robust to the exclusion of the Eurozone countries, particularly since such countries experienced major imbalances since the recent crisis. As emphasized by line [8], the estimated effects are negative and statistically

[67] We discuss the results of the estimated ATTs in this section for saving space. All the corresponding estimations of propensity scores for the following lines [1]-[8] are reported in columns [1]-[8] of Appendix 3.

significant. In addition, the magnitude of the effect is stronger compared to the benchmark, namely around 2.3, and corroborates our findings when excluding post-2008 observations.

4.3. Alternative specifications: additional covariates

We account for different groups of additional covariates, selected since they may affect the likelihood of CDS trading and SDC occurrence. These additional variables capture stock market conditions (stock market crisis dummy, stock market capitalization-to-GDP, stock price volatility, stock market return); bond market conditions (sovereign bond yield spreads, sovereign debt ratings, debt crisis contagion dummy); banking sector conditions (banking crisis dummy, financial system deposits-to-GDP); monetary conditions (currency crisis, official exchange rate); key institutional and structural features (UK legal origin dummy, IMF program dummy, CDS country dummy); and external conditions (capital account balance, financial account balance). Except for UK legal origin, all these variables are one-year lagged, to perform the matching on pre-treatment observations.[68]

Estimated ATTs are presented on lines [9]-[13] of Table 3. From a general perspective, results are consistent with benchmark findings, since the existence of CDS contracts significantly raises the likelihood of SDC. In addition, the magnitude of this effect is broadly around its benchmark range, with lower (higher) values arising when accounting for stock market conditions (banking crisis and CDS country dummy).

[68] Estimations of propensity scores are not reported for saving space. There are available upon request.

Table 2: The impact of CDS trading on SDC using Bias-Corrected Matching: Alternative specifications

Dependent variable:	Bias-corrected matching estimators									
Sovereign debt crisis (SDC)	n=1	n=2	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
[1] Alternative CDS trading dates	0.0088	0.0123**	0.0145***	0.0147***	0.0158***	0.0157***	0.0150***	0.0149***	0.0148***	0.0151***
	(0.0070)	(0.0048)	(0.0043)	(0.0039)	(0.0038)	(0.0036)	(0.0036)	(0.0038)	(0.0043)	(0.0043)
	1.25/2386	2.54/2386	3.33/2386	3.72/2386	4.13/2386	4.28/2386	4.12/2386	3.86/2386	3.43/2386	3.45/2386
[2] Include Brazil, China, Greece, Hungary, Mexico	0.0117*	0.0134***	0.0153***	0.0159***	0.0167***	0.0161***	0.0155***	0.0153***	0.0156***	0.0156***
	(0.0063)	(0.0043)	(0.0040)	(0.0038)	(0.0037)	(0.0035)	(0.0037)	(0.0041)	(0.0042)	(0.0042)
	1.83/2481	3.10/2481	3.78/2481	4.15/2481	4.48/2481	4.51/2481	4.13/2481	3.69/2481	3.72/2481	3.72/2481
[3] Drop Argentina, Dominican Republic, Uruguay, Indonesia	0.0075	0.0131***	0.0132***	0.0132***	0.0137***	0.0136***	0.0136***	0.0137***	0.0136***	0.0137***
	(0.0065)	(0.0032)	(0.0032)	(0.0033)	(0.0031)	(0.0029)	(0.0028)	(0.0028)	(0.0029)	(0.0029)
	1.17/2330	4.06/2386	4.05/2386	4.00/2386	4.43/2386	4.68/2386	4.84/2386	4.75/2386	4.64/2386	4.73/2386
[4] Exclude poorest countries	0.0134***	0.0131***	0.0133***	0.0135***	0.0134***	0.0136***	0.0136***	0.0137***	0.0136***	0.0136***
	(0.0034)	(0.0033)	(0.0034)	(0.0031)	(0.0032)	(0.0032)	(0.0031)	(0.0029)	(0.0029)	(0.0029)
	3.91/2028	3.93/2028	3.91/2028	4.25/2028	4.11/2028	4.22/2028	4.40/2028	4.60/2028	4.62/2028	4.62/2028
[5] Exclude African countries	0.0154***	0.0166***	0.0170***	0.0171***	0.0169***	0.0164***	0.0166***	0.0169***	0.0171***	0.0167***
	(0.0051)	(0.0044)	(0.0038)	(0.0039)	(0.0037)	(0.0036)	(0.0034)	(0.0035)	(0.0034)	(0.0033)
	3.01/1680	3.78/1680	4.43/1680	4.32/1680	4.51/1680	4.52/1680	4.77/1680	4.82/1680	4.93/1680	4.94/1680
[6] Drop pre-1994 sample	0.0143**	0.0146***	0.0166***	0.0164***	0.0169***	0.0164***	0.0158***	0.0155***	0.0158***	0.0159***
	(0.0069)	(0.0047)	(0.0044)	(0.0039)	(0.0038)	(0.0037)	(0.0040)	(0.0043)	(0.0044)	(0.0044)
	2.06/2157	3.08/2157	3.76/2157	4.19/2157	4.45/2157	4.40/2157	3.95/2157	3.60/2157	3.57/2157	3.63/2157
[7] Drop post-2008 sample	0.0129	0.0170*	0.0195**	0.0207***	0.0203***	0.0214***	0.0209***	0.0206***	0.0207***	0.0207***
	(0.0138)	(0.0094)	(0.0084)	(0.0073)	(0.0068)	(0.0067)	(0.0068)	(0.0078)	(0.0077)	(0.0076)
	0.94/1607	1.81/1607	2.33/1607	2.81/1607	2.96/1607	3.16/1607	3.06/1607	2.62/1607	2.69/1607	2.71/1607
[8] Drop Eurozone	0.0227***	0.0227***	0.0227***	0.0228***	0.0227***	0.0231***	0.0230***	0.0230***	0.0230***	0.0231***
	(0.0051)	(0.0050)	(0.0052)	(0.0054)	(0.0051)	(0.0049)	(0.0048)	(0.0048)	(0.0049)	(0.0048)
	4.49/1871	4.46/1871	4.33/1871	4.16/1871	4.42/1871	4.68/1871	4.82/1871	4.77/1871	4.69/1871	4.73/1871

Table 3: The impact of CDS trading on SDC using Bias-Corrected Matching: Additional covariates

Dependent variable: Sovereign debt crisis (SDC)	Bias-corrected matching estimators									
	n=1	n=2	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
[9A] Adding stock market crisis (t-1)	0.0134**	0.0134**	0.0176***	0.0163***	0.0157***	0.0159***	0.0159***	0.0160***	0.0156***	0.0152***
	(0.0056)	(0.0055)	(0.0053)	(0.0050)	(0.0046)	(0.0046)	(0.0044)	(0.0044)	(0.0042)	(0.0041)
	2.36/830	2.40/830	3.27/830	3.21/830	3.37/830	3.45/830	3.60/830	3.63/830	3.70/830	3.66/830
[9B] Adding stock market capitalization (t-1)	0.0082**	0.0082***	0.0082***	0.0082***	0.0096***	0.0106***	0.0103***	0.0100***	0.0098***	0.0096***
	(0.0032)	(0.0027)	(0.0027)	(0.0027)	(0.0025)	(0.0028)	(0.0029)	(0.0030)	(0.0030)	(0.0029)
	2.56/1477	3.00/1477	2.98/1477	3.05/1477	3.72/1477	3.71/1477	3.53/1477	3.33/1477	3.26/1477	3.27/1477
[9C] Adding stock market price volatility (t-1)	0.0091***	0.0091***	0.0091***	0.0091***	0.0091***	0.0091***	0.0107***	0.0095***	0.0090***	0.0088***
	(0.0032)	(0.0032)	(0.0028)	(0.0034)	(0.0033)	(0.0033)	(0.0032)	(0.0032)	(0.0033)	(0.0032)
	2.83/1071	2.78/1071	3.21/1071	2.68/1071	2.73/1071	2.76/1071	3.27/1071	2.89/1071	2.75/1071	2.73/1071
[9D] Adding stock market return (t-1)	0.0090***	0.0090***	0.0105***	0.0101***	0.0094***	0.0096***	0.0094***	0.0089***	0.0087***	0.0086***
	(0.0033)	(0.0033)	(0.0032)	(0.0034)	(0.0035)	(0.0033)	(0.0032)	(0.0032)	(0.0032)	(0.0032)
	2.68/1135	2.68/1135	3.28/1135	2.92/1135	2.66/1135	2.86/1135	2.95/1135	2.75/1135	2.66/1135	2.67/1135
[10A] Adding government bond yield spreads (t-1)	0.0141***	0.0141***	0.0164***	0.0140***	0.0162***	0.0157***	0.0155***	0.0153***	0.0149***	0.0139***
	(0.0036)	(0.0036)	(0.0037)	(0.0038)	(0.0037)	(0.0036)	(0.0036)	(0.0036)	(0.0036)	(0.0035)
	3.84/1139	3.90/1139	4.33/1139	3.62/1139	4.34/1139	4.27/1139	4.26/1139	4.21/1139	4.14/1139	3.96/1139
[10B] Adding sovereign rating (t-1)	0.0156***	0.0172***	0.0158***	0.0155***	0.0150***	0.0151***	0.0151***	0.0148***	0.0148***	0.0146***
	(0.0043)	(0.0038)	(0.0037)	(0.0033)	(0.0031)	(0.0030)	(0.0030)	(0.0030)	(0.0031)	(0.0030)
	3.63/1621	4.45/1621	4.19/1621	4.67/1621	4.78/1621	4.88/1621	4.88/1621	4.85/1621	4.74/1621	4.78/1621
[10C] Adding debt crisis contagion (t-1)	0.0134***	0.0132***	0.0131***	0.0131***	0.0134***	0.0133***	0.0135***	0.0137***	0.0136***	0.0136***
	(0.0034)	(0.0032)	(0.0031)	(0.0032)	(0.0029)	(0.0028)	(0.0027)	(0.0028)	(0.0027)	(0.0026)
	3.92/2386	4.12/2386	4.15/2386	4.11/2386	4.55/2386	4.75/2386	4.90/2386	4.84/2386	4.88/2386	5.06/2386
[11A] Adding banking crisis (t-1)	0.0200***	0.0200***	0.0200***	0.0200***	0.0215***	0.0212***	0.0207***	0.0206***	0.0205***	0.0205***
	(0.0052)	(0.0057)	(0.0053)	(0.0053)	(0.0052)	(0.0052)	(0.0050)	(0.0049)	(0.0047)	(0.0047)
	3.84/1080	3.46/1080	3.74/1080	3.72/1080	4.14/1080	4.07/1080	4.06/1080	4.16/1080	4.32/1080	4.36/1080
[11B] Adding financial system deposits (t-1)	0.0101*	0.0118**	0.0139***	0.0148***	0.0149***	0.0156***	0.0151***	0.0151***	0.0150***	0.0148***
	(0.0059)	(0.0049)	(0.0043)	(0.0043)	(0.0043)	(0.0042)	(0.0045)	(0.0043)	(0.0043)	(0.0044)
	1.69/2249	2.38/2249	3.20/2249	3.43/2249	3.45/2249	3.66/2249	3.35/2249	3.45/2249	3.44/2249	3.33/2249
[12A] Adding UK legal origin	0.0131***	0.0132***	0.0138***	0.0139***	0.0141***	0.0140***	0.0142***	0.0143***	0.0141***	0.0141***
	(0.0044)	(0.0035)	(0.0038)	(0.0039)	(0.0036)	(0.0034)	(0.0033)	(0.0033)	(0.0033)	(0.0033)
	2.92/2386	3.77/2386	3.60/2386	3.53/2386	3.88/2386	4.05/2386	4.24/2386	4.31/2386	4.24/2386	4.17/2386
[12B] Adding IMF program dummy (t-1)	0.0129***	0.0130***	0.0133***	0.0136***	0.0135***	0.0134***	0.0134***	0.0133***	0.0133***	0.0132***
	(0.0047)	(0.0042)	(0.0039)	(0.0037)	(0.0035)	(0.0034)	(0.0034)	(0.0034)	(0.0033)	(0.0032)
	2.72/2341	3.03/2341	3.37/2341	3.66/2341	3.80/2341	3.95/2341	3.93/2341	3.89/2341	4.00/2341	4.09/2341
[12C] Adding CDS country dummy (t-1)	0.0129***	0.0181***	0.0163***	0.0169***	0.0171***	0.0169***	0.0166***	0.0166***	0.0181***	0.0173***
	(0.0037)	(0.0038)	(0.0043)	(0.0037)	(0.0033)	(0.0031)	(0.0030)	(0.0029)	(0.0030)	(0.0029)
	3.43/2386	4.68/2386	3.76/2386	4.48/2386	5.14/2386	5.35/2386	5.51/2386	5.66/2386	6.01/2386	5.80/2386
[13A] Adding capital account balance (t-1)	0.0132***	0.0129***	0.0134***	0.0134***	0.0134***	0.0134***	0.0134***	0.0133***	0.0133***	0.0133***
	(0.0040)	(0.0033)	(0.0036)	(0.0035)	(0.0032)	(0.0030)	(0.0029)	(0.0029)	(0.0029)	(0.0030)
	3.31/2323	3.86/2323	3.65/2323	3.82/2323	4.10/2323	4.45/2323	4.52/2323	4.54/2323	4.45/2323	4.42/2323
[13B] Adding financial account balance (t-1)	0.0137***	0.0135***	0.0136***	0.0140***	0.0143***	0.0141***	0.0139***	0.0139***	0.0140***	0.0139***
	(0.0037)	(0.0032)	(0.0033)	(0.0034)	(0.0031)	(0.0029)	(0.0030)	(0.0030)	(0.0030)	(0.0030)
	3.68/2336	4.09/2336	4.05/2336	4.12/2336	4.52/2336	4.75/2336	4.66/2336	4.59/2336	4.54/2336	4.57/2336

V. Robustness

Estimations presented seem to support our hypothesis. Next, we follow the recommendations of Li & Prabhala (2007) and Roberts & Whited (2012) in corporate finance literature, and draw upon several econometric methods to overcome a potential selection bias and an endogeneity issue.

5.1. Entropy balancing

Generalizing conventional matching methods, entropy balancing was proposed by Hainmueller (2012). By combining matching and regression approach, it presents some advantages over other treatment effect estimators (Neuenkirch & Neumeier, 2016). Compared to regression approach (for example, difference-in-difference) or propensity scores matching, since its implementation does not require specifying a model for the selection to treatment, it avoids potential misspecification or multicollinearity. Compared to matching methods, it ensures covariate balancing between treated and control groups. Finally, entropy balancing allows accounting for unobservable factors related to the panel dimension of the data, through including year and regional fixed-effects.

Entropy balancing consists of generating a synthetic control group as close as possible to CDS countries in terms of observable characteristics. To this end, we compute weights for untreated units that may satisfy pre-specified balance constraints, involving sample moments of pretreatment characteristics, by remaining as close as possible to uniform base weights. Following Neuenkirch & Neumeier (2016), we impose equal covariate means between the treatment and the control groups; thus, the synthetic control group contains, on average, untreated units that are as close as possible to treated units. We compute weights using the pre-treatment covariates from the benchmark specification.

Let us focus on some descriptive statistics before and after weighting. Appendix 4 presents pre-weighting sample means of all matching covariates for the treatment group (CDS trading, column [1]) and the control group (No CDS trading, column [2]), as well as differences in covariates' means (column [3]). Interestingly, aside from reserve-to-GDP, tests in column [3] reveal significant different covariates' means between the treatment and the control group,[69] suggesting the need for modifying the control group to make it comparable to the treated group. This modified (synthetic) control group is reported in column [4],

[69] On average, CDS countries present significantly lower debt, fiscal deficit, and inflation, and higher current account balance, and private credit-to-GDP ratio, while no-CDS countries present significantly higher GDP growth, and lower executive constraints.

together with covariates' means differences with respect to the treated group (column [5]). Column [5] reveals the effectiveness of entropy balancing, as no significant differences remain after weighting, i.e. the synthetic control group and the treatment group present statistically equal covariates' means.

Table 4: The impact of CDS trading on SDC using Entropy Balancing

	[14A]	[14B]	[14C]	[14D]
Dependent variable: Sovereign debt crisis	Baseline	Adding controls	Adding controls, and year fixed effects	Adding controls, year and regional fixed effects
CDS dummy	0.0112**	0.0112**	0.0181***	0.0175***
	(0.0043)	(0.0043)	(0.0060)	(0.0063)
t-statistic	2.55	2.58	2.99	2.77
Observations	2390	2390	2390	2390

Note: Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Using these weights, we perform in Table 4 weighted least squares regressions, in which SDC is the dependent variable, and CDS trading is the explanatory variable. Estimations in column [14A] show that CDS trading significantly increases SDC occurrence, consistent with benchmark findings. This result is confirmed when we subsequently add the matching covariates employed to compute weights (column [14B][70]), unobservable time-specific factors (column [14C]), and regional dummies (column [14D]). Interestingly, in the latter two specifications, the magnitude of the effect is even stronger compared to benchmark estimations, namely around 1.8 pp. Consequently, using entropy balancing support previous findings based on bias-corrected matching.

5.2. Endogeneity: Instrumental variable estimation

So far, we employed matching approaches to identify the treatment effect of CDS trading initiation. In the following, we take a closer look at endogeneity. Indeed, CDS traders and bondholders may anticipate a deterioration of credit quality for a borrowing government, and thus initiate CDS contracts for future distressed borrowers.

To deal with such endogeneity issues, we draw upon an external instrumental variable (IV) strategy. Keeping in mind that an appropriate instrument must satisfy the relevance and the exclusion restrictions, i.e. it should be correlated with CDS trading, and have no direct influence on SDC occurrence, we select the Joint votes of Nations with the US at the UN General Assembly (*Joint votes US*) as the exogenous instrument for CDS trading. This choice

[70] Including covariates employed in the first step of entropy balancing in the regression step is similar to introducing control variables in a randomized experiment (Neuenkirch & Neumeier, 2016).

is motivated by the fact that CDS contracts were invented in US in 1994 by J.P. Morgan, and they are mostly traded by US investment banks and hedge funds. Since the US is the CDS market leader, we expect CDS sellers to initiate CDS transactions in countries related to the US, because expected losses from the occurrence of credit events may be lower.[71]

Appendix 5 reports first-stage regressions based on a probit model. According to the first column, joint votes US significantly increases CDS trading. Besides, since the F-test statistic of the instrument is 12.43, namely above the threshold of 10 recommended by Staiger & Stock (1997), our instrument is relevant and not weak.[72] However, since we cannot test the exclusion restriction formally with only one instrument, we consider a probit SDC regression in which we include CDS trading, joint votes US, and control variables, and we test the null hypothesis that joint votes US is not statistically different from zero.[73] Appendix 6 shows that CDS trading is positively correlated with SDC occurrence, and, more importantly, that the coefficient of joint votes US is never statistically significant. Adding to previous findings on its relevance, this last result proves that our instrument is equally valid.

We now turn to the probit estimation of main regressions, reported in Table 5. Following the previous literature on SDC, we include in the benchmark IV-regression [15A] the lagged value of: government debt-to-GDP, reserve-to-GDP, inflation rate, GDP growth rate, executive constraint, and financial openness (Kaopen). Confirming matching estimations, results show that instrumented CDS trading increases the probability of SDC. Besides, the magnitude of this effect is slightly stronger compared to our main findings, namely around 2.1 pp.[74] Moreover, we extend specification [15A] by subsequently introducing additional control variables, namely: UK legal origin, log of US aid, current account balance, capital account balance, and financial account balance. Columns [15B-F] in Table 5 show that, irrespective of the considered specification, instrumented CDS trading significantly increases SDC occurrence, corroborating, yet again, our findings based on bias-corrected matching.

[71] For instance, monitoring in case of credit events may be less complex in country ideologically close to the US, making CDS payments less expensive.

[72] These findings are confirmed when successively introducing additional control variables that may affect both joint US votes and SDC, namely a common law legal origin, log of US development aid, current account balance, capital account balance, and financial account balance.

[73] This should be the case if the joint US votes is not directly correlated with SDC occurrence.

[74] Our instrumentation strategy, which consists of using binomial models in the instrumentation and in the main regression, follows closely the one of Subrahmanyam et al. (2014, see their section 3.3 at pages 2940-42). Alternatively, we performed the instrumentation and the main regression using OLS, and then we instrumented using OLS and we used a probit model in the main regression. These two additional estimations, available upon request, reveal that, although with a higher magnitude (which may be explained by the use of OLS for left-hand side variables), instrumented CDS still significantly increases SDC probability, consistent with main results.

Table 5: The impact of CDS trading on SDC using Instrumental Variable (IV) estimations

Dependent variable: SDC	[15A]	[15B]	[15C]	[15D]	[15E]	[15F]
CDS trading	3.062***	3.070***	2.952***	3.064***	3.075***	3.061***
	(0.157)	(0.109)	(0.350)	(0.121)	(0.111)	(0.173)
CDS trading *marginal effect*	0.0213	0.0214	0.0199	0.0214	0.0218	0.0218
Government debt-to-GDP (t-1)	0.000461	0.000480	0.000410	0.000510	-0.000298	0.000477
	(0.00136)	(0.00122)	(0.00133)	(0.00149)	(0.00130)	(0.00151)
Inflation (t-1)	-0.00105	-0.00102	-0.00179	-0.00128	-0.00107	-0.000966
	(0.00193)	(0.00165)	(0.00282)	(0.00172)	(0.00174)	(0.00206)
Reserve-to-GDP (t-1)	-1.686	-1.296	-2.933	-1.261	-1.354	-1.836
	(1.758)	(1.348)	(2.412)	(1.554)	(1.582)	(1.996)
GDP growth (t-1)	-0.0125	-0.0104	-0.00782	-0.0113	-0.0104	-0.0110
	(0.0142)	(0.0118)	(0.00735)	(0.0118)	(0.0125)	(0.0140)
Executive constraint (t-1)	-0.146***	-0.135***	-0.134***	-0.137***	-0.144***	-0.135***
	(0.0438)	(0.0367)	(0.0476)	(0.0389)	(0.0430)	(0.0456)
Kaopen (t-1)	-0.137**	-0.123***	-0.174*	-0.128**	-0.121**	-0.126**
	(0.0538)	(0.0446)	(0.0910)	(0.0515)	(0.0512)	(0.0601)
UK legal origin		-0.184				
		(0.173)				
Log US aid (t-1)			0.110***			
			(0.0359)			
Current account balance (t-1)				2.76e-05		
				(0.00836)		
Capital account balance (t-1)					0.0172	
					(0.0140)	
Financial account balance (t-1)						-0.00461*
						(0.00271)
Constant	-1.294**	-1.097**	-1.820***	-1.229**	-1.148*	-1.346*
	(0.629)	(0.472)	(0.593)	(0.581)	(0.593)	(0.709)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Wald test of exogeneity (p-value)	0.0495	0.0136	0.0625	0.0378	0.0447	0.0721
Wald test (chi2)	778.96	1066.59	497.25	953.13	1094.37	758.72
Wald test (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	1290	1290	1084	1290	1263	1262

Note: The instrumented variable is CDS trading. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

5.3. Selection of CDS trading

Complementing our IV approach, we use Heckman's (1979) two-stage model to deal with the selection bias of CDS trading. Indeed, the selection of sovereign entities for CDS trading is analogous to an omitted variable problem in the spirit of Heckman, since we do not observe the outcome of CDS countries without CDS trading. To remove this bias, we follow Subrahmanyam et al. (2014) using a two-step regression approach. In the first step, we estimate the first-stage IV regression using a probit model, and then compute the Inverse

Mills Ratio (IMR) representing the omitted variable, using *joint votes US* as an excluded variable.[75] In the second step, we estimate the likelihood of SDC occurrence using a linear probability model in which we include the Inverse Mills Ratio as an additional explanatory variable.

Table 6: The impact of CDS trading on SDC when controlling for selection of CDS trading

Dependent variable: SDC	[16A]	[16B]	[16C]	[16D]	[16E]	[16F]
CDS dummy	0.0109***	0.0111**	0.00912**	0.0099***	0.0106***	0.0112***
	(0.0026)	(0.00438)	(0.00461)	(0.0020)	(0.00336)	(0.00289)
Government debt-to-GDP (t-1)	0.00005*	5.19e-05	2.16e-05	0.00006	6.10e-05	5.73e-05
	(0.00003)	(4.86e-05)	(6.93e-05)	(0.00011)	(6.27e-05)	(0.000133)
Reserve-to-GDP (t-1)	-0.0117***	-0.0107***	-0.00980**	-0.0143***	-0.0146***	-0.0143**
	(0.00299)	(0.00282)	(0.00397)	(0.0044)	(0.00173)	(0.00587)
Inflation (t-1)	0.0003***	0.000340	-0.000197	0.0003	0.000323***	0.000347**
	(0.00009)	(0.000775)	(0.000155)	(0.00038)	(0.000107)	(0.000154)
GDP growth (t-1)	-0.0003	-0.000390	0.000100	-0.00030	-0.000358	-0.000353
	(0.00055)	(0.000467)	(0.000213)	(0.00041)	(0.000389)	(0.000260)
Executive constraint (t-1)	-0.0013***	-0.00128	-0.00128	0.0011	-0.00122	-0.00122
	(0.00032)	(0.00176)	(0.00172)	(0.00082)	(0.00157)	(0.000763)
Kaopen (t-1)	-0.0011**	-0.000748	-0.00165*	-0.00114	-0.00102	-0.000967**
	(0.00055)	(0.00109)	(0.000963)	(0.00115)	(0.00165)	(0.000408)
UK legal origin		-0.00413***				
		(0.000903)				
Log US aid (t-1)			0.00102***			
			(0.000375)			
Current account balance (t-1)				-0.00021		
				(0.00019)		
Capital account balance (t-1)					-9.53e-05	
					(0.000203)	
Financial account balance (t-1)						-2.87e-05***
						(2.50e-07)
Inverse Mills Ratio (t-1)	-0.00059***	-0.000649*	-0.000675***	-0.00053**	-0.000503***	-0.000568*
	(0.00007)	(0.000352)	(0.000222)	(0.00023)	(0.000113)	(0.000311)
Constant	0.0236***	0.0282***	0.00597	0.0222	0.0237***	0.0177
	(0.0008)	(0.00927)	(0.00727)	(0.01954)	(0.000301)	(0.0195)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1.558	1.558	1.477	1.558	1.541	1.519

Note: Second-stage estimations of the Heckman selection model using a linear regression. The IMR is computed from first-stage probit regressions reported in Appendix 5. Bootstrap standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

[75] The use of a nonlinear model for computing the IMR makes our analysis comparable to the related literature (see, for example, Ismailescu & Phillips, 2015).

Tables 6 reports the estimations of the second-stage Heckman correction, based on IMR computed from Appendix 5. Most of control variables are not significant, probably due to potential multicollinearity induced by the inclusion of the IMR. The coefficient of IMR is negative and statistically significant, which might suggest that the link between CDS trading and SDC is likely to be driven by a negative selection bias. Finally, and more importantly, CDS trading significantly increases SDC. Although the magnitude of this effect is somewhat lower compared to matching estimates (around 1pp), its significance is unaltered when considering different specifications (see regressions [16A-F] in Table 6).

5.4. Falsification test

Finally, we conduct a falsification test to address potential measurement errors in CDS trading. Indeed, given that CDS are not traded on an organized market, potential measurement errors could arise from the identification of CDS introduction (Subrahmanyam et al., 2014). To this end, we generate arbitrary CDS initiation dates for each CDS country, by lagging the CDS introduction by ten years, namely the mid-period of the pre-treatment period (1980-2001).[76] Results reported in Table 7 based on the bias-corrected matching estimator show that, contrary to our benchmark results, the treatment effect using these placebo CDS introduction dates is not statistically different from zero. Consequently, the falsification test confirms that the effect we unveiled is triggered by CDS trading rather than measurement errors.

Table 7: The impact of CDS trading on SDC using a falsification test

Dependent variable:	Bias-corrected matching estimators				
Sovereign Debt Crisis (SDC)	n=1	n=2	n=3	n=4	n=5
[17] ATT	0.0219	0.0192	0.0131	0.0230	0.0249
	(0.0175)	(0.0182)	(0.0160)	(0.0157)	(0.0152)
Z-statistic/Observations	1.25/1076	1.05/1076	0.82/1076	1.47/1076	1.63/1076
	n=6	n=7	n=8	n=9	n=10
[16] ATT	0.0225	0.0209	0.0174	0.0143	0.0161
	(0.0152)	(0.0142)	(0.0121)	(0.0118)	(0.0114)
Z-statistic/Observations	1.48/1076	1.47/1076	1.44/1076	1.21/1076	1.41/1076

Note: We shift the true CDS trading initiation date for each CDS country by 10 years, which is the mid-period of the pre-treatment period (1980-2001), as a falsification test. Heteroskedasticity-consistent standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

[76] Alternatively, Subrahmanyam et al. (2014) and Ismailescu & Phillips (2015) shift forward the CDS introduction by one year in their falsification tests; however, this is not appropriate for our analysis focusing on the average treatment effect.

VI. Heterogeneity of the CDS trading effect

We previously revealed that CDS trading increases SDC occurrence. Next, we explore potential heterogeneities of this effect across CDS countries' characteristics, or related to the considered time span.

6.1. CDS countries' characteristics

We consider several key CDS countries' characteristics, namely (i) the level of economic development, (ii) the debt ratings grade at the timing of CDS introduction, (iii) the degree of public sector transparency, and (iv) the degree of Central Bank's independence. Bias-corrected matching results based on the benchmark specification are reported in Table 8.

Lines [18A-B] show that the magnitude of the effect of CDS trading on SDC occurrence dramatically changes with the level of economic development, as it is around 0.8 pp for developed countries and 1.8 pp for developing countries. One possible explanation is that credibility in financial markets is better anchored in developed countries, which may help mitigating adverse adjustments between bond and CDS markets.

Next, we consider ratings grades at the time CDS trading was introduced. Indeed, risk-sharing opportunities may vary substantially across lenders, depending on their initial creditworthiness. To test this hypothesis, we split CDS countries based on their grades, into investment and speculative. According to initial long-term sovereign debt ratings of the three main rating agencies (Standard's and Poor's, Moody's, and Fitch), one-third of the 74 CDS countries in our sample had speculative debt rating grades at the time of CDS initiation, while the rest belong to the investment grade group. Lines [19A-B] in Table 8 show that CDS trading has no statistically significant effect on SDC occurrence in countries with initial investment ratings grades (in seven cases out of ten). On the contrary, the adverse effect is significant in speculative grades CDS countries, and its magnitude is larger compared to benchmark results, namely around 3.4 pp. Thus, CDS countries with initial lower creditworthiness appear more prone to debt crises.

Moreover, we condition the effect of CDS trading on countries' degree of transparency. Following Alesina & Weder (2002) and Garde & Parsley (2014), we proxy the degree of transparency by public sector's corruption perception index (CPI) of Transparency International, and define "Low" ("High") countries with CPI between 0-5 (6-10). Lines [20A-B] show that, although ATTs are significant and positive in both groups, their magnitude is almost twice larger in "Low" compared to "High" countries, namely around 2.1 pp. Thus, by

helping borrowing governments to build reputation with private agents and improve market efficiency, transparency may mitigate the adverse effect of CDS trading on SDC occurrence.

Finally, we investigate the role of the limits imposed on Central Bank's lending to the Government, by differentiating between "Low" and "High" Central Bank independence, using the mean level of Central Bank lending to Government Index from Crowe & Meade (2008). Lines [21A-B] in Table 8 show that the effect of CDS trading on SDC occurrence is more important for countries with relatively low Central Bank independence. Thus, limits imposed on Central Bank's lending to Government may improve fiscal discipline and help avoid potential adverse consequences arising from fiscal dominance.

6.2. The time span

To understand how the effect of CDS trading on SDC occurrence evolves over time, we follow Balima et al. (2017) and estimate cumulative ATT_t, $t = \overline{1;13}$, spanning from the year of first CDS trading initiation (2001), until the last year of the sample (2013). Lines [22A-M] in Table 9 reveal the following. Except for some cases, the impact of CDS trading is not significant over 2001-2004. Moreover, the cumulative effect of CDS trading on SDC occurrence becomes significant starting 2005, corroborating the findings of Peristiani & Savino (2011) who outline higher expected default frequency of CDS markets since 2004 for US firms. Finally, albeit remaining significant, the cumulative adverse effect decreases in the following years towards its value in 2013, which corresponds to benchmark values.

Table 8: Heterogeneity in the impact of CDS trading on SDC using Bias-Corrected Matching: CDS countries' characteristics

Dependent variable: Sovereign debt crisis	Bias-corrected matching estimators									
	n=1	n=2	n=3	n=4	N=5	n=6	n=7	n=8	n=9	n=10
Level of economic development										
[18A] Developed countries	0.0083**	0.0083***	0.0083***	0.0083***	0.0083***	0.0083***	0.0083***	0.0083***	0.0083***	0.0083***
	(0.0032)	(0.0029)	(0.0025)	(0.0022)	(0.0022)	(0.0021)	(0.0020)	(0.0021)	(0.0020)	(0.0021)
	2.53/956	2.83/956	3.27/956	3.65/956	3.70/956	3.82/956	4.05/956	3.83/956	4.04/956	3.89/956
[18B] Developing countries	0.0139*	0.0178**	0.0178**	0.0185***	0.0189***	0.0192***	0.0195***	0.0193***	0.0196***	0.0197***
	(0.0084)	(0.0069)	(0.0071)	(0.0071)	(0.0068)	(0.0067)	(0.0066)	(0.0066)	(0.0065)	(0.0064)
	1.65/1430	2.56/1430	2.49/1430	2.59/1430	2.76/1430	2.88/1430	2.94/1430	2.94/1430	2.99/1430	3.07/1430
Rating grade										
[19A] Investment grade	0.0038***	0.0038*	0.0038	0.0038	0.0038	0.0038*	0.0038	0.0038	0.0038	0.0038
	(0.0013)	(0.0022)	(0.0028)	(0.0026)	(0.0024)	(0.0022)	(0.0023)	(0.0026)	(0.0028)	(0.0027)
	2.83/2044	1.73/2044	1.38/2044	1.49/2044	1.59/2044	1.70/2044	1.66/2044	1.47/2044	1.39/2044	1.42/2044
[19B] Speculative grade	0.0307***	0.0333***	0.0345***	0.0335***	0.0342***	0.0345***	0.0351***	0.0344***	0.0348***	0.0346***
	(0.0108)	(0.0096)	(0.0101)	(0.0098)	(0.0096)	(0.0090)	(0.0088)	(0.0087)	(0.0087)	(0.0088)
	2.82/1436	3.44/1436	3.40/1436	3.40/1436	3.56/1436	3.80/1436	3.95/1436	3.95/1436	3.99/1436	3.92/1436
Degree of Transparency										
[20A] Low Transparency	0.0188**	0.0208***	0.0216***	0.0211***	0.0214***	0.0214***	0.0217***	0.0219***	0.0221***	0.0221***
	(0.0188)	(0.0065)	(0.0069)	(0.0070)	(0.0065)	(0.0063)	(0.0065)	(0.0067)	(0.0067)	(0.0066)
	2.43/1404	3.18/1404	3.13/1404	3.01/1404	3.26/1404	3.38/1404	3.32/1404	3.26/1404	3.28/1404	3.33/1404
[20B] High Transparency	0.0068**	0.0068**	0.0068***	0.0068***	0.0068***	0.0068***	0.0068***	0.0068***	0.0068***	0.0068***
	(0.0034)	(0.0027)	(0.0026)	(0.0024)	(0.0022)	(0.0021)	(0.0019)	(0.0022)	(0.0021)	(0.0020)
	2.00/1685	2.45/1685	2.62/1685	2.83/1685	3.04/1685	3.24/1685	3.43/1685	3.10/1685	3.25/1685	3.40/1685
Central Bank independence										
[21A] Low Central Bank independence	0.0226	0.0232*	0.0232**	0.0245***	0.0228***	0.0227**	0.0224**	0.0222**	0.0220**	0.0218**
	(0.0152)	(0.0130)	(0.0103)	(0.0097)	(0.0087)	(0.0102)	(0.0102)	(0.0102)	(0.0109)	(0.0108)
	1.49/1053	1.78/1053	2.23/1053	2.51/1053	2.61/1053	2.21/1053	2.18/1053	2.18/1053	2.01/1053	2.02/1053
[21B] High Central Bank independence	0.0120***	0.0120***	0.0120***	0.0120***	0.0125***	0.0124***	0.0123***	0.0126***	0.0125***	0.0127***
	(0.0035)	(0.0032)	(0.0032)	(0.0032)	(0.0033)	(0.0032)	(0.0033)	(0.0033)	(0.0033)	(0.0033)
	3.41/1333	3.70/1333	3.66/1333	3.71/1333	3.78/1333	3.79/1333	3.70/1333	3.81/1333	3.77/1333	3.76/1333

Note for Tables 8-9: Heteroskedasticity-consistent standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Heterogeneity in the impact of CDS trading on SDC using Bias-Corrected Matching: Cumulative ATTs and the Time Span

Dependent variable:	Bias-corrected matching estimators									
Sovereign debt crisis	n=1	n=2	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
[22A] ATT_1	0.0384	0.0384	0.0384	0.0384	0.0384	0.0511*	0.0463*	0.0395*	0.0388*	0.0389*
	(0.0471)	(0.0384)	(0.0339)	(0.0301)	(0.0275)	(0.0256)	(0.0239)	(0.0227)	(0.0225)	(0.0213)
	0.82/822	1.00/822	1.13/822	1.28/822	1.40/822	1.99/822	1.94/822	1.74/822	1.73/822	1.82/822
[22B] ATT_2	-0.0468	-0.0293	-0.0189	-0.0159	-0.0135	-0.0129	-0.0135	-0.0171	-0.0294	-0.0323
	(0.0803)	(0.0473)	(0.0431)	(0.0359)	(0.0337)	(0.0322)	(0.0315)	(0.0346)	(0.0365)	(0.0354)
	-0.58/947	-0.62/947	-0.44/947	-0.44/947	-0.40/947	-0.40/947	-0.43/947	-0.49/947	-0.81/947	-0.91/947
[22C] ATT_3	-0.0256	0.0011	0.0133	0.0190	0.0222	0.0243	0.0253	0.0259	0.0211	0.0192
	(0.0449)	(0.0276)	(0.0250)	(0.0213)	(0.0201)	(0.0191)	(0.0198)	(0.0223)	(0.0220)	(0.0220)
	-0.57/1076	0.04/1076	0.53/1076	0.90/1076	1.10/1076	1.27/1076	1.27/1076	1.16/1076	0.96/1076	0.87/1076
[22D] ATT_4	-0.0180	0.0050	0.0150	0.0184	0.0198	0.0213*	0.0220*	0.0218	0.0201	0.0194
	(0.0297)	(0.0180)	(0.0161)	(0.0141)	(0.0132)	(0.0126)	(0.0132)	(0.0145)	(0.0149)	(0.0147)
	-0.60/1204	0.28/1204	0.93/1204	1.31/1204	1.50/1204	1.68/1204	1.66/1204	1.50/1204	1.35/1204	1.32/1204
[22E] ATT_5	0.0072	0.0185	0.0252**	0.0277**	0.0273***	0.0286***	0.0285***	0.0284**	0.0280**	0.0279**
	(0.0228)	(0.0140)	(0.0127)	(0.0111)	(0.0104)	(0.0102)	(0.0106)	(0.0119)	(0.0117)	(0.0117)
	0.32/1334	1.32/1334	1.98/1334	2.49/1334	2.62/1334	2.80/1334	2.68/1334	2.39/1334	2.40/1334	2.38/1334
[22F] ATT_6	0.0146	0.0201*	0.0232**	0.0241***	0.0234***	0.0244***	0.0244***	0.0241***	0.0242***	0.0240***
	(0.0167)	(0.0112)	(0.0101)	(0.0089)	(0.0083)	(0.0082)	(0.0083)	(0.0094)	(0.0093)	(0.0092)
	0.88/1470	1.79/1470	2.30/1470	2.71/1470	2.83/1470	2.96/1470	2.94/1470	2.56/1470	2.59/1470	2.60/1470
[22G] ATT_7	0.0129	0.0170*	0.0195**	0.0207***	0.0203***	0.0214***	0.0209***	0.0206***	0.0207***	0.0207***
	(0.0138)	(0.0094)	(0.0084)	(0.0073)	(0.0068)	(0.0067)	(0.0068)	(0.0078)	(0.0077)	(0.0076)
	0.94/1607	1.81/1607	2.33/1607	2.81/1607	2.96/1607	3.16/1607	3.06/1607	2.62/1607	2.69/1607	2.71/1607
[22H] ATT_8	0.0153	0.0180**	0.0199***	0.0206***	0.0201***	0.0212***	0.0204***	0.0200***	0.0204***	0.0204***
	(0.0118)	(0.0081)	(0.0074)	(0.0065)	(0.0061)	(0.0060)	(0.0061)	(0.0067)	(0.0071)	(0.0070)
	1.30/1742	2.23/1742	2.68/1742	3.14/1742	3.27/1742	3.51/1742	3.36/1742	2.95/1742	2.87/1742	2.89/1742
[22I] ATT_9	0.0166	0.0180**	0.0200***	0.0207***	0.0203***	0.0209***	0.0202***	0.0198***	0.0204***	0.0204***
	(0.0104)	(0.0072)	(0.0066)	(0.0059)	(0.0057)	(0.0055)	(0.0056)	(0.0062)	(0.0066)	(0.0066)
	1.59/1874	2.48/1874	3.03/1874	3.50/1874	3.56/1874	3.77/1874	3.58/1874	3.20/1874	3.06/1874	3.08/1874
[22J] ATT_{10}	0.0181*	0.0185***	0.0203***	0.0205***	0.0206***	0.0210***	0.0202***	0.0198***	0.0205***	0.0204***
	(0.0093)	(0.0062)	(0.0059)	(0.0053)	(0.0051)	(0.0050)	(0.0050)	(0.0056)	(0.0059)	(0.0059)
	1.94/2005	2.96/2005	3.42/2005	3.87/2005	4.03/2005	4.19/2005	4.02/2005	3.50/2005	3.44/2005	3.47/2005
[22K] ATT_{11}	0.0174**	0.0173***	0.0189***	0.0191***	0.0190***	0.0195***	0.0187***	0.0182***	0.0190***	0.0188***
	(0.0083)	(0.0056)	(0.0052)	(0.0047)	(0.0045)	(0.0045)	(0.0046)	(0.0051)	(0.0053)	(0.0052)
	2.08/2135	3.09/2135	3.58/2135	4.00/2135	4.17/2135	4.34/2135	4.01/2135	3.55/2135	3.55/2135	3.56/2135
[22L] ATT_{12}	0.0150**	0.0157***	0.0177***	0.0177***	0.0184***	0.0180***	0.0171***	0.0169***	0.0174***	0.0173***
	(0.0076)	(0.0052)	(0.0048)	(0.0043)	(0.0041)	(0.0040)	(0.0042)	(0.0046)	(0.0048)	(0.0048)
	1.97/2263	3.01/2263	3.70/2263	4.11/2263	4.44/2263	4.47/2263	4.05/2263	3.61/2263	3.57/2263	3.59/2263
[22M] ATT_{13}	0.0140**	0.0147***	0.0165***	0.0162***	0.0170***	0.0165***	0.0157***	0.0155***	0.0160***	0.0159***
	(0.0069)	(0.0048)	(0.0043)	(0.0039)	(0.0038)	(0.0037)	(0.0039)	(0.0042)	(0.0044)	(0.0044)
	2.02/2386	3.06/2386	3.83/2386	4.16/2386	4.46/2386	4.47/2386	4.03/2386	3.62/2386	3.58/2386	3.58/2386

VI. Conclusion

We analyzed the effect of CDS trading on the occurrence of SDC using a large sample of 141 developed and developing countries over 1980-2013. We draw upon different econometric techniques to address the self-selection and endogeneity issues of CDS trading initiation.

Results confirm our hypothesis, namely that SDC increases after the introduction of CDS trading. This effect is economically meaningful: on average, countries with CDS contracts on their debt present a 1.5-2 pp higher probability of experiencing SDC than countries without CDS contracts.

Consequently, our paper develops the nascent literature on the effect of *sovereign* CDS trading. Complementing previous studies emphasizing favorable effects of CDS initiation, our analysis suggests that sovereign entities become more vulnerable to debt crisis following CDS trading initiation. These opposite effects should, on the one hand, trigger additional research for assessing the impact of CDS trading initiation, and, on the other hand, contribute to the policy design and the implementation of CDS trading initiation. On this last point, our study provides some first insights for limiting the effects of CDS trading on SDC, as this detrimental effect is found to be weaker in developed countries, in countries with high public sector transparency, and in countries with high Central Bank independence, and even statistically not significant in countries with investment grades at the moment of their CDS initiation.

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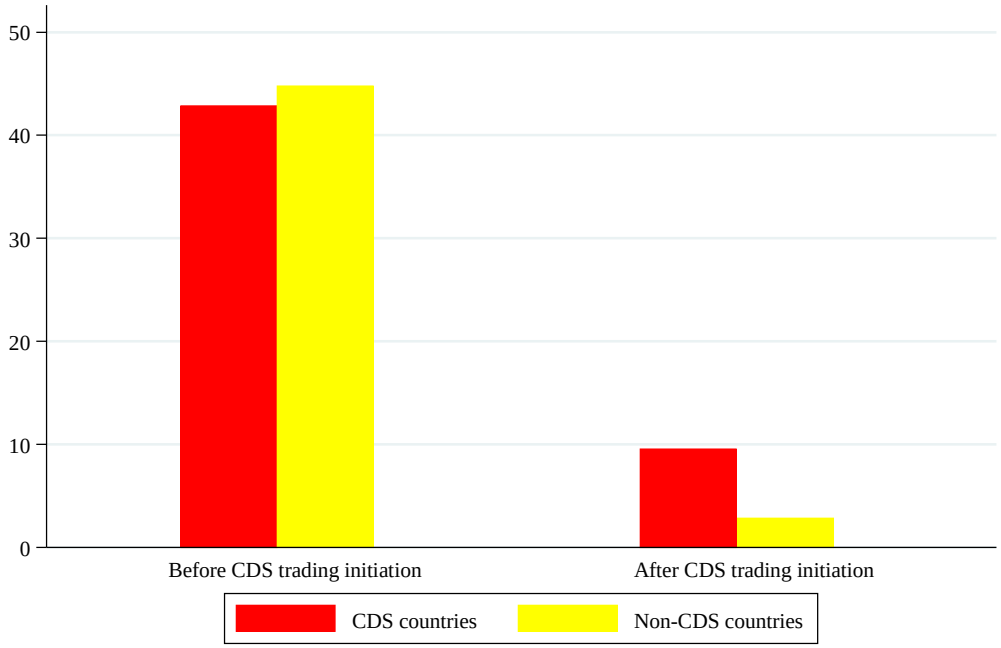
Supplementary Material

Figure 1. The Proportion of SDC occurrence



Note: Figure 1 presents the proportion of SDC occurrence in CDS and Non-CDS countries, before and after CDS trading initiation.

Appendix 1: CDS trading countries and their CDS starting dates

Country	CDS starting dates	Country	CDS starting dates	Country	CDS starting dates	Country	CDS starting dates
Angola	09/09/2008	Egypt	21/03/2002	Malaysia	23/04/2001	Slovakia	24/05/2001
Argentina	28/02/2001	El Salvador	29/07/2002	Malta	18/07/2003	Slovenia	26/04/2001
Austria	29/05/2001	Estonia	09/06/2004	Morocco	26/03/2001	South Africa	11/01/2001
Australia	30/04/2003	Finland	23/04/2001	Netherlands	31/07/2003	Spain	31/01/2001
Belgium	31/01/2001	France	12/04/2002	Norway	24/10/2003	Serbia and Montenegro	23/06/2006
Bulgaria	28/02/2001	Guatemala	29/07/2003	New Zealand	31/07/2003	Sweden	04/01/2001
Bahrain	09/02/2004	Iceland	31/12/2003	Oman	15/10/2008	Switzerland	05/06/2007
Canada	01/01/2003	Indonesia	29/11/2001	Pakistan	29/06/2004	Thailand	28/02/2001
Chile	01/02/2002	Iraq	13/02/2006	Panama	01/02/2002	Trinidad and Tobago	23/11/2004
Hong Kong	02/07/2002	Ireland	01/01/2003	Peru	01/02/2002	Turkey	19/01/2001
Colombia	28/02/2001	Israel	23/04/2001	Philippines	22/03/2001	United Arab Emirates	21/02/2007
Costa Rica	29/07/2003	Italy	31/01/2001	Poland	04/01/2001	United Kingdom	27/10/2004
Croatia	04/01/2001	Jamaica	22/05/2003	Portugal	07/02/2002	Ukraine	26/09/2002
Cyprus	01/02/2002	Japan	04/01/2001	Qatar	05/09/2001	Uruguay	25/03/2002
Czech Republic	26/02/2001	Kazakhstan	17/11/2003	Romania	11/02/2002	United States	01/12/2003
Germany	02/07/2002	Korea (Republic of)	28/03/2001	Ghana	15/09/2008	Venezuela	26/02/2001
Denmark	26/11/2002	Latvia	29/08/2003	Russian Federation	23/04/2001	Viet Nam	06/08/2002
Dominican Republic	22/05/2003	Lebanon	02/07/2002	Saudi Arabia	09/06/2004		
Ecuador	06/06/2003	Lithuania	15/04/2002	Singapore	18/07/2003		

Notes: The list of CDS trading countries and their corresponding CDS introduction dates, using data come from Markit Group Limited.

Appendix 2: Sources and definitions of variables

Variables	Definitions	Sources
CDS dummy	Dummy variable equal to 1 if a country has a USD-denominated CDS contracts with a maturity of 5-years on its sovereign debt, 0 otherwise	Markit database
SDC dummy	Dummy variable equal to 1 if a country experiences a sovereign debt crisis or debt restructuring in a particular year, and 0 otherwise	Laeven & Valencia (2013)
Banking crisis	Dummy variable equal to 1 if a country experiences a banking crisis in a particular year, and 0 otherwise	
Currency crisis	Dummy variable equal to 1 if a country experiences a currency crisis in a particular year, and 0 otherwise	
Government debt-to-GDP	General government gross debt, percent of GDP	World Economic Outlook (WEO), IMF
Fiscal balance-to-GDP	General government net lending/borrowing, percent of GDP	
Inflation rate	Inflation, average consumer prices, percent change	
Current account balance-to-GDP	Current account balance, percent of GDP	
Government bond yield	Long term government bond Yield	International Financial Statistics (IFS), IMF
Financial system deposits	Demand, time and saving deposits in deposit money banks and other financial institutions as a share of GDP	
Reserve-to-GDP	Annual total exchange reserves, percent of GDP	World Development Indicators (WDI), World Bank
Private credit-to-GDP	Domestic credit to private sector, percent of GDP	
GDP growth rate	Annual growth rate of GDP	
Official exchange rate	Annual average official exchange rate, local currency units relative to the U.S. dollar	
Capital account balance	Capital account balance, percent of GDP	
Financial account balance	Financial account balance, percent of GDP	
Executive constraint	Extent of institutionalized constraints on the decision-making powers of chief executives	Polity IV
Financial openness index	Index measuring the extent of openness in capital account transactions based on the information from IMF's Annual Report on Exchange Arrangements and Exchange Restrictions	Chinn & Ito (2008), update
Stock market crisis	Dummy variable equal to 1 if a country experiences a stock market crisis in a particular year, and 0 otherwise	Reinhard & Rogoff (2010)
Crisis contagion	Dummy variable equal to 1 if at least one country in a same region faces a sovereign debt crisis; 0 otherwise. We use the World Bank country classification by region	Authors calculations based on sovereign debt crisis data from Laeven & Valencia (2013)
Sovereign rating	Long-term foreign currency government debt ratings	Standard & Poor's, Moody's and Fitch websites
UK legal origin	Dummy variable equal to 1 if a country has a British legal origin, and 0 otherwise	La Porta, Lopez-de-Silanes, Shleifer (2008)
IMF program dummy	Dummy variable equal to 1 if IMF standby arrangement or IMF extended facility arrangement is in effect for at least 5 months in a particular year; 0 otherwise	IMF website
CDS country dummy	Dummy variable equal to 1 if a country is a CDS trading country, and 0 otherwise	Authors' constructions based on Markit database
Stock market capitalization	Total value of all listed shares in a stock market as a percentage of GDP	Global Financial Development, World Bank
Stock price volatility	Average of the 360-day volatility of the national stock market index	Bloomberg
Stock market return	Growth rate of annual average stock market index	
Joint votes with US	Joint votes of each Nation with the United States at the United Nations General Assembly	Strezhney & Voeten (2013)
US aid	Net official development assistance and official aid received from the United States	Query Wizard for International Development Statistics (QWIDS), OECD
Corruption perception index	Corruption index of the public sectors	Transparency International website
Central Bank lending to government	Index of the limits on CB lending to government	Crowe & Meade (2008), update

Appendix 3: Estimation of Propensity Scores based on a logit model

Dependent variable: CDS dummy	[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Government debt-to-GDP (t-1)	-0.00679	-0.00564	-0.00939	-0.00411	-0.00869	-0.00679	-0.0114*	-0.00407	-0.00564
	(0.00600)	(0.00561)	(0.00689)	(0.00623)	(0.00647)	(0.00600)	(0.00592)	(0.00702)	(0.00561)
Fiscal balance-to-GDP (t-1)	-0.141***	-0.144***	-0.144***	-0.151***	-0.142***	-0.141***	-0.128***	-0.131***	-0.144***
	(0.0406)	(0.0400)	(0.0402)	(0.0432)	(0.0481)	(0.0406)	(0.0447)	(0.0434)	(0.0400)
Inflation (t-1)	0.0197***	0.017***	0.020***	0.017***	0.036*	0.019***	0.015**	0.019***	0.017***
	(0.00623)	(0.00641)	(0.00647)	(0.00629)	(0.0207)	(0.00623)	(0.00661)	(0.00657)	(0.00641)
Current account balance (t-1)	-0.0947***	-0.096***	-0.088***	-0.097***	-0.101***	-0.094***	-0.094***	-0.097***	-0.096***
	(0.0269)	(0.0272)	(0.0259)	(0.0284)	(0.0308)	(0.0269)	(0.0350)	(0.0299)	(0.0272)
Reserve-to-GDP (t-1)	-1.585	-1.707	-1.162	-1.779	-0.441	-1.585	-1.097	-1.978	-1.707
	(1.083)	(1.100)	(1.026)	(1.114)	(1.202)	(1.083)	(1.071)	(1.251)	(1.100)
Private credit-to-GDP (t-1)	0.0262***	0.026***	0.029***	0.0226***	0.0188***	0.0262***	0.0201**	0.0310***	0.0268***
	(0.00774)	(0.00756)	(0.00819)	(0.00771)	(0.00695)	(0.00774)	(0.00880)	(0.00918)	(0.00756)
GDP growth (t-1)	0.0425	0.0431	0.0397	0.0394	0.0162	0.0425	0.0234	0.0607	0.0431
	(0.0361)	(0.0360)	(0.0382)	(0.0386)	(0.0367)	(0.0361)	(0.0406)	(0.0379)	(0.0360)
Executive constraint (t-1)	0.355**	0.355**	0.298*	0.261	0.337*	0.355**	0.348**	0.220	0.355**
	(0.163)	(0.161)	(0.158)	(0.165)	(0.184)	(0.163)	(0.168)	(0.172)	(0.161)
Kaopen (t-1)	0.151	0.129	0.155	0.177	0.276	0.151	0.0413	0.0695	0.129
	(0.147)	(0.144)	(0.147)	(0.151)	(0.177)	(0.147)	(0.156)	(0.168)	(0.144)
Constant	-5.591***	-5.591***	-5.651***	-5.482***	-4.645***	-4.183**	-5.591***	-5.216***	-5.150***
	(1.117)	(1.117)	(1.123)	(1.108)	(1.166)	(1.989)	(1.117)	(1.274)	(1.173)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo-R2	0.4909	0.4926	0.4989	0.4178	0.312	0.4909	0.4501	0.4486	0.4926
Observations	1682	1746	1630	1404	1138	1682	903	1374	1746

Note: Heteroskedasticity-consistent standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Estimations in columns [1]-[8] correspond to the ATTs reported in line [1]-[8] of Table 2, respectively.

Appendix 4: Descriptive Statistics and Covariate Balancing

	[1]	[2]	[3] = [2] - [1]			[4] Synthetic Group	[5] = [4] - [1]		
	CDS trading	No CDS trading	Difference	t-test	p-value	No CDS trading	Difference	t-test	p-value
Government debt-to-GDP (t-1)	49.832	60.744	10.911	6.131	0.000	50.306	0.474	0.371	0.711
Fiscal balance-to-GDP (t-1)	-1.570	-2.853	-1.282	-2.178	0.029	-1.591	-0.021	-0.032	0.974
Inflation (t-1)	5.188	7.720	2.532	6.154	0.000	5.187	-0.001	-0.005	0.996
Current account balance (t-1)	0.289	-3.172	-3.462	-8.726	0.000	0.301	0.012	0.029	0.977
Reserve-to-GDP (t-1)	0.175	0.162	-0.012	-1.645	0.100	0.174	-0.001	-0.194	0.846
Private credit-to-GDP (t-1)	78.558	37.380	-41.177	-18.789	0.000	79.452	0.894	0.396	0.692
GDP growth (t-1)	3.702	4.499	0.797	3.797	0.000	3.677	-0.025	-0.160	0.873
Executive constraint (t-1)	5.937	4.752	-1.185	-15.005	0.000	5.949	0.012	0.185	0.854
Kaopen (t-1)	1.312	0.155	-1.157	-18.370	0.000	1.321	0.009	0.149	0.881
Observations	771	1619				771			

Notes: This Table presents the pre-weighting sample means of the matching covariates for country-year observations where CDS trading were in place (the treatment group) in column [1], and country-year observations where no CDS trading were in place (the potential control group) in column [2]. Column [3] reports the differences in means between treated and control group before weighting, and the corresponding t-test statistics and p-values. Column [4] reports the synthetic control group means matching covariates obtained from entropy balancing after weighting. Column [5] shows the differences in means, the t-test statistics and the associated p-values between treated and synthetic control groups.

Appendix 5: First-stage (FS) IV-probit estimations

Dependent variable: CDS trading	[FS.A]	[FS.B]	[FS.C]	[FS.D]	[FS.E]	[FS.F]
Joint votes US	0.172***	0.173***	0.167***	0.164***	0.154***	0.168***
	(0.0488)	(0.0486)	(0.0494)	(0.0469)	(0.0467)	(0.0488)
Government debt-to-GDP (t-1)	0.000883	0.00105	0.000919	0.00287**	0.00201	0.000936
	(0.00111)	(0.00110)	(0.00117)	(0.00117)	(0.00126)	(0.00110)
Inflation (t-1)	0.00403	0.00355	4.18e-05	0.00415	0.00343	0.00298
	(0.00443)	(0.00481)	(0.00551)	(0.00391)	(0.00430)	(0.00488)
Reserve-to-GDP (t-1)	-0.892***	-0.966***	-0.897***	-1.254***	-0.939***	-0.855***
	(0.238)	(0.238)	(0.236)	(0.267)	(0.266)	(0.257)
GDP growth (t-1)	-0.00933	-0.00871	-0.00806	-0.00501	-0.00907	-0.0104
	(0.0118)	(0.0118)	(0.0122)	(0.0118)	(0.0116)	(0.0120)
Executive constraint (t-1)	0.197***	0.194***	0.166***	0.231***	0.206***	0.184***
	(0.0336)	(0.0338)	(0.0340)	(0.0348)	(0.0348)	(0.0334)
Kaopen (t-1)	0.0986***	0.0850***	0.0887***	0.0792***	0.0913***	0.0866***
	(0.0310)	(0.0320)	(0.0320)	(0.0307)	(0.0321)	(0.0315)
UK legal origin		0.247**				
		(0.113)				
Log US aid (t-1)			-0.0935***			
			(0.0222)			
Current account balance (t-1)				-0.0293***		
				(0.00525)		
Capital account balance (t-1)					-0.283***	
					(0.0492)	
Financial account balance (t-1)						0.000870
						(0.00111)
Constant	-13.56***	-13.77***	-12.64***	-13.10***	-12.13***	-13.25***
	(3.310)	(3.288)	(3.337)	(3.192)	(3.172)	(3.304)
F-statistic instrument (test)	12.43	12.74	11.38	12.15	10.91	11.92
F-statistic instrument (pvalue)	0.0004	0.0004	0.0007	0.0005	0.0010	0.0006
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo-R2	0.4432	0.4454	0.4544	0.4616	0.4866	0.4360
Observations	1574	1574	1511	1574	1558	1534

Notes: First-stage estimations using a probit model. The dependent variable is *CDS trading* dummy, and the instrumental variable is *Joint votes with US*. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Appendix 6: Test of the validity (V) of the instrument

Dependent variable: SDC	[V.A]	[V.B]	[V.C]	[V.D]	[V.E]	[V.F]
CDS trading	0.982***	0.985***	0.952***	0.946***	0.972***	0.983***
	(0.311)	(0.321)	(0.344)	(0.315)	(0.316)	(0.318)
Joint votes with US	0.0143	0.0184	0.0118	0.0148	0.0143	0.0128
	(0.00983)	(0.0149)	(0.00904)	(0.00956)	(0.00995)	(0.00983)
Government debt-to-GDP (t-1)	0.00271	0.00337	0.000277	0.00389*	0.00276	0.00296
	(0.00217)	(0.00206)	(0.00209)	(0.00226)	(0.00220)	(0.00220)
Inflation (t-1)	0.00238	0.00336	0.00314	0.00218	0.00220	0.00252
	(0.00355)	(0.00309)	(0.00315)	(0.00320)	(0.00358)	(0.00354)
Reserve-to-GDP (t-1)	-5.672***	-5.739***	-7.972***	-5.585***	-5.562***	-5.798***
	(1.681)	(1.842)	(1.879)	(1.668)	(1.683)	(1.724)
GDP growth (t-1)	-0.0320	-0.0328	-0.0125	-0.0279	-0.0315	-0.0279
	(0.0272)	(0.0271)	(0.0217)	(0.0277)	(0.0272)	(0.0272)
Executive constraint (t-1)	-0.167**	-0.161**	-0.140*	-0.156**	-0.173**	-0.157**
	(0.0730)	(0.0759)	(0.0796)	(0.0733)	(0.0740)	(0.0723)
Kaopen (t-1)	-0.188***	-0.177***	-0.276***	-0.192***	-0.187***	-0.188***
	(0.0642)	(0.0674)	(0.0771)	(0.0664)	(0.0637)	(0.0644)
UK legal origin		-0.660*				
		(0.377)				
Log US aid (t-1)			0.0354			
			(0.0682)			
Current account balance (t-1)				-0.0217*		
				(0.0117)		
Capital account balance (t-1)					-0.00965	
					(0.0336)	
Financial account balance (t-1)						-0.0085***
						(0.0026)
Constant	-3.202***	-3.285***	-2.885***	-3.209***	-3.182***	-3.157***
	(0.838)	(0.872)	(0.874)	(0.816)	(0.853)	(0.836)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Wald test (chi2)	95.92	107.70	103.53	107.57	97.67	98.47
Wald test (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PseudoR2	0.2797	0.2908	0.2560	0.2855	0.2779	0.2836
Observations	1290	1290	976	1290	1263	1262

Notes: Estimations of the probability of SDC occurrence, based on a probit model. The dependent variable is *SDC* dummy, and control variables include *CDS trading* dummy and its instrument *Joint votes with US*. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Part 3. Bond Vigilantes

Chapter 5. Bond Markets Initiation and Tax Revenue Mobilization in Developing Countries[77]

Abstract:

We analyze the relationship between the introduction of a sovereign bond market (BM), and tax revenue mobilization behavior, using a large sample of 119 developing countries. Propensity Scores Matching estimations reveal that BM participation significantly fosters domestic tax revenue mobilization. Moreover, we find that this favorable effect is sensitive to BM countries' characteristics, namely the stance of monetary and fiscal policies, the exchange rate regime, the level of economic development, and the degree of financial openness and financial development. Finally, our results show that BM participation fosters internal taxes and reduces their instability, compared to international trade taxes. These findings highlight the strength of BM in promoting structural reforms in developing countries, through encouraging them to increase their tax effort and even by contributing to some extent to the fiscal transition process.

Keywords: Bond markets; Tax policy; Developing countries; Propensity scores matching.

JEL Codes : E4, E6, G1, H2.

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I used to think if there was reincarnation, I wanted to come back as the president or the pope or a .400 baseball hitter. But now I want to come back as the bond market. You can intimidate everybody.

— James Carville, Wall Street Journal (February 25, 1993, p. A1)

I. Introduction

Despite being one of the main financing sources in the 1980s in the developing world, commercial bank loans suffer from many constraints. Indeed, in such countries, commercial banks cannot provide enough long-term funds to finance infrastructure. Besides, banks are subject to national regulators, which can lead to political interferences in credit allocation and to imprudent bank lending. But more importantly, 1990s financial crises in, among others, Asia or Latin America, recalled that some financing mechanisms could be more "dangerous" than others. In particular, there is some agreement that short-term commercial bank loans can result in extreme vulnerability, confidence crises, and sudden capital flight (Rodrik & Velasco, 1999; Jeanne, 2000; Tirole, 2003). Thus, starting the 1990s, policymakers gave a particular attention to the development of long-term government bond markets (BM), both in domestic and foreign currencies.[78] Indeed, compared to commercial bank lending, a long-maturity BM is more appropriate for financing long-term government infrastructure projects, and can also sustain economic stability by providing funds that could finance fiscal stimuli during economic downturns (Mu et al., 2013).

Nevertheless, developing a publicly-traded long-term sovereign BM in developing countries is not without difficulties. For example, some mature countries lack a BM because the cost of setting it up is potentially large (World Bank, 2001). Other countries face problems related to the high risk of default, weakness of the regulator, absence of a credible and stable government, or lack of sound fiscal and monetary policies. But, more importantly, as a growing financing source, BM may affect domestic resource mobilization behavior. Indeed, access to BM may discourage tax efforts, since the borrowing country might be tempted to substitute its domestic resource by market lending. In this context, this paper investigates if the presence of a BM fosters or, on the contrary, impedes domestic tax revenue mobilization in developing countries.

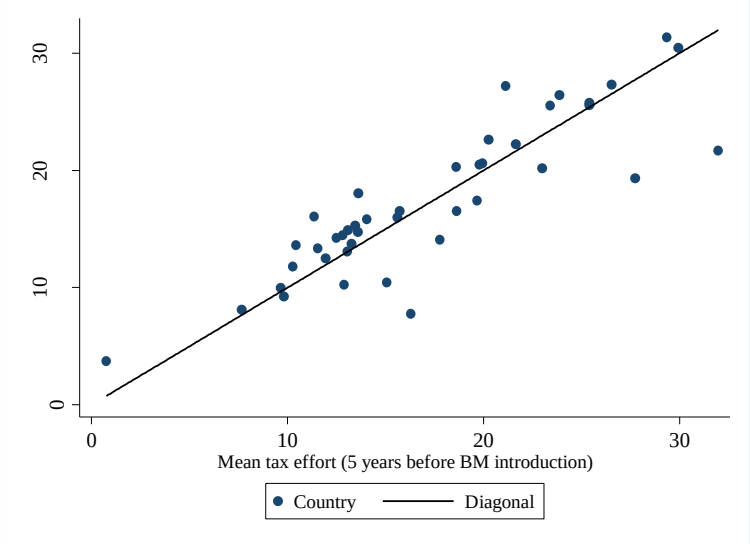
A rich literature investigated the determinants of domestic resource mobilization, especially in the developing world. In a seminal contribution, Lotz & Morss (1967) emphasize

[78] Some classical examples include Brazil (1994) and Philippine (1996). In addition, many African countries recently introduced a BM, or plan to do so, in the context of the November 2011 action plan by the G20, in cooperation with the World Bank, IFM, BIS, UNCTAD, OECD, and regional development banks, supporting the establishment of BM in the developing world.

that per capita income and trade openness are positive determinants of tax revenue. Subsequent work highlights additional determinants. Focusing on African countries, Stotsky & WoldeMariam (1997) find that the share of the agriculture sector is negatively correlated with tax revenues, while trade openness raises them. In an influential paper, Tanzi (1992) points out that half of the variation of tax revenues is due to per capita income, the share of imports, the share of the agriculture sector, and the size of foreign debt. More recent studies, including Gupta (2007), Clist & Morrissey (2011), and Feger & Asafu-Adjaye (2014), outlined the role of inflation, human capital, corruption, political stability, foreign aid, and colonial policies.

Building on this literature, the present paper analyzes the effect of bond market participation on domestic tax revenue mobilization.[79] Figure 1 shows that about three-fourth of BM countries experienced an improvement in their tax effort after having introduced BM (i.e. they are located above the 45° line). In addition, several arguments support the idea that BM countries could behave differently in tax revenue mobilization.

Figure 1. Tax revenue to GDP ratio before and after BM introduction



First, the development of a BM can have a direct impact on government tax revenue. Indeed, BM can generate other kinds of taxes, such as capital gains and income taxes (Harwood, 2000). Second, since tax revenues are an important component of government's domestic revenue, they provide valuable information on government's solvency for BM participants. As such, BM can help governments build credibility and reputation regarding their ability to honor long-term obligations to investors (World Bank, 2001). Moreover, the

[79] Alternatively, the recent paper of Rose & Spiegel (2015) studies the effect of BM participation on inflation.

need to attract new BM investors may encourage governments to increase their fiscal performances, by reforming the tax system through the fight against tax evasion and corruption. Therefore, we should expect an increase in tax revenue mobilization following BM participation.

Finally, the existence of a BM may allow governments to increase their public tax compliance. Indeed, the literature on the effect of aid on tax revenues suggests that concessional loans are used more effectively than grants, since they have to be reimbursed (Clist & Morrissey, 2011). Following this line, it is appealing to claim that loans from BM would be used more effectively than concessional loans, because they are more costly for the borrowing government. As such, loans from BM should enhance the readability of government spending, improve public accountability and confidence in governments, and increase tax morale and tax compliance, all the more in developing countries (IMF, 2011).[80] Consequently, we expect BM participation to raise tax revenue mobilization.

However, the presence of BM could also exert an adverse effect on tax revenue mobilization. Indeed, the ability to raise funds from BM could lead governments to substitute domestic tax revenues by market resources. This might be all the more appealing that it may be politically harder to finance spending through raising taxes rather through borrowing, in particular when governments expect no longer be in power when the time comes to repay. Thus, we should expect a reduction in tax revenue following BM participation.

To solve the theoretically-ambiguous linkage between the presence of BM and tax revenue mobilization, we resort to an empirical analysis. We draw upon a method recently used for macroeconomic policy evaluation, namely the propensity score matching (PSM).[81] The PSM addresses the self-selection bias in BM participation by appropriately identifying the group of control countries, based on a vector of observed variables that are both BM and tax revenue determinants. Applying a wide variety of PSM methods in our large sample of 119 developing countries over 1985-2012, we reveal the following results.

First, we show that the existence of a long-maturity BM significantly encourages governments in developing countries to improve their tax revenue mobilization. The magnitude of this favorable effect is economically meaningful: on average, BM participation increases the tax ratio by roughly 1.6 pp of GDP. The robustness of this finding is supported

[80] Indeed, figures on tax non-compliance in developing countries are alarming. For instance, the VAT gap is 50-60% in Indonesia and Mozambique, compared to only 13% in UK (Silvani et al., 2008; Castro et al., 2009).
[81] PSM was used for assessing the effects of capital account liberalization (Glick et al., 2006), inflation targeting adoption (Lin & Ye, 2007, 2009, 2012, 2013, Lin, 2010, Minea & Tapsoba, 2014), real exchange rate appreciation (Bussière et al., 2014), IMF-supported programs on development aid and banking crises (Gündüz & Crystallin, 2014, Papi et al., 2015), and policy response to crises (Forbes & Klein, 2015), among others. See also Caliendo & Kopeinig (2008) for a detailed discussion regarding the implementation of PSM.

by several tests for the quality of the matching, and by a wide set of specifications including the use of alternative samples, accounting for additional covariates, or using alternative specifications to compute propensity scores.

Second, we explore potential heterogeneities by disaggregating the sample based on several structural characteristics, namely the stance of monetary and fiscal policies, the exchange rate regime, the level of economic development, the degree of financial openness, and the degree of financial development of the banking sector. Regarding the monetary policy stance, we find that BM participation encourages tax revenue collection exclusively in low-seigniorage regimes, revealing the additional constraint imposed by the presence of a more conservative central bank on government's tax effort. Turning to the fiscal stance, BM participation increases tax collection only when the debt stock is relatively low, underlining the difficulty of raising additional taxes when debt is large. Next, we show that BM participation exerts a more pronounced effect on tax revenue mobilization in pegged, compared to floating exchange rate regimes. Besides, the level of economic development equally affects BM performances, since its favorable impact is larger in "low-income" compared to "middle-income" developing countries. Moreover, BM participation fosters tax revenue both in "high" and "low" financial openness regimes, but the effect is more pronounced in the former regime. Likewise, tax revenues increase exclusively in a context of "high" financial development of the banking sector, following BM participation.

Finally, we extend our analysis by looking at the effect of BM participation on the composition and the instability of tax revenue. On the one hand, we emphasize a "composition effect", by highlighting that the increase in tax revenues is more important for internal taxes compared to international trade taxes. On the other hand, BM participation significantly reduces tax revenue instability, and particularly internal tax instability, in the developing world. These results might suggest that BM participation contributes to the success of fiscal transition in developing countries.

The paper is organized as follows. Section II presents the data and details the empirical strategy. Section III outlines the main findings for the effect of BM participation on tax revenue mobilization. Section IV discusses the quality of the matching, explores potential heterogeneities of our main results, and analyzes the effect of BM participation on the composition and the instability of tax revenue, and Section V concludes.

II. Data and Methodology

2.1. Data

We draw upon an unbalanced yearly panel dataset for 119 developing countries covering the period 1985-2012. Following Rose & Spiegel (2015), we use the Fixed Income Database from Global Financial Data (GFD). As emphasized by these authors, "*bond data from GFD appear to be available for those bonds traded with sufficient liquidity to have prices quoted, typically over the counter, and often after an initial auction*", and in particular is the most comprehensive one compared to concurrent data sources (including Bloomberg, Financial Times, BIS, Investing.com, and Dealogic). However, unlike Rose & Spiegel (2015) who specifically focus on long-maturity domestic-currency government BM, we look at BM denominated in home or foreign currency, as both may influence government's tax revenue mobilization behavior. We corrected potential errors in GFD data, following Guscina et al. (2014) and Rose & Spiegel (2015).[82]

In our benchmark specification, we use a BM series with a maturity of at least 5-years, which is a fairly long horizon to exclude (most of) "Ponzi schemes", in addition to being a benchmark in developing countries.[83] From an initial sample of 200 countries in GFD, we choose to focus exclusively on developing countries for two main reasons. On the one hand, from a methodological standpoint, the largest majority of *developed* countries introduced BM before the first year of our sample (namely, 1985), forcing us to rule them out. One the other hand, from an economic standpoint, developed countries are less concerned with the issue of domestic tax revenue mobilization than developing ones. Finally, we had to exclude countries that lack tax revenue data.

Our treatment variable is a dummy equal to 1 if country i at period t has a publicly-traded, at least 5-year maturity, domestic or foreign currency denominated government bond market, and 0 otherwise. Out of the 119 developing countries in our sample, the treated group consists of 54 countries that introduced government BM. The rest of 65 countries without government BM or with less than 5-year BM belong to the control group. Appendices 1 and 2 provide the list of BM countries and their participation dates, and Appendices 3 and 4 present descriptive statistics and definitions of data.

[82] Specifically, Guscina et al. (2014) correct GFD data concerning foreign currency-denominated BM in Albania, Jordan, Montenegro, and Mongolia, using information provided on central banks' websites, and Rose & Spiegel (2015) correct GFD data for omissions regarding domestic BM introduction in Armenia, Brazil, Kazakhstan, Nigeria, Peru, and Ukraine.

[83] Robustness results will consider a BM of at least 10 years and 1 year, respectively.

Consistent with the related literature (see, for instance, Brückner, 2012), our outcome variable is the ratio of the general government total tax revenue over GDP. Tax revenue has the advantage of being more homogeneous than total public revenue, thus enabling international comparisons. However, the limit of this variable often lies in the data availability, especially for studies covering a long time period. We deal with these issues by compiling tax revenue ratios from several sources. We start with the remarkably rich dataset developed by the International Centre for Tax and Development (ICTD).[84] Moreover, we extend the ICTD coverage from 2009 onward using data from World Development Indicators (WDI). Finally, whenever ICTD data are not available for Sub-Saharan African countries, we use the unique tax revenue from the IMF.[85]

2.2. Methodology

Our goal is to compare the effect of the presence of a government BM on tax revenue mobilization, relative to countries without BM (or where only bonds with maturity below 5 years are traded). A viable approach used in macroeconomic policy evaluations is the Propensity Matching Method (PSM).[86] Indeed, capitalizing on the early work of Glick et al. (2006) and Lin & Ye (2007), a recent strand of literature, including Forbes & Klein (2013), Bussière et al. (2014), Gündüz & Crystallin (2014), Minea & Tapsoba (2014), and Papi et al. (2015), draws upon PSM to assess the consequences of macroeconomic policies, including the effect of BM on inflation (Rose & Spiegel, 2015).

The average treatment effect of BM participation on domestic tax revenue (TR) mobilization, namely the average treatment effect on the treated (ATT), is defined as

$$ATT = E\left[\left(TR_{i1} - TR_{i0}\right)\middle| BM_i = 1\right] = E\left[TR_{i1}\middle| BM_i = 1\right] - E\left[TR_{i0}\middle| BM_i = 1\right], \qquad (1)$$

with BM_i the bond market dummy, TR_{i1} the tax revenue of the BM country i, and TR_{i0} the tax revenue of the same country i has it not had initiated BM. Given that TR_{i0} cannot be observed, we compute the ATT by contrasting the results of the treated group (BM) with the

[84] The ICTD combines government revenue data from several major international databases, including IMF Global Financial Statistics, OECD Tax Statistics, African Economic Outlook, Economic Commission for Latin America, Inter American Center of Tax Administrations, and World Bank's World Development Indicators.

[85] An extensive analysis of the consistency of these datasets was performed before merging them, including through unreported regressions performed exclusively on the ICTD dataset.

[86] In particular, the difficulty of finding a valid instrument, which in our case should affect tax revenue mobilization only through its effect on BM participation, makes the use of an instrumental variable method difficult (for example, the instruments used by Rose & Spiegel, 2015, namely the size of government spending relative to GDP and the length of time since national independence, do not seem appropriate for our analysis focusing on BM initiation as the dependent variable).

results of the control group (non-BM), assuming that BM participation is random. However, this assumption is implausible, and the related work outlined some requirements to the BM development. Thus, we focus on PSM methods to circumvent a possible self-selection problem related to omitted variables (correlated with both tax revenue and BM participation).

Through the PSM method, we pair BM and non-BM based on the likelihood to initiate BM. Put differently, the PSM allows comparing countries that display identical observed characteristics X, and considering that differences in results among treated and non-treated are due to BM initiation. By replacing $E[TR_{i0}|BM_i=1]$ with the observable term $E[TR_{i0}|BM_i=0,X_i]$, we can rewrite (1) as

$$ATT = E[TR_{i1}|BM_i=1,X_i]-E[TR_{i0}|BM_i=0,X_i]. \quad (2)$$

Lastly, given the possible presence of a large number of covariates, Rosenbaum & Rubin (1983) advise for matching treated with untreated based on propensity scores (PS). PS are defined as the (country) probability of receiving the treatment, conditional to observable characteristics X : $p(X_i)=E[BM_i|X_i]=Pr(BM_i=1|X_i)$.[87] Using PS, we write the ATT as

$$ATT = E[TR_{i1}|BM_i=1,p(X_i)]-E[TR_{i0}|BM_i=0,p(X_i)]. \quad (3)$$

To estimate (3), the literature has by now outlined a certain number of PSM methods. The N-nearest-neighbor performs the matching between each BM and N-untreated-countries displaying the closest PS; we use the nearest, two-nearest and three-nearest PS (namely, N=1, 2, and 3, respectively). For this method, the matching is usually performed with replacement, meaning that an untreated observation in the control group may be associated with more than one treated observations. Next, following Dehejia & Wahba (2002), we consider the radius method, which consists of matching every treated with untreated situated at a certain length, established in terms of PS. Consistent with the literature, we focus on a small, a medium, and a large radius (namely, r=0.005, 0.01 and 0.05, respectively). Moreover, following Heckman et al. (1998), we draw upon the kernel matching. This method matches each treated with the distribution of untreated in the common support, by using weights that are inversely proportional with the distance from the PS of each treated. In addition, we use the local linear

[87] The estimated PS allows summarizing the vector of observable characteristics X into a one-dimensional variable. Its empirical validity is based on the condition of common support: $p(X_i<1)$, assuming the existence of comparable counterfactual for each treated observation for each year (i.e. for each BM country, there are some non-BM countries with fairly close probabilities of participating BM).

matching. This method is comparable to the kernel matching, except it considers a linear term when defining the weighting function. Finally, we draw upon Cochran & Chambers (1965) and divide the common support of PS in several equal strata, by ensuring the absence of statistical differences between the PS of BM and those of non-BM. Under such a stratification, the ATT corresponds to the mean of the computed treatment effect for every stratum, weighted using the proportion of treated observations in every stratum.

III. Results and robustness

This section presents the results of the ATT of BM participation on tax revenue mobilization. We first present benchmark results, and then discuss their robustness.

3.1. Benchmark results

We estimate the PS using a probit model, in which the dependent variable is BM participation. Following the previous literature on the determinants of BM and domestic tax revenue mobilization, we consider eight covariates in our benchmark probit specification, namely real GDP per capita, trade openness (% of GDP), total population, domestic credit to private sector (% of GDP), real GDP growth, a measure of autocracy/democracy, agriculture value added (% of GDP), and inflation.[88] All these covariates are lagged by one year to avoid a potential simultaneity bias. The first six variables are expected to be positively correlated with BM participation. Indeed, demand for financial services increases with the level of economic development (proxied by per capita GDP), while large-population countries may have scale advantages in developing deep and liquid BM (Essers et al., 2014). The development of the banking sector can in some way discourage BM participation since the two funding modalities may be substitutable; nonetheless, a well-developed banking sector can serve as a dealer and a market-maker, thereby counteracting the substitution effect and stimulating BM participation. Maintaining strong growth would require long-term investments, which the BM could provide, and sound institution may offer stronger investors' protection, thus fostering BM participation. Regarding the latter two variables, we expect a negative effect of agriculture value added and inflation, as an important primary sector may discourage BM participation through the "demand-following-phenomenon", while a credible monetary policy

[88] The goal of estimating PS is not to find the best model for predicting BM participation. According to the conditional independence assumption, it is not a problem to exclude variables that systematically affect BM participation but do not affect tax revenue.

restraining inflation may be crucial for BM participation, in particular for bond denominated in domestic currency (Hausmann & Panizza, 2003).

The results of the estimation of PS for the benchmark model are reported in Table 1. All estimated parameters are significant, except for the share of agriculture, and present the expected sign. More specifically, real GDP per capita, trade openness, total population, domestic credit to private sector, democratic institutions, and real GDP growth positively affect BM participation, while countries with higher inflation are less likely to introduce BM. Given that McFadden's pseudo-R2 equals 0.45, our specification performs rather well in explaining BM adoption.

Table 1. Estimation of Propensity Scores for Bond Market Participation: benchmark model

	Benchmark model
Log real gdp per capita (t-1)	0.592***
	(0.0671)
Log trade openness/gdp (t-1)	0.531***
	(0.0940)
Log agriculture added value/gdp (t-1)	-0.134
	(0.0896)
Log total population (t-1)	0.587***
	(0.0342)
Log inflation rate (t-1)	-0.189***
	(0.0357)
Log private credit/gdp (t-1)	0.549***
	(0.0580)
Polity (t-1)	0.0459***
	(0.00618)
Real gdp growth (t-1)	0.0209**
	(0.00848)
Constant	-17.71***
	(1.177)
Pseudo-R2	0.4585
Observations	2,145

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Once the PS estimated, we need to define a common support ensuring that treated and control groups are fairly comparable. For this purpose, we follow Dehejia & Wahba (1999), and remove treated observations whose PS are higher than the maximum or less than the minimum PS of the non-treated group. The estimated ATT of BM participation on tax revenue mobilization using different matching methods is reported in Table 2. Benchmark results reported on line [0] show that ATTs are positive and statistically significant for all considered matching techniques. The estimated effect ranges from 1.225 (for one-nearest neighbor matching) to 1.769 (for kernel matching) percentage points. Thus, developing countries with BM present tax ratios larger by approximately 1.6 pp of GDP on average

relative to their non- BM peers, a sizable effect with respect to the average tax for our sample of developing countries (around 15% of GDP).

3.2. Robustness

We test the robustness of our finding that BM participation significantly encourages tax revenue mobilization in developing countries in different ways. We begin by taking a closer look at the definition of the treatment variable. Following Rose & Spiegel (2015), we consider the existence of a BM with at least 10-year (1-year) maturity as the treatment variable, which leaves us with 46 (56) BM countries. Based on probit regressions in Appendix 5, corresponding ATTs are reported on lines [1]-[2] of Table 2. When using a BM of at least 10-year maturity, ATTs are positive, statistically significant, and of fairly close magnitude to benchmark results. However, estimated ATTs lose both significance and magnitude when using BM maturity of at least 1-year. One possible explanation is that a relatively short maturity is not sufficiently important to generate sizable tax reforms.

Second, since the 54 BM countries are relatively the richest and the largest, we want to ensure that the comparability between treated and control groups is appropriate. To this end, we redefine the groups of control and treated countries as follows. On line [3] of Table 2 we exclude from the control group the countries with real GDP per capita below that of the poorest BM country or with population size below that of the smallest BM country. Analogously, on line [4] we exclude from the treated group the countries that have a real GDP per capita above that of the richest non-BM country and with a population size above that of the largest non-BM country. Lastly, line [5] combines the two changes performed in lines [3] and [4]. As emphasized by lines [3]-[5] in Table 2, estimated ATTs are more significant and quantitatively larger (up to 3 pp of GDP), suggesting that focusing our analysis on a more homogenous sample, both in GDP per capita and population size, increases the robustness of the estimated effect of BM participation on tax revenue mobilization.

Table 2. ATT of Bond Markets participation on domestic tax revenue: main results and robustness

Dependent variable: Tax revenue ratio	N Nearest Neighbor Matching			Radius Matching			Kernel Matching	Local linear Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Benchmark result									
[0] **ATT**	**1.225****	**1.473*****	**1.565*****	**1.565*****	**1.669*****	**1.758*****	**1.769*****	**1.727*****	**1.555*****
	(0.614)	(0.584)	(0.544)	(0.514)	(0.496)	(0.443)	(0.476)	(0.467)	(0.479)
Treated/Untreated/Total observations	511/1300/1811	511/1300/1811	511/1300/1811	465/1300/1765	505/1300/1805	511/1300/1811	511/1300/1811	511/1300/1811	587/1160/1747
Robustness									
[1] At least 10-year maturity bond	1.156*	1.597***	1.472***	1.034*	1.341***	1.675***	1.651***	1.681***	1.317***
	(0.652)	(0.584)	(0.564)	(0.589)	(0.530)	(0.498)	(0.511)	(0.479)	(0.490)
[2] At least 1-year maturity bond	0.679	0.824	0.869*	1.071**	0.905**	0.827**	0.828**	0.794*	0.636
	(0.633)	(0.547)	(0.523)	(0.537)	(0.478)	(0.423)	(0.428)	(0.436)	(0.436)
[3] Exclude poorest and smallest non-treated	1.839***	1.946***	1.834***	1.668***	1.708***	1.687***	1.695***	1.702***	2.185***
	(0.649)	(0.593)	(0.575)	(0.538)	(0.521)	(0.488)	(0.482)	(0.504)	(0.555)
[4] Exclude richest and largest treated	2.902***	3.066***	3.130***	2.501***	2.745***	2.909***	2.903***	3.149***	2.530***
	(0.807)	(0.744)	(0.667)	(0.649)	(0.643)	(0.582)	(0.573)	(0.549)	(0.500)
[5] Exclude poorest & smallest non-treated, and richest & largest treated	2.547***	2.713***	2.431***	2.031***	2.454***	2.623***	2.620***	2.908***	2.473***
	(0.797)	(0.742)	(0.711)	(0.631)	(0.604)	(0.560)	(0.575)	(0.533)	(0.518)
[6] Exclude African countries	2.406***	2.467***	2.360***	1.799***	2.075***	2.179***	2.218***	2.341***	2.428***
	(0.622)	(0.588)	(0.575)	(0.590)	(0.530)	(0.465)	(0.497)	(0.488)	(0.506)
[7] Exclude earliest and latest treated	2.009***	1.862***	1.921***	1.554***	1.688***	1.977***	1.971***	2.074***	1.854***
	(0.672)	(0.594)	(0.607)	(0.593)	(0.528)	(0.467)	(0.477)	(0.482)	(0.519)
[8] Exclude outliers	2.604***	2.258***	2.400***	2.286***	2.227***	2.245***	2.244***	2.282***	2.241***
	(0.551)	(0.501)	(0.450)	(0.433)	(0.414)	(0.394)	(0.371)	(0.401)	(0.424)
[9] Exclude transition treated	2.184***	2.302***	2.578***	1.973*	2.135**	2.359***	2.354***	2.366***	2.436***
	(0.909)	(0.868)	(0.899)	(1.057)	(0.889)	(0.797)	(0.792)	(0.749)	(0.517)
[10] Exclude post-2002 sample	1.265*	1.446**	1.406**	1.309*	1.439**	1.270***	1.289***	1.337***	2.085***
	(0.732)	(0.690)	(0.661)	(0.720)	(0.622)	(0.521)	(0.542)	(0.505)	(0.514)

Bootstrapped standard errors based on 500 replications in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Third, to account for the fact that, of all countries, BM in African countries remain underdeveloped and most African countries strongly rely on commercial bank loans, we exclude them from our sample. Estimated ATTs on line [6] in Table 2 are found to be statistically positive and quantitatively larger (up to 2.5 pp of GDP) compared to the benchmark. Consequently, our results are not sensitive to the group of African countries.

Our fourth robustness check consists of excluding "earliest" and "latest" BM countries. Indeed, 8 BM countries (India, Malaysia, Morocco, Pakistan, South Africa, Sri Lanka, Thailand and Venezuela) implemented BM before 1985, leaving no observations for the pre-treatment period ("earliest"), while Angola and Mongolia, and Albania and Montenegro, initiated BM in 2012 and 2010, respectively ("latest"). Line [7] of Table 2 reports ATTs estimated by excluding these countries. ATTs remain positive and statistically significant independent of the matching method, confirming the robustness of our main results.

Fifth, we look for a potential role of tax revenue outliers. For this purpose, we exclude countries with tax ratios above 30 percent of GDP, which is roughly the average level in developed countries (Fricke & Süssmuth, 2014).[89] ATTs on line [8] in Table 2 are significant and larger (up to 2.6 pp of GDP) compared to our benchmark results. Thus, corroborating our findings when abstracting from real GDP per capita and population size outliers, we find that the favorable effect of BM on tax revenue mobilization is not driven by high-tax revenue developing countries.

Sixth, since transition countries present tax systems historically different from other countries, we perform our estimations by dropping them from the treatment group.[90] As shown by line [9] of Table 2, excluding transition BM countries does not affect our results, since estimated ATTs remain positive and statistically significant.

Finally, on line [10] of Table 2 we drop post-2002 observations, in order to enlarge the control group with countries that introduced BM less than a decade before the end of our sample. As such, the new sample consists of 38 treated countries and 81 non-treated countries. Yet again, estimated ATTs are positive and significant, adding to the robustness of our main results.

3.3. Additional robustness

[89] Based on this ratio, we exclude Algeria, Cuba, Lesotho, and Seychelles, whose average tax ratios are 38, 31, 40, and 30%, respectively.

[90] The transition countries removed from the treatment group are Armenia, Belarus, Bulgaria, China, Hungary, Kazakhstan, Romania, Serbia, Ukraine, and Vietnam.

We investigate whether estimated ATTs are robust to a wide set of different specifications of the probit model used to compute PS.

To this end, we alternatively introduce additional covariates that may affect tax revenue mobilization and BM participation, divided into three groups. First, we consider variables that exert a direct effect on the conduct of fiscal policy by affecting government resources, and thus, potentially, on the tax revenue ratio, namely: external debt (% of GDP), fiscal deficit (% of GDP), fiscal rule, VAT dummy, net foreign aid received, IMF program dummy, and International Country Risk Guide (ICRG) index for institutional quality.[91] Second, we introduce additional variables capturing key structural features, namely total investment (% of GDP), Chinn-Ito financial openness index, exchange rate regime, total national resources rents (% of GDP), and the Gini index. Third, we account for the instability of the countries in our sample, approached by the number of past crisis episodes, income volatility, and trade volatility. As illustrated by columns [11]-[25] in Appendix 6, most of additional covariates are significant and display the expected sign. For instance, countries with fiscal rules, a VAT system, sound institutions or higher financial openness are more likely to introduce BM. On the contrary, large external debt, fiscal deficit or natural resources, as well as a higher number of crises discourage BM participation.

Based on PS computed from these regressions, we present matching results on lines [11]-[25] of Table 3. To ease up reading, we report in Table 3 ATTs based on only four alternative matching methods (see Appendix 7 for the full table). Most of estimated ATTs are significant and positive, and their magnitude is comparable to our benchmark results. Albeit we observe some significance loss when accounting for the exchange rate regime or for the number of crisis episodes, the effect of BM adoption on tax revenue mobilization is still positive and significant for most matching methods. Besides, the same holds when considering jointly all the additional fifteen covariates in line [0bis] of Table 3. Finally, to look for some anticipation effects of the response of tax revenues to the introduction of a BM, we consider the one-period lead and lag of the treatment variable, namely BM initiation, when performing the computation of propensity scores.[92] ATTs reported on lines [26]-[27] of Table 3 remain remarkably significant and of comparable magnitude with the benchmark model [0], confirming the robustness of our results.

[91] Following Frankel et al. (2013), we build an index of institutional quality by calculating an average of four normalized variables, namely investment profile, corruption, law & order, and bureaucratic quality.
[92] We thank an anonymous referee for suggesting this robustness test.

Table 3. ATT of Bond Markets participation on domestic tax revenue: additional robustness

Dependent variable: Tax revenue ratio	N Nearest Neighbor Matching (N=2)	Radius Matching (r=0.01)	Kernel Matching	Stratification Matching
Benchmark result				
[0] **ATT**	**1.473*** (0.584)	**1.669*** (0.496)	**1.769*** (0.476)	**1.555*** (0.479)
Treated/Untreated/Total observations	511/1300/1811	505/1300/1805	511/1300/1811	587/1160/1747
Additional Robustness				
[11] Adding external debt (t-1)	1.462** (0.661)	1.308** (0.613)	1.394*** (0.543)	2.198*** (0.540)
[12] Adding fiscal deficit (t-1)	2.660*** (0.694)	2.634*** (0.663)	2.552*** (0.552)	3.473*** (0.959)
[13] Adding fiscal rule (t-1)	1.814*** (0.616)	1.954*** (0.517)	1.725*** (0.528)	2.361*** (0.599)
[14] Adding VAT dummy (t-1)	1.968*** (0.639)	1.809*** (0.608)	1.444*** (0.552)	1.408*** (0.467)
[15] Adding foreign aid (t-1)	1.654*** (0.618)	1.416*** (0.547)	1.443*** (0.479)	1.566*** (0.460)
[16] Adding IMF program (t-1)	1.715*** (0.623)	1.767*** (0.511)	1.731*** (0.491)	2.458*** (0.584)
[17] Adding ICRG index (t-1)	1.419** (0.667)	1.934*** (0.574)	1.829*** (0.563)	2.260*** (0.657)
[18] Adding total investment (t-1)	1.798*** (0.679)	1.629*** (0.580)	1.587*** (0.487)	3.170*** (0.956)
[19] Adding financial openness (t-1)	1.806*** (0.562)	2.081*** (0.544)	2.007*** (0.458)	1.617*** (0.452)
[20] Adding exchange rate regime (t-1)	1.288* (0.689)	1.420** (0.614)	1.528*** (0.557)	2.057*** (0.514)
[21] Adding natural resources (t-1)	1.558*** (0.612)	1.654*** (0.519)	1.789*** (0.475)	1.739*** (0.437)
[22] Adding GINI index (t-1)	2.655*** (0.551)	2.159*** (0.459)	2.410*** (0.437)	2.295*** (0.444)
[23] Adding number of crisis episodes (t-1)	1.289* (0.745)	1.125* (0.661)	1.727*** (0.696)	1.653*** (0.528)
[24] Adding income volatility (t-1)	2.426*** (0.730)	2.627*** (0.625)	2.450*** (0.618)	2.864*** (0.698)
[25] Adding trade volatility (t-1)	2.257*** (0.612)	2.161*** (0.525)	1.930*** (0.486)	2.302*** (0.475)
[0bis] Adding all covariates (t-1)	1.851*** (0.743)	1.903** (0.854)	1.891*** (0.708)	2.342*** (0.440)
[26] Using bond market (t+1)	1.762*** (0.588)	1.562*** (0.500)	1.636*** (0.436)	2.161*** (0.552)
[27] Using bond market (t-1)	1.863*** (0.550)	1.877*** (0.465)	1.718*** (0.446)	2.101*** (0.583)

Bootstrapped standard errors based on 500 replications in brackets. *** p<0.01, ** p<0.05, * p<0.1.

IV. Sensitivity and heterogeneity

The empirical evidence revealed so far that BM participation significantly encourages the governments of the developing world to increase their tax revenue mobilization. However, our results are based on two key hypotheses underlying the implementation of matching, namely the

common support assumption, and the conditional independence assumption; the first subsection is devoted to these issues. In addition, in the last two subsections we explore the potential heterogeneity of the ATT to several structural characteristics, and we provide additional results of BM participation on the composition and instability of tax revenue.

4.1. Assessing the quality of the matching

We first analyze the sensitivity of our results to the common support assumption, by implementing the pseudo-R2 test of Sianesi (2004). The idea is to re-estimate the PS on matched BM and non-BM, and then compare the overall fit (pseudo-R2) before and after matching. Indeed, if the matching provides balanced scores, there should not be a significant difference between the two groups, and the pseudo-R2 should be close to 0. Since Table 4 (see Appendix 8 for the full table) displays pseudo-R2s around zero (namely, between 0.02 and 0.03), we conclude that our matching allowed obtaining balanced scores, and thus that the estimated effect of BM participation on tax revenue mobilization is robust with respect to the common support hypothesis.[93]

Turning to the conditional independence assumption, we test the robustness of our results using the statistical test coined by Rosenbaum (2002). It evaluates the extent to which unobservables could lead to a "hidden bias", by testing the null hypothesis that the ATT of BM participation on tax revenue mobilization is zero. Table 4 reports the statistics for the upper bounds with a significance level of 5%, under the assumption that the estimated ATT in the benchmark specification was overestimated. Results show that our treatment effect may be questioned for an odds ratio between 1.84 (for the n=2) and 2.29 (for stratification matching), namely if an unmeasured variable would change the odds ratio between BM and non-BM countries by a factor between 1.84 and 2.29. Since these values are comparable with other studies (for instance, Caliendo & Künn, 2011, concluded with critical values between 1.25 and 3), we conclude that our findings are robust to the conditional independence assumption.[94]

4.2. Heterogeneity in the treatment effect of BM participation

[93] The same conclusion arises based on pseudo-R2 values computed for all robustness specifications (results are available upon request).

[94] As for the pseudo-R2 test, conclusions are identical based on odds ratios for each robustness specification (results are available upon request).

We begin by exploring potential differences in the estimated treatment effect depending on the monetary policy stance. Our starting point is that the delegation of monetary policy to a more conservative or an independent central bank imposes an additional constraint on government's intertemporal budget constraint. Indeed, under such "monetary dominance", the government loses the control of seigniorage revenue (Berument, 1998), and such limits on seigniorage might encourage the government to reform its tax system to fill the shortfall in its budget. We examine this hypothesis by separating countries in two groups, based on the median level of seigniorage proxied by the variation in reserves money over GDP. Estimations presented on lines [28]-[29] of Table 4 show that, unlike its beneficial effect in low seigniorage countries, BM introduction does not have a statistically significant effect on tax revenue in high seigniorage countries: the positive effect of BM participation on tax revenue mobilization holds only when the monetary policy stance constraints seigniorage revenues.[95]

Second, we focus on the fiscal stance. According to Ostry et al. (2010), large debt levels make it more difficult to raise taxes, since large debt may reflect less fiscal space (and this may be particularly true if the country is around its fiscal limit). Thus, we expect the estimated effect to be more important in relatively less indebted countries. We test this hypothesis by distinguishing between "low" and "high" public debt levels, using the median of total government debt in % of GDP to separate the two groups. According to estimated ATTs on lines [30]-[31] of Table 4, BM participation significantly improves tax revenue mobilization exclusively in "low" debt countries, consistent with theoretical insights.

Third, we examine a potential influence of the exchange rate regime. Indeed, countries with pegged exchange rate regimes (at least) partially lose their seigniorage revenues (Fisher, 1981); as such, we expect estimated ATTs to be more important in pegged, compared to floating, exchange rate regimes. Thus, we distinguish between "pegged" and "floating" exchange rate regimes, the former capturing countries with de facto hard or soft pegs. Results depicted on lines [32]-[33] in Table 4 confirm our hypothesis. Although BM participation significantly improves tax revenue mobilization in both pegged and floating regimes, estimated ATTs are stronger (by at least 1 pp, and even above 2.5 pp) in pegged regimes (and climb up to even 4 pp of GDP).

[95] Alternatively, we differentiated the group of countries in which the central bank is under an inflation targeting regime or in a currency union, from other countries. We report that conclusions are consistent with those based on splitting the countries using the median value of seigniorage (results are available upon request).

Table 4. ATT of Bond Markets participation on domestic tax revenue: sensitivity and heterogeneity

Dependent variable: Tax revenue ratio	N Nearest Neighbor Matching (N=2)	Radius Matching (r=0.01)	Kernel Matching	Stratification Matching
BENCHMARK RESULT				
[0] **ATT**	**1.473*** ** (0.584)	**1.669*** ** (0.496)	**1.769*** ** (0.476)	**1.555*** ** (0.479)
Treated/Untreated/Total observations	511/1300/1811	505/1300/1805	511/1300/1811	587/1160/1747
Testing matching quality: Common support assumption				
Pseudo-R2	0.026	0.018	0.017	0.031
Testing matching quality: Conditional independence assumption				
Rbounds (p-value=0.05)	1.84	2.20	2.23	2.29
HETEROGENEITY IN THE TREATMENT EFFECT				
Monetary policy stance				
[28] Low seigniorage	1.801**	1.864***	1.745***	3.169***
	(0.789)	(0.720)	(0.658)	(0.575)
Treated/Untreated/Total observations	221/487/708	191/487/678	221/487/708	300/381/681
[29] High seigniorage	0.446	0.925	1.108	1.030
	(1.146)	(1.036)	(0.891)	(0.831)
Treated/Untreated/Total observations	185/526/711	160/526/686	185/526/711	209/389/598
Fiscal policy stance				
[30] Low debt	3.500***	2.900**	2.641**	2.567***
	(1.355)	(1.233)	(1.144)	(0.758)
Treated/Untreated/Total observations	177/307/484	154/307/461	177/307/484	310/244/554
[31] High debt	-0.856	-0.002	-0.701	0.162
	(1.145)	(1.196)	(1.071)	(1.410)
Treated/Untreated/Total observations	168/384/552	116/384/500	168/384/552	248/217/465
Exchange rate regime				
[32] Fixed exchange rate regime	2.965***	4.321***	2.984***	3.499***
	(1.004)	(1.636)	(1.010)	(0.741)
Treated/Untreated/Total observations	80/362/442	36/362/398	80/362/442	130/660/790
[33] Floating exchange rate regime	1.751***	1.547***	1.673***	1.244**
	(0.662)	(0.585)	(0.530)	(0.592)
Treated/Untreated/Total observations	429/938/1367	419/938/1357	429/938/1367	487/836/1323
Level of economic development				
[34] Low income countries	5.110***	1.666	4.457**	4.006***
	(1.954)	(3.232)	(2.214)	(1.285)
Treated/Untreated/Total observations	37/470/507	7/470/477	29/470/499	46/123/169
[35] Middle income countries	1.472**	1.447***	1.443***	3.004***
	(0.602)	(0.556)	(0.494)	(0.992)
Treated/Untreated/Total observations	425/777/1202	419/777/1196	425/777/1202	614/674/1288
Financial openness				
[36] Below the median	1.851**	2.106***	2.162***	2.415***
	(0.797)	(0.804)	(0.703)	(0.669)
Treated/Untreated/Total observations	227/774/1001	178/774/952	227/774/1001	288/611/899
[37] Above the median	2.794***	2.612***	2.991***	3.122***
	(0.639)	(0.611)	(0.553)	(0.406)
Treated/Untreated/Total observations	300/487/787	252/487/739	300/487/787	372/352/724
Financial development of the banking sector				
[38] Below the median	-0.301	-1.417	-0.892	-0.898
	(1.373)	(1.270)	(1.016)	(1.000)
Treated/Untreated/Total observations	111/885/996	97/885/982	111/885/996	129/969/1098
[39] Above the median	4.012***	3.699***	3.595***	3.867***
	(0.748)	(0.658)	(0.644)	(0.448)
Treated/Untreated/Total observations	431/429/860	406/429/835	431/429/860	536/422/958

Bootstrapped standard errors based on 500 replications in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Fourth, we search for a potential impact of the level of economic development on the effect of BM participation. Using World Bank's classification, we split our sample in "low income" and "middle income" countries. Indeed, according to Teera & Hudson (2004), the tax revenue-to-GDP ratio is lower in "low-income" compared to "middle-income" countries, and this is also the case in our sample (the tax ratio equals 11% and 17.5%, respectively). Consequently, fiscal potential might be beyond its effective level in the former group of countries, which might generate a stronger estimated ATT in "low-income" compared to "middle-income" countries. Results presented on lines [34]-[35] in Table 4 show that ATTs are larger in "low-income" countries in most cases.[96]

Fifth, we take a closer look at financial openness, by dividing the sample into "high" and "low" openness degree, using the median level of the Chinn-Ito index. This is motivated by the fact that more open countries might attract more foreign investors in their BM, but will also be more vulnerable to risk. As a result, domestic tax revenue mobilization might serve as a social protection tool and provide a "spare tire" for governments, in particular against negative shocks affecting the access to financial markets. Thus, we expect the estimated ATT to be stronger in the "high" regime, compared to the "low" one. Results on lines [36]-[37] of Table 4 confirm our hypothesis, as estimated ATTs are larger in "high" openness contexts.

Sixth, we condition the effect of BM participation on the degree of financial development of the banking sector, by splitting our sample into "high" and "low", using the median of domestic credit to private sector (% of GDP). Indeed, a well-developed banking sector may foster tax revenue mobilization (Gordon & Li, 2009), and probably attract more investors into the BM. However, a large banking sector may render investors increasingly cautious, thus causing an illiquid BM; thus, governments in deep banking sector countries should increase their tax effort to support the liquidity of the BM. Matching results reported on lines [38]-[39] of Table 4 show that BM participation encourages tax revenue collection exclusively in more financially developed countries,[97] confirming our hypothesis that a relatively more developed banking sector might be a prerequisite for the effectiveness of BM participation on tax revenue mobilization.

Finally, all these results are confirmed when using a control function regression approach from Lin & Ye (2009). This approach consists of estimating an OLS regression of tax revenue on a BM dummy within the common support from the matching in the benchmark model [0], and

[96] Since we estimate ATTs depending on the level of economic development, we exclude GDP per capita from the covariates of probit equations.

[97] As previously, we exclude domestic credit to private sector from the covariates of probit regressions.

controlling for the estimated PS from the benchmark probit regression. Results reported in Appendix 9 show, first, that the magnitude of the significantly positive coefficient of the BM dummy is fairly close to our benchmark results. Moreover, the estimated coefficient of PS is statistically significant in most specifications, thus confirming the presence of self-selectivity in BM participation. Lastly, all estimated coefficients of interaction terms are statistically significant, and consistent with results in Table 4. On the one hand, the beneficial effect of BM participation on tax revenue mobilization is more pronounced when seigniorage or debt are relatively low. On the other hand, the effectiveness of BM participation in promoting tax revenue is more important in pegged regimes, low-income countries, and in countries with higher financial openness or more developed banking sector, thus confirming our previous findings.

4.3. BM participation, and the composition and instability of tax revenue

In this last sub-section, we extend our analysis by looking to the effect of BM participation on the composition and the instability of tax revenue.

We look at the effect of BM participation on tax revenue composition, by disaggregating tax data between internal (namely, indirect and income) taxes and trade taxes. Indeed, one of the goals of fiscal transition or tax reforms in developing countries consists in choosing those taxes that can raise revenue with the least distortions (Tanzi & Zee, 2000). This results in reducing the weight of international trade taxes though a reinforcement of internal taxes, mainly because trade taxes are (more) distortionary. Based on the benchmark model PS, we provide on lines [40]-[47] in Table 5 (see Appendix 10 for the full table) ATTs estimates of BM participation for internal and trade taxes, respectively. Our findings are twofold. On the one hand, BM participation increases internal taxes, even after excluding outliers, namely countries with internal taxes higher than those of OECD countries (see lines [40]-[41]). In particular, this result is driven by the favorable effect in countries with internal taxes above the median value, as shown by lines [42]-[43]. On the other hand, the effect of BM participation on international trade taxes is considerably weaker in both significance and size, all the more when we exclude outliers, namely countries with trade taxes lower than those of OECD countries (see lines [44]-[45]). In particular, a favorable effect arises in countries with relatively low trade taxes, namely below the median, as shown by lines [46]-[47]. Thus, consistent with our hypothesis, the presence of BM can improve the mobilization of internal taxes compared to trade taxes, defended by the fiscal transition process.

Lastly, we explore the effect of BM participation on tax revenue instability, defined as the standard deviation of the tax revenue ratio over 5-year rolling window, as in Bekaert et al. (2006). Indeed, as stressed by Bleaney et al. (1995), governments in developing countries are generally more concerned with the instability of tax revenue, probably because such instability leads to adverse consequences, including procyclical fiscal policy (Talvi & Végh, 2005) or public investment and consumption volatility (Ebeke & Ehrhart, 2013).

Based on the benchmark probit regression on line [0], results depicted on line [48] of Table 5 show that BM participation significantly decreases tax revenue instability in developing countries, as the estimated ATT is significant and negative in most cases. Besides, this effect remains robust when abstracting of outliers (see line [49]), and is economically important: given an average tax revenue variability of 1.72 in non-BM countries, our findings of an ATT between -0.32 and -0.20 suggest that BM participation can reduce tax revenue instability by a range between 12% and 19%, and even more if we consider exclusively the countries with tax revenues above the median level (see line [51]).

In addition, we equally explore the effect of BM participation on the instability of internal and international trade taxes. As illustrated by lines [52]-[59] in Table 5, BM participation reduces internal tax instability (and particularly in countries with internal tax rates above the median), but has no effect on trade taxes instability. Consequently, by stabilizing internal taxes, the presence of BM can further contribute to the fiscal transition process.

Table 5. ATT of Bond Markets participation on domestic tax revenue: composition and instability of tax revenue

Dependent variable: Tax revenue ratio	N Nearest Neighbor Matching (N=2)	Radius Matching (r=0.01)	Kernel Matching	Stratification Matching
BENCHMARK RESULT				
[0] **ATT**	**1.473*****	**1.669*****	**1.769*****	**1.555*****
	(0.584)	(0.496)	(0.476)	(0.479)
Treated/Untreated/Total observations	511/1300/1811	505/1300/1805	511/1300/1811	587/1160/1747
COMPOSITION OF TAX REVENUE				
[40] Internal tax	1.552***	1.095**	1.062**	1.121***
	(0.622)	(0.560)	(0.545)	(0.432)
[41] Internal tax excluding outliers	1.926***	1.896***	2.082***	1.974***
	(0.559)	(0.432)	(0.416)	(0.400)
[42] Low initial internal tax	-0.133	-0.090	-0.420	-0.090
	(0.551)	(0.913)	(0.579)	(0.424)
[43] High initial internal tax	1.326*	1.222**	1.124*	(--)
	(0.747)	(0.608)	(0.637)	(--)
[44] Tax on international trade	0.335*	0.336**	0.336***	(--)
	(0.183)	(0.139)	(0.126)	(--)
[45] Tax on int. trade excluding outliers	0.265*	0.346**	0.368***	(--)
	(0.154)	(0.140)	(0.134)	(--)
[46] Low initial tax on international trade	0.322***	0.244***	0.246***	0.298***
	(0.093)	(0.090)	(0.085)	(0.069)
[47] High initial tax on international trade	0.943	0.307	0.860	(--)
	(0.595)	(0.440)	(0.916)	(--)
INSTABILITY OF TAX REVENUE				
[48] Tax revenue instability	-0.133	-0.197**	-0.195**	-0.322***
	(0.118)	(0.094)	(0.089)	(0.093)
[49] Tax revenue instability excl. outliers	-0.239**	-0.215**	-0.201**	-0.251***
	(0.115)	(0.093)	(0.088)	(0.084)
[50] Low initial tax revenue	0.105	-0.030	0.030	-0.071
	(0.235)	(0.312)	(0.189)	(0.148)
[51] High initial tax revenue	-0.538***	-0.499***	-0.379***	-0.482***
	(0.166)	(0.148)	(0.130)	(0.135)
[52] Internal tax instability	-0.161*	-0.198**	-0.171*	(--)
	(0.090)	(0.099)	(0.094)	(--)
[53] Internal tax instability excl. outliers	-0.153	-0.191**	-0.167**	(--)
	(0.141)	(0.098)	(0.088)	(--)
[54] Low initial internal tax	0.248	0.332	0.150	0.132
	(0.314)	(0.340)	(0.231)	(0.122)
[55] High initial internal tax	-0.386**	-0.377***	-0.366***	-0.363***
	(0.169)	(0.147)	(0.128)	(0.117)
[56] Tax on international trade instability	0.021	0.069	0.028	0.044
	(0.096)	(0.132)	(0.133)	(0.123)
[57] Tax on int. trade instability excl. outliers	0.021	0.069	0.028	(--)
	(0.096)	(0.132)	(0.133)	(--)
[58] Low initial tax on international trade	-0.089	-0.130	-0.079	-0.114
	(0.126)	(0.107)	(0.119)	(0.180)
[59] High initial tax on international trade	0.107	0.156	0.120	(--)
	(0.124)	(0.192)	(0.226)	(--)

Bootstrapped standard errors based on 500 replications in brackets. *** p<0.01, ** p<0.05, * p<0.1.
(--) Not enough observations to generate needed strata.

V. Conclusion

Over the last decade, many efforts were made by policymakers to support the development of sovereign BM in developing countries. A particular concern is that access to this financial mechanism may discourage tax efforts, since the borrowing country could be tempted to substitute its domestic resource by market lending. In this paper, we explore a potential incentive effect of the existence of a government long-maturity bond market on tax revenue mobilization behavior in developing countries. Our work contributes to the related literature on several grounds.

First, using an appropriate method, namely the propensity scores matching, on a large sample of 119 developing countries, we show that BM participation encourages government in developing countries to increase their tax revenue mobilization. This result is supported by a wide set of robustness tests, including tests for the quality of the matching, alternative samples, alternative specifications, and additional covariates for estimating propensity scores.

Second, we explore the potential heterogeneity of our findings based on several structural characteristics. We emphasize that the favorable effect of BM participation on tax revenue is significant exclusively when seigniorage or public debt are relatively low. A possible explanation is that, to compensate for the loss of seigniorage resources, governments have strong incentives to increase their tax revenues. Moreover, BM participation is found to increases tax revenues more in pegged compared to floating regimes, and in "low-income" compared to "middle-income" countries. Besides, we reveal that the beneficial effect of BM participation on tax revenue is stronger in the "high" financial openness and financial development regimes.

Finally, we extend our analysis to examine the impact of BM participation on the composition and the instability of tax revenues in developing countries. In a nutshell, we find that BM participation improves the mobilization of internal taxes and reduces their instability in the developing world. These results suggest that BM participation could contribute to the success of fiscal transition in developing countries.

Consequently, our analysis provides straightforward and valuable policy recommendations. On the practical side, the highest effect of BM participation in terms of tax revenue mobilization arises when combined with sound monetary or fiscal policy frameworks, and in relatively more open and financially developed contexts. Under such circumstances, BM participation can improve tax revenue mobilization in developing countries, and thus provide an adequate framework for the funding of growth-enhancing long-term infrastructures.

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SUPPLEMENTARY MATERIAL

Appendix 1. BM countries (treated group) and their BM starting dates (at least 5-year maturity).

Benchmark specification				Excluding richest and largest BM countries		Drop post-2002 sample	
Country	BM beginning date	Country	BM beginning date	Country		Country	
Albania	2010	Kenya	1998	Albania	Panama	Argentina	Philippines
Angola	2012	Lebanon	1997	Argentina	Peru	Armenia	Romania
Argentina	1993	Malaysia	1964	Armenia	Philippines	Brazil	South Africa
Armenia	2000	Mauritius	2002	Belarus	Romania	Bulgaria	Sri Lanka
Bangladesh	2004	Mexico	1996	Belize	Serbia	China	Tanzania
Belarus	2003	Mongolia	2012	Botswana	South Africa	Colombia	Thailand
Belize	2007	Montenegro	2010	Bulgaria	Sri Lanka	Dominican Republic	Tunisia
Botswana	2005	Morocco	1983	Colombia	Tanzania	Ecuador	Turkey
Brazil	1994	Namibia	1992	Costa Rica	Thailand	Egypt	Ukraine
Bulgaria	1993	Nigeria	1997	Dominican Republic	Tunisia	El Salvador	Venezuela
China	1994	Pakistan	1949	Ecuador	Turkey	Fiji	Zimbabwe
Colombia	1998	Panama	1998	Egypt	Ukraine	Hungary	
Costa Rica	2004	Peru	1997	El Salvador	Venezuela	India	
Dominican Republic	2001	Philippines	1996	Fiji	Vietnam	Jamaica	
Ecuador	1996	Romania	2001	Gabon	Zambia	Jordan	
Egypt	2003	Serbia	2005	Ghana	Zimbabwe	Kazakhstan	
El Salvador	2003	South Africa	1860	Hungary		Kenya	
Fiji	1999	Sri Lanka	1951	Iraq		Lebanon	
Gabon	2007	Tanzania	2000	Jordan		Malaysia	
Ghana	2008	Thailand	1979	Kazakhstan		Mauritius	
Hungary	1997	Tunisia	1994	Kenya		Mexico	
India	1800	Turkeybe	1999	Lebanon		Morocco	
Indonesia	2004	Ukraine	2001	Malaysia		Namibia	
Iraq	2006	Venezuela	1984	Mauritius		Nigeria	
Jamaica	1998	Vietnam	2005	Montenegro		Pakistan	
Jordan	2001	Zambia	2005	Morocco		Panama	
Kazakhstan	2002	Zimbabwe	1962	Namibia		Peru	

Appendix 2. Non-BM countries (control group)

Benchmark specification			Excluding poorest and smallest non-		Drop post-2002 sample		
Afghanistan	Iran	Suriname	Afghanistan	Madagascar	Afghanistan	Gabon	Myanmar
Algeria	Kiribati	Swaziland	Algeria	Mali	Albania	Gambia, The	Nepal
Azerbaijan	Kyrgyz Republic	Syria	Azerbaijan	Moldova	Algeria	Georgia	Nicaragua
Benin	Lao PDR	Tajikistan	Benin	Mozambique	Angola	Ghana	Niger
Bhutan	Lesotho	Togo	Bolivia	Myanmar	Azerbaijan	Grenada	Papua New Guinea
Bolivia	Liberia	Uganda	Bosnia &	Nepal	Bangladesh	Guatemala	Paraguay
Bosnia &	Libya	Uzbekistan	Burkina Faso	Nicaragua	Belarus	Guinea	Rwanda
Burkina Faso	Macedonia	Vanuatu	Cambodia	Niger	Belize	Guinea-Bissau	Sao Tome and Principe
Burundi	Madagascar	Yemen	Cameroon	Papua New	Benin	Honduras	Senegal
Cambodia	Malawi		Central Afr Republic	Paraguay	Bhutan	Indonesia	Serbia
Cameroon	Maldives		Chad	Rwanda	Bolivia	Iran	Seychelles
Cape Verde	Mali		Congo, Dem. Rep.	Senegal	Bosnia &	Iraq	Sierra Leone
Central Afr Republic	Micronesia, Fed. Sts.		Congo, Rep.	Sierra Leone	Botswana	Kiribati	St. Lucia
Chad	Moldova		Cote d'Ivoire	Swaziland	Burkina Faso	Kyrgyz Republic	St. Vincent &
Comoros	Mozambique		Cuba	Syria	Burundi	Lao PDR	Suriname
Congo, Dem. Rep.	Myanmar		Gambia, The	Tajikistan	Cambodia	Lesotho	Swaziland
Congo, Rep.	Nepal		Georgia	Togo	Cameroon	Liberia	Syria
Cote d'Ivoire	Nicaragua		Guatemala	Uganda	Cape Verde	Libya	Tajikistan
Cuba	Niger		Guinea	Uzbekistan	Central Afr Republic	Macedonia	Togo
Dominica	Papua New Guinea		Guinea-Bissau	Yemen	Chad	Madagascar	Uganda
Ethiopia	Paraguay		Honduras		Comoros	Malawi	Uzbekistan
Gambia, The	Rwanda		Iran		Congo, Dem. Rep.	Maldives	Vanuatu
Georgia	Sao Tome and Principe		Kyrgyz Republic		Congo, Rep.	Mali	Vietnam
Grenada	Senegal		Lao PDR		Costa Rica	Micronesia, Fed.	Yemen
Guatemala	Seychelles		Lesotho		Cote d'Ivoire	Moldova	Zambia
Guinea	Sierra Leone		Liberia		Cuba	Mongolia	
Guinea-Bissau	St. Lucia		Libya		Dominica	Montenegro	
Honduras	St. Vincent &		Macedonia		Ethiopia	Mozambique	

Appendix 3. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Bond Market (at least 5-year)	3332	0.2409964	0.4277523	0	1
Bond Market (at least 10-year)	3332	0.1971789	0.3979282	0	1
Bond Market (at least 1-year)	3332	0.2632053	0.440439	0	1
Tax revenue/GDP	2589	15.70675	7.523835	0.4274276	58.73198
Internal tax/GDP	2345	12.34009	6.690017	0.5882939	46.53457
Tax on international trade/GDP	2357	3.579094	3.973602	-1.605391	39.90318
Tax revenue instability	2453	1.619961	1.756721	0.0067246	20.93419
Internal tax instability	2235	1.450218	1.625993	0.0076208	18.9009
Tax on international trade instability	2242	0.6635259	0.9016267	0	11.26059
Log real GDP per capita	3115	7.131442	1.069929	3.912867	9.565847
Log trade openness/GDP	3053	4.191436	0.5873229	-1.175052	5.409844
Log agriculture added value/GDP	2972	2.847623	0.7403881	0.6233449	4.543055
Log total population	3208	15.73669	1.937171	11.08214	21.01901
Log inflation rate	2940	2.243198	1.331906	-5.809136	10.07635
Log private credit/GDP	2892	2.975641	0.9138185	-1.618047	5.121198
Polity	2830	1.232155	6.397311	-10	10
Real GDP growth	3139	3.815462	7.134619	-64.0471	106.2798
External debt/GNI	2857	72.64106	88.11595	0.2385863	1380.766
General government debt/GDP	1862	61.67101	57.83342	0	795.945
Fiscal deficit/GDP	2233	-2.293879	5.825344	-35.398	125.445
Fiscal rule	3332	0.1395558	0.3465776	0	1
VAT dummy	3332	0.5054022	0.5000459	0	1
Log net foreign aid received	3150	19.46265	1.40048	9.903487	23.98081
IMF program dummy	3236	0.4357231	0.4959279	0	1
ICRG index	2263	0.4670043	0.1250163	0.03125	0.9166667
Total investment/GDP	2876	22.64576	9.43482	1.177	79.349
Financial openness index	2874	-0.3593993	1.3319	-1.863972	2.439009
Exchange rate regime	2229	7.388066	4.487531	1	15
Total natural resources rents/GDP	3130	9.949513	13.29258	0	94.6403
Gini index	2094	41.51924	8.781234	18.9915	76.97958
Number of crisis episodes	1066	1.293621	1.359058	0	6
Income volatility	2711	121.9945	160.3531	1.238602	2409.97
Trade volatility	2688	8.204808	7.126259	0.0337935	53.63714
Inflation targeting	3332	0.0453181	0.2080322	0	1
Monetary union	3332	0.2322929	0.4223582	0	1
Seigniorage	2130	9.84e+11	4.54e+13	-673.5902	2.10e+15
Low income dummy	3332	0.2521008	0.434284	0	1
Fixed ERR	3332	0.2370948	0.4253648	0	1

Appendix 4. Sources and Definitions of variables

Variable	Definitions	Sources
Bond Market (at least 5-year)	Dummy variable equal 1 if a country i at period t has a publicly-traded government bond market with at least 5-year maturity; 0 otherwise	Global Financial Database, Rose & Spiegel (2015), Guscina et al. (2014)
Bond Market (at least 10-year)	Dummy variable equal 1 if a country i at period t has a publicly-traded government bond market with at least 10-year maturity; 0 otherwise	
Bond Market (at least 1-year)	Dummy variable equal 1 if a country i at period t has a publicly-traded government bond market with at least 1-year maturity; 0 otherwise	
Tax revenue/GDP	Ratio of general government total tax revenue over GDP.	International Centre for Tax and Development, World Development Indicators, Keen & Mansour (2010)
Internal tax/GDP	Ratio of indirect and income taxes over GDP.	
Tax on international trade/GDP	Ratio of tax on imports and exports over GDP.	
Tax revenue instability Internal tax instability Trade tax instability	Standard deviation of tax over 5-year rolling windows.	Authors' calculation based on tax data
Inflation targeting	Dummy variable equal to 1 if a country is under IT regime in a given year; 0 otherwise.	Rose & Spiegel (2015)
Monetary union	Dummy variable equal to 1 if a country is in a monetary union in a given year; 0 otherwise.	Rose & Glick (2002), De Sousa (2012)
Log real GDP per capita	Gross domestic product per capita, constant 2005 US$.	World Development Indicators
Log trade openness/GDP	Volume of imports and exports divided by GDP.	
Log agriculture added value/GDP	Net output of forestry, hunting, and fishing, as well as cultivation of crops and livestock production after adding up all outputs and subtracting intermediate inputs, over GDP.	
Log total population	Facto definition of population, which counts all residents regardless of legal status or citizenship except for refugees not permanently settled in the country of asylum.	
Log private credit/GDP	Financial resources provided to the private sector by financial corporations, in percentage of GDP.	
Real GDP growth	Annual growth rate of GDP.	
Total investment/GDP	Total value of the gross fixed capital formation and changes in inventories and acquisitions less disposals of valuables for a unit or sector, over GDP.	
External debt/GNI	General government external debt to GNI.	
Log net foreign aid received	Disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients, constant 2012 US$.	
Total natural resources rents/GDP	Sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents over GDP.	
Log inflation rate	Annual growth rate of average consumer price index, expressed in end of the period.	

General government debt/GDP	Gross general government debt to GDP.	World Economic Outlook Database
Fiscal deficit/GDP	General government net lending/borrowing to GDP.	
Polity	Political regime characteristics in democratic and autocratic "patterns of authority". Polity ranges from -10 that correspond to extreme autocracy, to +10 for extreme democracy.	Polity IV project
Exchange rate regime	Fine classification codes for exchange rates regimes, ranging from 1 (no separate legal tender) to 15 (Dual markets in which parallel market data is missing). The higher the code value, the more flexible the exchange rate regime.	Reinhart & Rogoff (2004), updated
Number of crisis episodes	Total number of past crisis episodes including banking crises, currency crashes, sovereign domestic or external default (or restructuring)	
IMF program dummy	Dummy variable equal to 1 if IMF standby arrangement or IMF extended facility arrangement is in effect for at least 5 months in a particular year; 0 otherwise.	IMF website
Fiscal rule	Dummy variable equal to 1 if a country had in place, at the national level, a numerical limit on fiscal aggregates (expenditures, revenue, budget balance, debt); 0 otherwise.	IMF Fiscal Rules Dataset (2013)
VAT dummy	Dummy variable equal to 1 if a country had in place a value added tax; 0 otherwise.	Bird & Gendron (2007)
Income instability	Standard deviation of GDP per capita over 5-year rolling window.	Authors' calculation
Trade instability	Standard deviation of trade-to-GDP ratio over 5-year rolling window.	
ICRG index	Average of four normalized variables: investment profile, corruption, law and order, and bureaucratic quality.	Authors' calculation using International Country Risk Guide (ICRG) database
Financial openness index	Index measuring the extent of openness in capital account transactions based on the information from IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.	Chinn & Ito (2008), updated
Seigniorage	Change in reserve money over GDP	Reserves are from IFS line 14a
Gini index	Area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line.	The Standardized World Income Inequality Database (SWIID)

Appendix 5. Estimation of Propensity Scores for Bond Market Participation: main results and robustness

	[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
VARIABLES	Benchmark model	At least 10-year maturity	At least 1-year maturity	Exclude poorest and smallest non-treated	Exclude richest and largest treated	Exclude [3] and [4]	Exclude African countries	Exclude earliest and latest treated	Exclude outliers	Exclude transition treated	Exclude post-2002
Log real gdp per capita (t-1)	0.592***	0.754***	0.529***	0.516***	0.605***	0.550***	0.659***	0.634***	0.615***	0.432***	0.457***
	(0.0671)	(0.0757)	(0.0661)	(0.0746)	(0.0769)	(0.0869)	(0.101)	(0.07372)	(0.0695)	(0.0697)	(0.0866)
Log trade openness/gdp (t-1)	0.531***	0.483***	0.608***	0.463***	0.426***	0.365***	0.598***	0.670***	0.547***	0.461***	0.618***
	(0.0940)	(0.0972)	(0.0904)	(0.0999)	(0.104)	(0.110)	(0.129)	(0.101)	(0.0955)	(0.107)	(0.116)
Log agriculture added value/gdp (t-1)	-0.134	0.0104	-0.127	-0.159*	-0.208**	-0.213**	-0.372***	-0.092	-0.171*	-0.294***	0.0372
	(0.0896)	(0.103)	(0.0868)	(0.0924)	(0.0993)	(0.103)	(0.139)	(0.0973)	(0.0907)	(0.0942)	(0.124)
Log total population (t-1)	0.587***	0.665***	0.538***	0.545***	0.572***	0.523***	0.608***	0.521***	0.606***	0.616***	0.583***
	(0.0342)	(0.0381)	(0.0319)	(0.0373)	(0.0390)	(0.0444)	(0.0478)	(0.0342)	(0.0352)	(0.0388)	(0.0459)
Log inflation rate (t-1)	-0.189***	-0.240***	-0.110***	-0.178***	-0.157***	-0.143***	-0.304***	-0.151***	-0.208***	-0.195***	-0.190***
	(0.0357)	(0.0390)	(0.0336)	(0.0366)	(0.0373)	(0.0381)	(0.0469)	(0.0366)	(0.0359)	(0.0391)	(0.0410)
Log private credit/gdp (t-1)	0.549***	0.480***	0.507***	0.571***	0.632***	0.665***	0.353***	0.496***	0.509***	0.665***	0.476***
	(0.0580)	(0.0604)	(0.0542)	(0.0584)	(0.0632)	(0.0636)	(0.0797)	(0.0616)	(0.0589)	(0.0659)	(0.0736)
Polity (t-1)	0.0459***	0.0549***	0.0584***	0.0473***	0.0387***	0.0396***	0.0620***	0.0438***	0.0426***	0.0450***	0.0553***
	(0.00618)	(0.00664)	(0.00589)	(0.00623)	(0.00673)	(0.00684)	(0.00946)	(0.00652)	(0.00629)	(0.00698)	(0.00826)
Real gdp growth (t-1)	0.0209**	0.0176*	0.0205***	0.0251***	0.0231**	0.0285***	0.0148	0.0317***	0.0170**	0.0111	5.26e-05
	(0.00848)	(0.00927)	(0.00795)	(0.00882)	(0.00920)	(0.00972)	(0.0112)	(0.00939)	(0.00844)	(0.00894)	(0.0108)
Constant	-17.71***	-20.40***	-16.71***	-16.19***	-17.26***	-15.91***	-17.47***	-17.75***	-17.94***	-16.68***	-17.40***
	(1.177)	(1.299)	(1.160)	(1.292)	(1.304)	(1.443)	(1.811)	(1.287)	(1.197)	(1.315)	(1.521)
Pseudo-R2	0.4585	0.4873	0.4305	0.3977	0.4571	0.3996	0.4389	0.4184	0.4659	0.4663	0.4097
Observations	2,145	2,145	2,145	1,764	1,854	1,489	1,156	1,874	2,091	1,977	1,256

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix 6. Estimation of Propensity Scores for Bond Market Participation: Additional Robustness

	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[0 bis]
	Adding the following variables															
VARIABLES	External debt	Fiscal deficit	Fiscal rule	VAT dummy	Foreign aid	IMF program	ICRG index	Total investment	Financial openness	Exch. rate regime	Natural resources	Gini index	Nb. of crisis episodes	Income volatility	Trade volatility	All covariates
Log real gdp per capita (t-1)	0.568***	0.799***	0.618***	0.561***	0.627***	0.583***	0.487***	0.601***	0.599***	0.484***	0.600***	0.560***	0.199*	0.461***	0.561***	0.233
	(0.0677)	(0.0833)	(0.0691)	(0.0662)	(0.0720)	(0.0668)	(0.0725)	(0.0679)	(0.0677)	(0.0769)	(0.0683)	(0.0716)	(0.113)	(0.0879)	(0.0707)	(0.341)
Log trade openness/gdp (t-1)	0.578***	0.223*	0.556***	0.484***	0.516***	0.526***	0.592***	0.574***	0.513***	0.638***	0.608***	0.547***	0.499***	0.486***	0.679***	0.526**
	(0.0944)	(0.120)	(0.0961)	(0.0954)	(0.0945)	(0.0935)	(0.105)	(0.0996)	(0.0958)	(0.106)	(0.0941)	(0.0998)	(0.123)	(0.0963)	(0.109)	(0.247)
Log agriculture added value/gdp (t-1)	-0.158*	-0.118	-0.0933	-0.177**	-0.124	-0.134	-0.102	-0.138	-0.0892	-0.202*	-0.210**	-0.0791	-0.431***	-0.0623	-0.114	0.833**
	(0.0917)	(0.107)	(0.0897)	(0.0890)	(0.0900)	(0.0893)	(0.0960)	(0.0902)	(0.0911)	(0.107)	(0.0937)	(0.104)	(0.154)	(0.0965)	(0.0951)	(0.341)
Log total population (t-1)	0.607***	0.536***	0.594***	0.564***	0.564***	0.585***	0.599***	0.583***	0.587***	0.642***	0.621***	0.568***	0.593***	0.566***	0.580***	0.475***
	(0.0362)	(0.0388)	(0.0349)	(0.0348)	(0.0370)	(0.0340)	(0.0431)	(0.0351)	(0.0350)	(0.0435)	(0.0356)	(0.0376)	(0.0514)	(0.0355)	(0.0359)	(0.0992)
Log inflation rate (t-1)	-0.194***	-0.0246	-0.152***	-0.174***	-0.175***	-0.189***	-0.219***	-0.198***	-0.166***	-0.239***	-0.181***	-0.217***	-0.154**	-0.181***	-0.164***	-0.151
	(0.0362)	(0.0414)	(0.0375)	(0.0365)	(0.0354)	(0.0355)	(0.0401)	(0.0371)	(0.0379)	(0.0486)	(0.0356)	(0.0376)	(0.0601)	(0.0361)	(0.0374)	(0.151)
Log private credit/gdp (t-1)	0.492***	0.576***	0.574***	0.545***	0.534***	0.540***	0.419***	0.570***	0.527***	0.461***	0.440***	0.494***	0.375***	0.586***	0.550***	0.304*
	(0.0589)	(0.0711)	(0.0598)	(0.0593)	(0.0596)	(0.0585)	(0.0631)	(0.0593)	(0.0596)	(0.0640)	(0.0637)	(0.0644)	(0.0827)	(0.0621)	(0.0614)	(0.162)
Polity (t-1)	0.0410***	0.0275***	0.0405***	0.0396***	0.0451***	0.0468***	0.0559***	0.0467***	0.0406***	0.0464***	0.0378***	0.0443***	0.0499***	0.0472***	0.0441***	0.0299*
	(0.00633)	(0.00739)	(0.00630)	(0.00650)	(0.00622)	(0.00630)	(0.00673)	(0.00618)	(0.00648)	(0.00700)	(0.00633)	(0.00718)	(0.00981)	(0.00656)	(0.00661)	(0.0181)
Real gdp growth (t-1)	0.0178**	0.0245**	0.0231***	0.0229***	0.0202**	0.0200**	0.0222**	0.0253***	0.0202**	0.0268***	0.0257***	0.0187**	0.000554	0.00968	0.0154*	-0.00935
	(0.00865)	(0.0104)	(0.00848)	(0.00863)	(0.00852)	(0.00854)	(0.00968)	(0.00895)	(0.00879)	(0.00941)	(0.00881)	(0.00929)	(0.0128)	(0.00916)	(0.00892)	(0.0356)
External debt/gdp (t-1)	-0.00229**															-0.00631*
	(0.000947)															(0.00363)
Fiscal deficit/gdp (t-1)		-0.0616***														-0.107***
		(0.0122)														(0.0323)
Fiscal rule/gdp (t-1)			0.523***													1.009***
			(0.0906)													(0.255)
VAT dummy (t-1)				0.516***												0.391
				(0.0955)												(0.331)
Log net foreign aid received (t-1)					0.0534											-0.0617
					(0.0422)											(0.140)
IMF program dummy (t-1)						-0.0700										0.0316
						(0.0777)										(0.180)
ICRG index (t-1)							2.556***									2.875***
							(0.403)									(1.060)
Total investment/gdp (t-1)								-0.0135**								0.0289
								(0.00563)								(0.0208)
Financial openness index (t-1)									0.0729**							0.0205
									(0.0331)							(0.0707)
Exchange rate regime (t-1)										0.0228						0.0156
										(0.0151)						(0.0286)
Total natural resources rents/gdp (t-1)											-0.0141***					0.00466
											(0.00352)					(0.0107)
Gini index (t-1)												0.000782				0.0393***
												(0.00541)				(0.0146)
Number of crisis episodes (t-1)													-0.155***			-0.0420
													(0.0581)			(0.0938)
Income volatility (t-1)														0.00127**		0.00622***
														(0.00059)		(0.00148)
Trade volatility (t-1)															-0.0341***	-0.0480**
															(0.00977)	(0.0211)
Constant	-17.68***	-17.52***	-18.48***	-17.21***	-18.59***	-17.53***	-18.26***	-17.64***	-17.77***	-17.97***	-17.97***	-17.20***	-13.25***	-16.67***	-17.88***	-18.13***
	(1.207)	(1.417)	(1.234)	(1.153)	(1.409)	(1.172)	(1.321)	(1.201)	(1.185)	(1.373)	(1.190)	(1.317)	(1.711)	(1.274)	(1.229)	(5.949)
Pseudo-R2	0.4624	0.4983	0.4675	0.4692	0.4435	0.4588	0.4307	0.4551	0.4595	0.4447	0.4658	0.4188	0.3333	0.4552	0.4543	0.4217
Observations	2,075	1,594	2,145	2,145	2,098	2,145	1,675	2,065	2,083	1,617	2,143	1,659	868	1,918	1,918	424

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix 7. ATT of Bond Markets participation on domestic tax revenue: additional robustness (completes Table 3 in the main text)

Dependent variable: Tax revenue ratio	N Nearest Neighbor Matching			Radius Matching			Kernel Matching	Local linear Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
Benchmark result									
[0] **ATT**	**1.225****	**1.473*****	**1.565*****	**1.565*****	**1.669*****	**1.758*****	**1.769*****	**1.727*****	**1.555*****
	(0.614)	(0.584)	(0.544)	(0.514)	(0.496)	(0.443)	(0.476)	(0.467)	(0.479)
Treated/Untreated/Total observations	511/1300/1811	511/1300/1811	511/1300/1811	465/1300/1765	505/1300/1805	511/1300/1811	511/1300/1811	511/1300/1811	587/1160/1747
Additional Robustness									
[11] Adding external debt (t-1)	1.479**	1.462**	1.434**	1.010*	1.308**	1.381***	1.394***	1.405***	2.198***
	(0.676)	(0.661)	(0.620)	(0.616)	(0.613)	(0.541)	(0.543)	(0.519)	(0.540)
[12] Adding fiscal deficit (t-1)	2.693***	2.660***	2.780***	2.919***	2.634***	2.574***	2.552***	2.649***	3.473***
	(0.743)	(0.694)	(0.646)	(0.690)	(0.663)	(0.564)	(0.552)	(0.523)	(0.959)
[13] Adding fiscal rule (t-1)	1.494**	1.814***	1.824***	1.641***	1.954***	1.680***	1.725***	1.735***	2.361***
	(0.643)	(0.616)	(0.588)	(0.561)	(0.517)	(0.497)	(0.528)	(0.494)	(0.599)
[14] Adding VAT dummy (t-1)	1.980***	1.968***	1.914***	1.806***	1.809***	1.425**	1.444***	1.460***	1.408***
	(0.697)	(0.639)	(0.680)	(0.582)	(0.608)	(0.572)	(0.552)	(0.563)	(0.467)
[15] Adding foreign aid (t-1)	1.303**	1.654***	1.551***	1.342**	1.416***	1.434***	1.443***	1.549***	1.566***
	(0.661)	(0.618)	(0.531)	(0.540)	(0.547)	(0.500)	(0.479)	(0.474)	(0.460)
[16] Adding IMF program (t-1)	1.445**	1.715***	1.983***	1.313**	1.767***	1.735***	1.731***	1.814***	2.458***
	(0.655)	(0.623)	(0.560)	(0.543)	(0.511)	(0.494)	(0.491)	(0.491)	(0.584)
[17] Adding ICRG index (t-1)	1.675**	1.419**	1.754***	1.315**	1.934***	1.812***	1.829***	1.842***	2.260***
	(0.698)	(0.667)	(0.596)	(0.584)	(0.574)	(0.553)	(0.563)	(0.535)	(0.657)
[18] Adding total investment (t-1)	1.697**	1.798***	1.694***	1.579***	1.629***	1.593***	1.587***	1.694***	3.170***
	(0.736)	(0.679)	(0.660)	(0.607)	(0.580)	(0.559)	(0.487)	(0.519)	(0.956)
[19] Adding financial openness (t-1)	2.030***	1.806***	2.031***	1.808***	2.081***	2.009***	2.007***	2.032***	1.617***
	(0.635)	(0.562)	(0.519)	(0.557)	(0.544)	(0.460)	(0.458)	(0.472)	(0.452)
[20] Adding exchange rate regime (t-1)	0.933	1.288*	1.259*	0.860	1.420**	1.537***	1.528***	1.529***	2.057***
	(0.739)	(0.689)	(0.695)	(0.644)	(0.614)	(0.583)	(0.557)	(0.588)	(0.514)
[21] Adding natural resources (t-1)	1.845***	1.558***	1.806***	1.648***	1.654***	1.796***	1.789***	1.881***	1.739***
	(0.615)	(0.612)	(0.588)	(0.558)	(0.519)	(0.476)	(0.475)	(0.474)	(0.437)
[22] Adding GINI index (t-1)	3.038***	2.655***	2.524***	2.288***	2.159***	2.386***	2.410***	2.450***	2.295***
	(0.588)	(0.551)	(0.500)	(0.500)	(0.459)	(0.435)	(0.437)	(0.455)	(0.444)
[23] Adding number of crisis episodes (t-1)	1.250	1.289*	1.603**	1.080	1.125*	1.767***	1.727***	1.708***	1.653***
	(0.794)	(0.745)	(0.728)	(0.732)	(0.661)	(0.652)	(0.696)	(0.621)	(0.528)
[24] Adding income volatility (t-1)	2.863***	2.426***	2.495***	2.559***	2.627***	2.425***	2.450***	2.663***	2.864***
	(0.814)	(0.730)	(0.647)	(0.633)	(0.625)	(0.606)	(0.618)	(0.608)	(0.698)
[25] Adding trade volatility (t-1)	2.299***	2.257***	2.091***	2.125***	2.161***	1.891***	1.930***	1.904***	2.302***
	(0.708)	(0.612)	(0.570)	(0.557)	(0.525)	(0.492)	(0.486)	(0.489)	(0.475)
[0bis] Adding all covariates (t-1)	2.000**	1.851***	1.835***	1.676*	1.903**	1.891***	1.891***	1.916***	2.342***
	(0.879)	(0.743)	(0.735)	(1.028)	(0.854)	(0.702)	(0.708)	(0.732)	(0.440)
[26] Using bond market (t+1)	2.050***	1.762***	1.774***	1.707***	1.562***	1.649***	1.636***	1.594***	2.161***
	(0.591)	(0.588)	(0.545)	(0.566)	(0.500)	(0.495)	(0.436)	(0.474)	(0.552)
[27] Using bond market (t-1)	1.894***	1.863***	1.750***	1.686***	1.877***	1.723***	1.718***	1.722***	2.101***
	(0.602)	(0.550)	(0.562)	(0.513)	(0.465)	(0.444)	(0.446)	(0.459)	(0.583)

Bootstrapped standard errors based on 500 replications in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Appendix 8. ATT of Bond Markets participation on domestic tax revenue: sensitivity and heterogeneity (completes Table 4 in the main text)

Dependent variable: Tax revenue ratio	N Nearest Neighbor Matching			Radius Matching			Kernel Matching	Local linear Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
BENCHMARK RESULT									
[0] **ATT**	**1.225****	**1.473*****	**1.565*****	**1.565*****	**1.669*****	**1.758*****	**1.769*****	**1.727*****	**1.555*****
	(0.614)	(0.584)	(0.544)	(0.514)	(0.496)	(0.443)	(0.476)	(0.467)	(0.479)
Treated/Untreated/Total observations	511/1300/1811	511/1300/1811	511/1300/1811	465/1300/1765	505/1300/1805	511/1300/1811	511/1300/1811	511/1300/1811	587/1160/1747
Testing matching quality: Common support assumption									
Pseudo-R2	0.031	0.026	0.020	0.016	0.018	0.017	0.017	0.031	0.031
Testing matching quality: Conditional independence assumption									
Rbounds (p-value=0.05)	1.96	1.84	1.96	2.11	2.20	2.20	2.23	2.29	2.29
HETEROGENEITY IN THE TREATMENT EFFECTS									
Monetary policy stance									
[28] Low seigniorage	1.267*	1.801**	1.924***	1.537*	1.864***	1.724***	1.745***	1.888***	3.169***
	(0.782)	(0.789)	(0.734)	(0.866)	(0.720)	(0.653)	(0.658)	(0.624)	(0.575)
Treated/Untreated/Total observations	221/487/708	221/487/708	221/487/708	151/487/638	191/487/678	221/487/708	221/487/708	221/487/708	300/381/681
[29] High seigniorage	0.927	0.446	0.997	1.172	0.925	1.096	1.108	1.157	1.030
	(1.077)	(1.146)	(1.115)	(1.159)	(1.036)	(0.872)	(0.891)	(0.917)	(0.831)
Treated/Untreated/Total observations	185/526/711	185/526/711	185/526/711	136/526/662	160/526/686	185/526/711	185/526/711	185/526/711	209/389/598
Fiscal policy stance									
[30] Low debt	3.312**	3.500***	3.342***	2.793**	2.900**	2.565**	2.641**	2.682***	2.567***
	(1.487)	(1.355)	(1.246)	(1.303)	(1.233)	(1.083)	(1.144)	(1.026)	(0.758)
Treated/Untreated/Total observations	177/307/484	177/307/484	177/307/484	127/307/434	154/307/461	177/307/484	177/307/484	177/307/484	310/244/554
[31] High debt	-0.411	-0.856	-0.308	0.561	-0.002	-0.624	-0.701	-0.390	0.162
	(1.204)	(1.145)	(1.092)	(1.558)	(1.196)	(1.050)	(1.071)	(1.097)	(1.410)
Treated/Untreated/Total observations	168/384/552	168/384/552	168/384/552	77/384/461	116/384/500	168/384/552	168/384/552	168/384/552	248/217/465
Exchange rate regime									
[32] Fixed exchange rate regime	2.982***	2.965***	3.162***	3.756*	4.321***	3.006***	2.984***	3.095***	3.499***
	(1.091)	(1.004)	(0.952)	(2.224)	(1.636)	(0.995)	(1.010)	(0.954)	(0.741)
Treated/Untreated/Total observations	80/362/442	80/362/442	80/362/442	29/362/391	36/362/398	79/362/441	80/362/442	80/362/442	130/660/790
[33] Floating exchange rate regime	1.908***	1.751***	1.629***	1.548**	1.547***	1.676***	1.673***	1.771***	1.244**
	(0.714)	(0.662)	(0.611)	(0.636)	(0.585)	(0.521)	(0.530)	(0.527)	(0.592)
Treated/Untreated/Total observations	429/938/1367	429/938/1367	429/938/1367	397/938/1335	419/938/1357	429/938/1367	429/938/1367	429/938/1367	487/836/1323
Level of economic development									
[34] Low income countries	5.289***	5.110***	5.159***	0.922	1.666	4.376**	4.457**	5.156***	4.006***
	(2.051)	(1.954)	(1.956)	(3.999)	(3.232)	(2.147)	(2.214)	(2.082)	(1.285)
Treated/Untreated/Total observations	37/470/507	37/470/507	37/470/507	4/470/474	7/470/477	24/470/494	29/470/499	37/470/507	46/123/169
[35] Middle income countries	1.135*	1.472**	1.349**	1.193*	1.447***	1.414***	1.443***	1.493***	3.004***
	(0.659)	(0.602)	(0.561)	(0.609)	(0.556)	(0.543)	(0.494)	(0.523)	(0.992)
Treated/Untreated/Total observations	425/777/1202	425/777/1202	425/777/1202	378/777/1155	419/777/1196	425/777/1202	425/777/1202	425/777/1202	614/674/1288
Financial openness									
[36] Below the median	1.214	1.851**	2.095***	1.864*	2.106***	2.110***	2.162***	2.272**	2.415***
	(0.840)	(0.797)	(0.753)	(0.995)	(0.804)	(0.651)	(0.703)	(0.722)	(0.669)
Treated/Untreated/Total observations	227/774/1001	227/774/1001	227/774/1001	155/774/929	178/774/952	225/774/999	227/774/1001	227/774/1001	288/611/899
[37] Above the median	2.652***	2.794***	2.793***	2.002***	2.612***	2.976***	2.991***	2.975***	3.122***
	(0.687)	(0.639)	(0.624)	(0.699)	(0.611)	(0.538)	(0.553)	(0.568)	(0.406)
Treated/Untreated/Total observations	300/487/787	300/487/787	300/487/787	216/487/703	252/487/739	300/487/787	300/487/787	300/487/787	372/352/724
Financial development of the banking sector									
[38] Below the median	-0.271	-0.301	-0.045	-0.449	-1.417	-0.936	-0.892	-0.758	-0.898
	(1.590)	(1.373)	(1.374)	(1.377)	(1.270)	(1.033)	(1.016)	(0.934)	(1.000)
Treated/Untreated/Total observations	111/885/996	111/885/996	111/885/996	85/885/970	97/885/982	111/885/996	111/885/996	111/885/996	129/969/1098
[39] Above the median	3.971***	4.012***	3.666***	3.314***	3.699***	3.573***	3.595***	3.780***	3.867***
	(0.743)	(0.748)	(0.669)	(0.739)	(0.658)	(0.640)	(0.644)	(0.641)	(0.448)
Treated/Untreated/Total observations	431/429/860	431/429/860	431/429/860	333/429/762	406/429/835	431/429/860	431/429/860	431/429/860	536/422/958

Bootstrapped standard based on 500 replications in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Appendix 9. Further exploring the heterogeneity in BM participation on domestic tax revenue: Control function regression approach

	[A1]	[A2]	[A3]	[A4]	[A5]	[A6]	[A7]	[A8]
BM	1.907***	0.947**	2.068***	1.756**	1.308***	0.872*	1.086**	1.968***
	(0.329)	(0.447)	(0.422)	(0.891)	(0.472)	(0.480)	(0.441)	(0.740)
PS		2.110***	1.702**	-0.133	2.472***	2.669***	2.389***	1.537*
		(0.681)	(0.747)	(1.025)	(0.674)	(0.806)	(0.687)	(0.884)
Seigniorage			0.00145***					
			(0.000543)					
BM*Seigniorage			-0.001157*					
			(0.000627)					
Debt				-0.0157***				
				(0.00522)				
BM*Debt				-0.0179*				
				(0.01087)				
Fixed ERR					1.926***			
					(0.515)			
BM*Fixed ERR					1.861**			
					(0.833)			
Low income						-6.744***		
						(0.392)		
BM*Low income						3.213***		
						(0.706)		
Financial openness							-0.463***	
							(0.129)	
BM*Financial openness							0.358*	
							(0.197)	
Financial development								0.103***
								(0.0146)
BM*Financial development								0.0371**
								(0.0169)

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix 9, presents results based on a control function regression approach from Lin & Ye (2009). The heterogeneity of the treatment effect is examined by including an interaction term of the BM dummy and the heterogeneity variable. Accordingly, columns [A1]-[A2] report OLS regressions of tax revenue on a BM dummy within the common support, and on the BM and the PS, while columns [A3]-[A8] explore the heterogeneity of the treatment effect. In the latter specifications, the coefficient of BM provides an estimate of the treatment effect at the mean of the PS, and the interaction term captures the potential heterogeneity. As illustrated by Appendix 9, the magnitude of the significantly positive coefficient of the BM dummy is fairly close to our benchmark results; in addition, except for column [A4], the estimated coefficient of PS is statistically significant, thus confirming the presence of self-selectivity in BM participation. More important, all estimated coefficients of interaction terms are statistically significant, and consistent with results in Table 4.

On the one hand, the coefficients of the interaction terms involving seigniorage and debt are significant and negative, suggesting that the beneficial effect of BM participation on

tax revenue mobilization is more pronounced when seigniorage or debt are relatively low. On the other hand, the coefficients of the interaction terms involving fixed exchange rate regime, low-income, financial openness, and financial development of the banking sector are all positive and statistically significant, suggesting that the effectiveness of BM participation in promoting tax revenue is more important in pegged regimes, low-income countries, and in countries with higher financial openness or more developed banking sector, thus confirming our previous findings.

Appendix 10. ATT of Bond Markets participation on domestic tax revenue: composition and instability of tax revenue (completes Table 5 in the main text)

	N Nearest Neighbor Matching			Radius Matching			Kernel Matching	Local linear Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
BENCHMARK RESULT									
[0] **ATT**	**1.225****	**1.473*****	**1.565*****	**1.565*****	**1.669*****	**1.758*****	**1.769*****	**1.727*****	**1.555*****
	(0.614)	(0.584)	(0.544)	(0.514)	(0.496)	(0.443)	(0.476)	(0.467)	(0.479)
Treated/Untreated/Total observations	511/1300/1811	511/1300/1811	511/1300/1811	465/1300/1765	505/1300/1805	511/1300/1811	511/1300/1811	511/1300/1811	587/1160/1747
COMPOSITION OF TAX REVENUE									
[40] Internal tax	1.369**	1.552***	1.400**	1.028*	1.095**	0.986*	1.062**	1.053	1.121***
	(0.659)	(0.622)	(0.607)	(0.559)	(0.560)	(0.544)	(0.545)	(0.659)	(0.432)
[41] Internal tax excluding outliers	1.508***	1.926***	2.049***	1.761***	1.896***	2.088***	2.082***	2.080***	1.974***
	(0.515)	(0.559)	(0.497)	(0.465)	(0.432)	(0.419)	(0.416)	(0.419)	(0.400)
[42] Low initial internal tax	-0.310	-0.133	0.017	0.575	-0.090	-0.439	-0.420	-0.598	-0.090
	(0.610)	(0.551)	(0.600)	(1.191)	(0.913)	(0.572)	(0.579)	(0.567)	(0.424)
[43] High initial internal tax	1.506**	1.326*	1.146*	1.118*	1.222**	1.146**	1.124*	0.987*	(--)
	(0.742)	(0.747)	(0.679)	(0.599)	(0.608)	(0.581)	(0.637)	(0.615)	(--)
[44] Tax on international trade	0.334*	0.335*	0.392**	0.297*	0.336**	0.328***	0.336***	0.335***	(--)
	(0.198)	(0.183)	(0.169)	(0.167)	(0.139)	(0.122)	(0.126)	(0.134)	(--)
[45] Tax on int. trade excluding outliers	0.111	0.265*	0.292*	0.215	0.346**	0.362***	0.368***	0.374***	(--)
	(0.200)	(0.154)	(0.170)	(0.178)	(0.140)	(0.136)	(0.134)	(0.130)	(--)
[46] Low initial tax on international trade	0.357***	0.322***	0.336***	0.266***	0.244***	0.251***	0.246***	0.259**	0.298***
	(0.103)	(0.093)	(0.091)	(0.091)	(0.090)	(0.085)	(0.085)	(0.103)	(0.069)
[47] High initial tax on international trade	0.941	0.943	0.677	0.346	0.307	0.860	0.860	0.865	(--)
	(0.598)	(0.595)	(0.446)	(0.497)	(0.440)	(0.913)	(0.916)	(0.478)	(--)
INSTABILITY OF TAX REVENUE									
[48] Tax revenue instability	-0.108	-0.133	-0.147	-0.263**	-0.197**	-0.199**	-0.195**	-0.227***	-0.322***
	(0.123)	(0.118)	(0.114)	(0.108)	(0.094)	(0.091)	(0.089)	(0.085)	(0.093)
[49] Tax revenue instability excl. outliers	-0.269**	-0.239**	-0.192*	-0.277***	-0.215**	-0.201**	-0.201**	-0.237***	-0.251***
	(0.129)	(0.115)	(0.109)	(0.108)	(0.093)	(0.088)	(0.088)	(0.083)	(0.084)
[50] Low initial tax revenue	0.124	0.105	-0.027	0.003	-0.030	0.036	0.030	0.004	-0.071
	(0.237	(0.235)	(0.233)	(0.365)	(0.312)	(0.187)	(0.189)	(0.199)	(0.148)
[51] High initial tax revenue	-0.631***	-0.538***	-0.472***	-0.412***	-0.499***	-0.373***	-0.379***	-0.421***	-0.482***
	(0.193)	(0.166)	(0.153)	(0.155)	(0.148)	(0.120)	(0.130)	(0.118)	(0.135)
[52] Internal tax instability	-0.177*	-0.161*	-0.166*	-0.208*	-0.198**	-0.166**	-0.171*	-0.177**	(--)
	(0.103)	(0.090)	(0.103)	(0.116)	(0.099)	(0.084)	(0.094)	(0.090)	(--)
[53] Internal tax instability excl. outliers	-0.134	-0.153	-0.173*	-0.203*	-0.191**	-0.164*	-0.167**	-0.173**	(--)
	(0.177)	(0.141)	(0.107)	(0.122)	(0.098)	(0.091)	(0.088)	(0.088)	(--)
[54] Low initial internal tax	0.281	0.248	0.188	0.467	0.332	0.139	0.150	0.046	0.132
	(0.335)	(0.314)	(0.302)	(0.427)	(0.340)	(0.245)	(0.231)	(0.235)	(0.122)
[55] High initial internal tax	-0.313*	-0.386**	-0.409***	-0.430***	-0.377***	-0.360***	-0.366***	-0.382***	-0.363***
	(0.180)	(0.169)	(0.160)	(0.168)	(0.147)	(0.126)	(0.128)	(0.111)	(0.117)
[56] Tax on international trade instability	0.008	0.021	0.017	0.084	0.069	0.030	0.028	0.042	0.044
	(0.128)	(0.096)	(0.085)	(0.124)	(0.132)	(0.133)	(0.133)	(0.128)	(0.123)
[57] Tax on int. trade instability excl. outliers	0.008	0.021	0.017	0.084	0.069	0.030	0.028	0.042	(--)
	(0.128)	(0.096)	(0.085)	(0.124)	(0.132)	(0.133)	(0.133)	(0.128)	(--)
[58] Low initial tax on international trade	-0.067	-0.089	-0.042	-0.156	-0.130	-0.093	-0.079	-0.016	-0.114
	(0.171)	(0.126)	(0.126)	(0.120)	(0.107)	(0.116)	(0.119)	(0.171)	(0.180)
[59] High initial tax on international trade	0.158	0.107	0.101	0.158	0.156	0.121	0.120	0.117	(--)
	(0.154)	(0.124)	(0.125)	(0.217)	(0.192)	(0.225)	(0.226)	(0.154)	(--)

Bootstrapped standard errors based on 500 replications in brackets. *** p<0.01, ** p<0.05, * p<0.1. (--) Not enough observations to generate needed strata.

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Chapter 6. Do Domestic Bond Markets Participation Help Reduce Financial Dollarization In Developing Countries?[98]

Abstract: In this paper, we analyze the effect of domestic sovereign bond market (BM) participation on financial dollarization using a large panel of 114 developing countries over the period 1984-2009. Building on entropy balancing, the results reveal strong evidence that domestic BM participation significantly reduces financial dollarization in domestic BM countries compared to their non-domestic BM peers. Moreover, we find that the favorable impact of domestic BM on financial dollarization (i) is larger for inflation targeting countries compared to non-inflation targeting countries, (ii) is apparent exclusively in a non-pegged exchange rate regime, (iii) and is larger when there are fiscal rules that constrain the discretion of fiscal policy makers. Finally, we show that the induced drop in inflation rate and its variability, nominal exchange rate variability, and seigniorage revenue are potential transmission mechanisms through which the presence of domestic BM reduces financial dollarization in domestic BM countries.

Key words: Domestic bond markets, financial dollarization
JEL Classifications: E4, E6, G1, G2

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Residents in developing economies save and borrow in foreign currencies. At the end of 2000 the share of domestic bank deposits denominated in foreign currencies was 35% on average in all developing economies, and 44% in those among them where dollar deposits are not illegal.

— Eduardo Levy Yeyati, Economic Policy (January 2006, p. 63)

I. Introduction

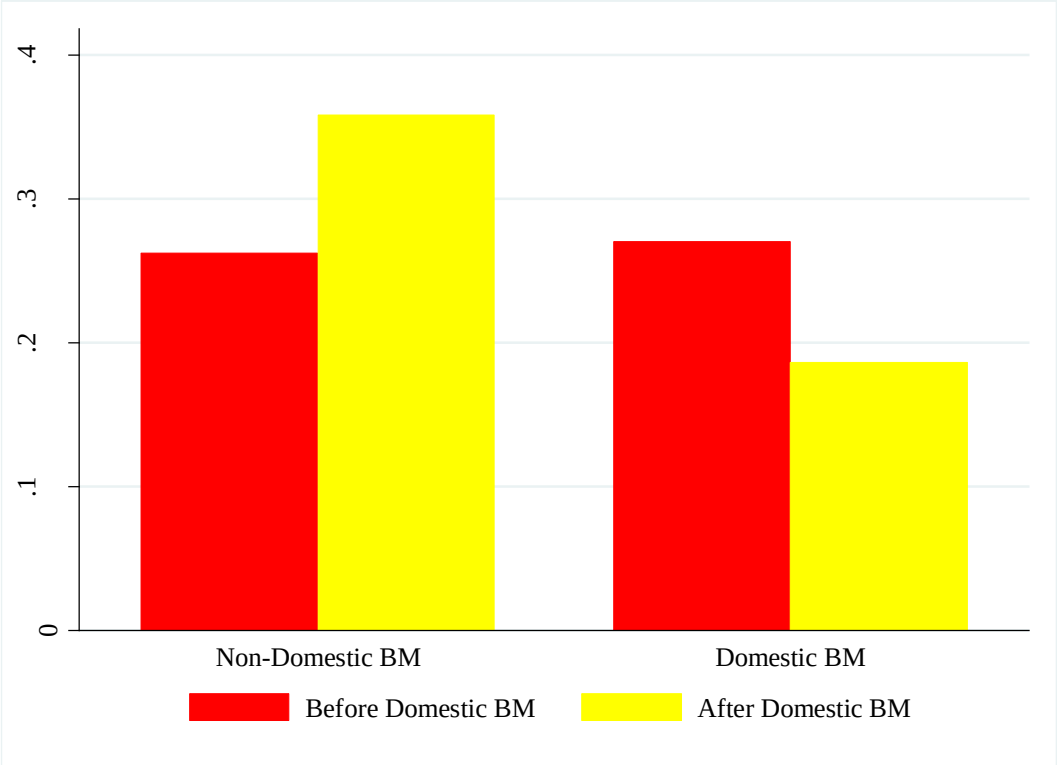
One of the distinctive features of financial development in many developing and emerging countries is the importance of financial dollarization, that is, the use of foreign currencies as an alternative to local currency in the three functions of money—as a medium of exchange, as a store of value, and as a unit of account (Ize and Levy Yeyati, 2003; Corrales et al., 2016). Previous research on the consequences of dollarization shows that it has damaging effects both on economic outcomes and stability as well as policy effectiveness. On the one hand, dollarization can significantly increase growth volatility and weaken the balance sheet of borrowers by creating an important currency mismatch (Gulde-Wolf et al., 2004; Levy Yeyati, 2006). On the other hand, it can sharply raise the elasticity of substitution between local and foreign currencies, particularly in cases of a floating exchange rate regime, thereby severely impeding the effectiveness of national independent monetary policy or counter-cyclical fiscal policy (Miles, 1978; Brillenbourg and Schadler, 1980; Girton and Roper, 1981). These damaging consequences have led many researchers and policymakers to the examination of the causes of dollarization.

Early studies on this phenomenon point out the role of currency substitution according to which dollarization is mainly the result of fear of inflation (Sahay and Vegh, 1995; Savastano, 1996). The direct policy implication of this initial literature is that inflation stabilization is an effective policy for fighting against dollarization. However, this currency substitution view failed to explain the persistence of dollarization in the 1990s in many developing countries and, in particular, in Latin America, despite a significant control of inflation, leading to renewed interest on the causes of dollarization (Edwards and Magendzo, 2003). The new emerging literature, starting from Levy Yeyati (2006) can be subdivided into three main views: *the portfolio view*, *the market development view*, and *the institutional view. The portfolio view* perceives dollarization as an optimal portfolio choice, resulting from the comparison between the real return in local and foreign currency (Ize and Levy Yeyati, 2003). *The market development view* attributes dollarization to market failures, for instance, the absence of investment opportunities in domestic currency

(Olalekan, 2009). Finally, *the institutional view* considers dollarization to be a result of institutional failures, namely the existence of a high level of corruption or political instability that directly affects the credibility and the effectiveness of fiscal, monetary, or exchange rate policies (De Nicolo et al., 2005).

The present paper contributes to this literature by analyzing the effect of participation in the domestic bond market (BM) on financial dollarization in developing countries.[99] Figure 1 presents the average ratio of financial dollarization in domestic and non-domestic BM countries before and after the introduction of domestic BM.[100] Indeed, the simple stylized facts in Figure 1 show that, contrary to non-domestic BM countries, domestic BM countries experienced a decrease in financial dollarization following domestic BM introduction.

Figure 1. The evolution of the average financial dollarization in (non-) domestic BM countries.



Note: This figure presents the evolution of the average rate of financial dollarization (*in the vertical axis*) in domestic and non-domestic BM countries, before and after domestic BM introduction.

[99] Alternatively, the recent paper of Balima et al. (2016) studies the effect of BM participation (including domestic and foreign markets) on tax revenue mobilization in developing countries.

[100] Regarding non-domestic BM countries, we borrow the approach used by Mishkin and Schmidt-Hebbel (2007) in the inflation targeting literature and define the cut-off date as the mid-year of the period running from the first introduction of domestic BM to the sample year end.

Building on this simple illustration, the paper provides a first answer to the link between domestic BM participation and financial dollarization using a large sample of 114 developing countries over the period 1985-2009. Our identification strategy is based on the entropy balancing approach, an innovative method developed by Hainmueller (2012) and recently used by Neuenkirch and Neumeier (2016) to study the impact of US sanctions on poverty. More specifically, we compare the degree of financial dollarization in domestic BM countries and non-domestic BM countries that are as similar as possible with regard to different macroeconomic characteristics, after controlling for the specific characteristics of domestic and non-domestic BM countries and time-specific factors. The findings are as follows.

First, we show that the presence of domestic BM significantly reduces financial dollarization in developing countries. The magnitude of the estimated effect is economically meaningful. On average, domestic BM participation reduces the level of financial dollarization by 7.1 percentage points (hereafter pp.) in domestic BM countries compared to non-domestic BM countries. This finding is widely robust to different specifications of the entropy balancing method and the use of alternative estimation techniques including propensity scores matching, bias-corrected matching, and standard panel fixed effects.

Second, we reveal that the impact of domestic BM on financial dollarization (i) is larger for inflation targeting countries compared to non-inflation targeting countries, (ii) is apparent exclusively in a non-pegged exchange rate regime, and (iii) is larger when there are fiscal rules that constrain the discretion of fiscal policymakers.

Lastly, we provide evidence that the induced drop in inflation rate and its variability, nominal exchange rate variability, and seigniorage revenue are potential transmission mechanisms through which the presence of domestic BM reduces financial dollarization in domestic BM countries.

The rest of this paper is organized as follows. Section 2 discusses theoretical considerations motivating a potential effect of domestic BM participation on financial dollarization. Section 3 presents the empirical methodology. Section 4 describes the data. Section 5 reports the baseline results and their robustness. Section 6 presents the sensitivity of the results. Section 7 describes potential transmission channels. We conclude in Section 8.

II. Theoretical Considerations

Several theoretical considerations support the idea that domestic BM participation can have an impact on financial dollarization in domestic BM countries. To begin with, in a recent research, Rose and Spiegel (2015) present a theoretical framework that considers the implication of local currency BM for price level and stability. The two authors consider a one-period model where the government finances expenditures through debt issuance, and debt service through taxes and inflation. They also consider households that participate in lobbying activities for lower and stable inflation. The authors show that inflation realization is decreasing with the presence of domestic BM though the lobbying activities of wealthy bondholders on their governments for lower and stable inflation. They also test empirically this theoretical prediction and find that countries with domestic BM experience a lower inflation than those without BM. Since domestic bondholders can have a significant impact on domestic price level and stability through lobbying activities, we should expect a decrease in financial dollarization following domestic BM introduction, as predicted by the *currency substitution view.*

Second, the presence of domestic BM provides a saving option in the local currency for local residents. This is all the more important given that many developing countries, including African nations, are net capital exporters to the rest of the world (IMF, 2012). Consequently, we expect domestic BM to decrease financial dollarization, as predicted by the *market development view.*

Third, a well-developed domestic BM can increase economic stability. Indeed, as stressed by Mu et al. (2013), domestic BM can help reduce the country's exposure to interest rate, currency, or others financial risks, and provide valuable resources for financing fiscal stimuli during economic downturns. This assessment is supported by the recent experience of Asian countries, where progress towards deeper domestic BM developments have allowed them to cope with the 2007 financial crisis. In the same vein, by providing an avenue for domestic funding of fiscal deficits, domestic BM may reduce the need for damaging monetary financing of government funding requirement and thus improve the transmission and implementation of monetary policy, including the realization of lower and stable inflation (World Bank, 2001). Therefore, by improving economic stability and the effectiveness of monetary policy, domestic BM may also improve private agents' confidence in the local currency, thus decreasing financial dollarization as predicted by the *institutional view.*

Fourth, at the microeconomic level, the development of domestic BM can improve the structure of the financial system through greater competition between the capital market and commercial banks (World Bank, 2001). This competition can, for instance, force commercial banks to develop new financial products denominated in local currency, leading to the interest rate parity, and thereby increasing the willingness of economic agents to hold the local currency. Consequently, the presence of domestic BM may reduce financial dollarization, as predicted by *the portfolio view.*

However, the presence of domestic sovereign BM can also increase the degree of financial dollarization. Indeed, the presence of domestic BM provides the government a nice way to reduce their domestic debt obligations outstanding through inflation. Such actions could significantly jeopardize citizens' confidence in the local currency and thereby increase financial dollarization. Given this theoretical conflictual linkage, the question of whether the presence of domestic BM has a positive or negative impact on financial dollarization is an empirical one.

III. Empirical Methodology

Our objective is to study whether the presence of a domestic government BM has an impact on the degree of financial dollarization in domestic BM countries. The bigger challenge is to establish a causal link running from domestic BM to financial dollarization. Indeed, domestic BM introduction may be endogenous for several reasons. For instance, countries with a history of dollarization would have more difficulty in developing sustainable domestic BM due to fear of currency risk, raising, in econometric terms, the problem of reverse causality. In addition, some mature countries that may have domestic BM do not have BM because the cost of setting BM up is potentially high (World Bank, 2001; Balima et al., 2016), and this raises the concern of selection bias. To offset these endogeneity issues with regard to the presence of domestic BM, we employ an impact assessment methodology.

Our impact assessment approach is based on the idea that the introduction of a government domestic BM represents the treatment and the degree of financial dollarization represents the outcome variable. The units of observations are country-year observations; observations with (without) domestic BM in place represent the treatment (control) group. The measure of interest is the well-known average treatment effect on the treated, τ, defined as

$$\tau = E\left[FD_{(1)} \middle| T = 1\right] - E\left[FD_{(0)} \middle| T = 1\right] \quad (1)$$

where $FD_{(.)}$ is my outcome variable, that is, the degree of financial dollarization. T indicates if the unit of observation is subject to the treatment of domestic BM introduction ($T = 1$) or not ($T = 0$). Consequently, $E\left[FD_{(1)} \middle| T = 1\right]$ is the degree of financial dollarization after domestic BM initiation and $E\left[FD_{(0)} \middle| T = 1\right]$ is the counterfactual outcome for a country having introduced domestic BM, i.e. the degree of financial dollarization in domestic BM countries if they had not introduced domestic BM. Given that we cannot observe the last one, we need to find an appropriate proxy. For instance, if the introduction of domestic BM is a random decision, we can easily identify τ by comparing financial dollarization in domestic and non-domestic BM countries. However, as pointed out by Balima et al. (2016), the introduction of BM is rather endogenous to several macroeconomic variables. To overcome this issue, we can match domestic and non-domestic BM units that are as close as possible with respect to pretreatment characteristics that meet the two following conditions: (i) they are correlated with domestic BM participation and (ii) they are associated with the degree of financial dollarization. Under the condition that the non-domestic BM units are fairly close to the domestic BM units, differences in financial dollarization between domestic BM and non-domestic BM countries are caused by the presence of domestic BM. Basically, equation (1) can be rewritten as

$$\tau = E\left[FD_{(1)} \middle| T = 1, X = x\right] - E\left[FD_{(0)} \middle| T = 0, X = x\right] \quad (2)$$

where x is a vector of relevant pretreatment characteristics that affect both domestic BM participation and financial dollarization, and is described in section 4 below. $E\left[FD_{(1)} \middle| T = 1, X = x\right]$ is the degree of financial dollarization for units that introduced domestic BM, and $E\left[FD_{(0)} \middle| T = 0, X = x\right]$ is the expected level of dollarization for the synthetic control units.

In this study, we use the entropy balancing approach, a generalization of conventional matching methods proposed by Hainmueller (2012), to select non-treated observations for units exposed to treatment and to estimate τ. This methodology is also used by Neuenkirch and Neumeier (2016) to study the impact of US sanctions on poverty and by Balima et al. (2016) to study the effect of the initiation of credit default swaps on sovereign debt crises. In the following, we adapt the presentation of entropy balancing method from Neuenkirch and Neumeier (2016). The implementation of entropy balancing follows two consecutive steps. The first step calculates

weights for non-treated units. These weights may satisfy pre-specified balanced constraints involving sample moments of pretreatment characteristics. Following Neuenkirch and Neumeier (2016), we choose the balance constraints that impose equal pretreatment covariate means across the treated and the non-treated groups. By doing so, we want to ensure that the non-treated group contains, on average, units not subject to treatment that are as similar as possible to the treated units. In the second step, the weights from the first step are used in regression analysis with financial dollarization as a dependent variable and domestic BM dummy as an explanatory variable. We then obtain the average treatment effect of domestic BM introduction on financial dollarization, that is, the estimated parameter of domestic BM dummy from the second step of the regression analysis.

Since it combines both matching (in its first step) and regression (in its second step), entropy balancing has some advantages over other treatment effect estimators (Neuenkirch and Neumeier, 2016). First, compared to simple regression-based approaches (namely difference-in-difference) or conventional matching methods (including propensity scores matching and bias-corrected matching), the use of the entropy balancing method does not require to specify an empirical model for the selection of domestic BM. This makes it possible to avoid potential problems of misspecification, multicollinearity, or wrong choice of the functional form. Second, entropy balancing ensures a perfect common support between treated and non-treated groups by creating a synthetic control group that corresponds to a virtually perfect image of the treated group.[101] Finally, using entropy balancing allows taking into account the panel dimension of the data by controlling for country and time fixed effects in its second step of the regression analysis.

IV. Data

We use an annual panel dataset covering 114 developing countries over the period 1985-2009. Following Rose and Spiegel (2015) and Balima et al. (2016), we collect domestic BM data using the Fixed Income Database from Global Financial Data (GFD). These authors compare GFD with concurrent data sources (including Bloomberg, Financial Times, BIS, Investing.com, and Dealogic) and report that GFD is the most comprehensive one compared to these concurrent

[101]Hainmueller (2012), in a Monte Carlo simulation, compares the performances of entropy balancing to other alternative impact assessment methodologies, including propensity score matching and genetic matching. He concludes that entropy balancing outperforms these alternative methodologies in terms of estimation bias and mean square error.

databases. GFD reports bond data for those bonds traded with sufficient liquidity to have prices quoted, typically in an over-the-counter market and often after an initial auction. We rely on series for government bonds since the corporate or municipal analogues from GFD tend to follow government bonds in time. We are interested in long, nominal, local-currency bonds since they are most vulnerable to financial dollarization. We corrected potential errors in GFD data, following Rose and Spiegel (2015).[102]

In our benchmark specification, we use a domestic BM series with a maturity of at least 10 years, as in Rose and Spiegel (2015).[103] From an initial sample of 200 countries in GFD, we focus exclusively on developing countries for two main reasons. On the one hand, from a methodological standpoint, domestic BM were introduced in the largest majority of developed countries before the first year of our sample (namely, 1985), forcing us to rule them out (Balima et al., 2016). One the other hand, from an economic standpoint, developed countries are less concerned with the issue of financial dollarization than developing ones.

Our treatment variable is a dummy equal to 1 if country i at period t has a publicly-traded, at least 10-year maturity, domestic currency-denominated government bond market, and 0 otherwise.[104] From the sample of 114 developing countries, the treated group consists of 30 countries that have domestic government BM. The remaining 84 countries without domestic BM or with less than 10-year BM belong to the control group. Appendices 1 and 2 provide the number of these (non-) domestic BM country-year observations selected from the second step of the entropy balancing approach.[105]

Consistent with the literature on financial dollarization (see, for instance, Lin and Ye, 2013), we measure financial dollarization using Levy Yeyati's (2006) database. The author defines financial dollarization as the ratio of foreign currency deposits to total deposits. In particular,

[102] Specifically, Rose and Spiegel (2015) correct GFD data for omissions regarding domestic BM introduction in Armenia, Brazil, Kazakhstan, Nigeria, Peru, and Ukraine.
[103] Robustness analysis will consider the presence of a domestic BM of at least 5 years.
[104] An important question here is why should we consider a dummy variable for domestic BM participation rather than using domestic BM capitalization that take into account the relative size of the domestic bond market (as mentioned by one referee from peer-review journal). The objective in this paper is to focus on countries with sufficient liquid domestic BM, and then compared the effect on these countries to countries without liquid domestic BM. However, a country can have a large domestic bond market capitalization without having really a liquid domestic BM. This can occur when the central bank is the dominant agent in the primary market—as is the case in many developing countries—without having a secondary market. Our measure of domestic BM takes into account market participants both in the primary and the secondary markets. As mentioned in GFD website, *GFD reports bond data for those bonds traded with sufficient liquidity to have prices quoted, typically in an over-the-counter market and often after an initial auction*.
[105] The list of the whole domestic and non-domestic BM countries is available upon request.

Levy Yeyati compiles a unique comprehensive deposit dollarization series using different sources including Balino et al. (1999), Arteta (2002), De Nicolo et al. (2003), and various central bank bulletins and IMF Article IV staff reports. Using this measure has the disadvantage of excluding loans dollarization. However, as stressed by Lin and Ye (2013), deposit dollarization may reflect loan dollarization and be considered as a good proxy of financial dollarization since bank deposits and loans often mirror each other.

We select a control group comprised of non-treated units and is, on average, as similar as possible to the treatment group with regard to relevant pretreatment characteristics. We consider two groups of control variables. The first group of variables captures factors that influence the likelihood of being selected into domestic BM introduction. Following the literature on the determinants of BM participation including Rose and Spiegel (2015) and Balima et al., (2016), we include the following covariates: (i) real GDP per capita, (ii) trade openness (% of GDP), (iii) total population, (iv) domestic credit to private sector (% of GDP), (v) real GDP growth, (vi) polity score (a measure of autocracy/democracy), (vii) fixed exchange rate regime dummy, (viii) agriculture value added (% of GDP), and (ix) inflation. We expect the first six (last two) variables to be positively (negatively) correlated with domestic BM participation.[106] The second group of variables is used to control for the likelihood of choosing a foreign currency BM as an alternative source of capital market access. We include (i) external debt to GNI ratio and (ii) financial openness index (KAOPEN). All these groups of variables are lagged by one year to avoid potential issues of reverse causality. We extract data on control variables mainly from World Development Indicator. Appendix 3 reports the sources and definitions of variables.

V. Results

5.1. Descriptive Statistics

Table 3 presents the results of the effect of domestic BM initiation on financial dollarization using entropy balancing. Before looking at the results in Table 3, let us focus on some descriptive statistics obtained before and after weighting used to compute the τ. In Table 1, we present the pre-weighting sample means of all matching covariates for country-year observations where domestic BM were in place (the treated group) in column [1], and country-year observations

[106] A good discussion about the expected impact of these variables on BM participation is presented in Balima et al. (2016).

Table 1. Descriptive statistics before weighting

	[1]	[2]	[3] = [2] - [1]		
Variables	Domestic BM	No domestic BM	Difference	t-test	p-value
Log(real GDP per capita)$_{t-1}$	2671.379	1597.582	-1073.797	-6.535	0.000
Log(trade openness)$_{t-1}$	4.220	4.180	-0.0406	-0.941	0.347
Log(total population)$_{t-1}$	17.623	16.279	-1.343	-11.140	0.000
Log(private credit)$_{t-1}$	3.718	2.695	-1.023	-14.048	0.000
Real GDP growth$_{t-1}$	5.459	4.863	-0.596	-1.892	0.059
Polity score$_{t-1}$	4.314	2.124	-2.190	-4.404	0.000
Fixed exchange rate$_{t-1}$	0.246	0.140	-0.106	-2.929	0.003
Agriculture value added$_{t-1}$	13.273	22.381	9.108	11.950	0.000
Inflation rate$_{t-1}$	7.169	21.130	13.960	6.141	0.000
External debt$_{t-1}$	45.648	75.977	30.328	11.174	0.000
Financial openness$_{t-1}$	-0.456	-0.155	0.301	3.202	0.001
Observations	162	740			

Notes: This Table presents the pre-weighting sample means of the matching covariates for country-year observations where domestic BM where in place (the treatment group) in column [1] and country-year observations where no domestic BM were in place (the potential control group) in column [2]. Column [3] reports the differences in means between treated and control group, and the corresponding t-test statistics and p-values.

Table 2. Descriptive statistics after weighting

	[1]	[4]	[5] = [4] - [1]		
Variables	Domestic BM	No domestic BM	Difference	t-test	p-value
Log(real GDP per capita)$_{t-1}$	2671.379	2669.919	-1.460	-0.015	0.988
Log(trade openness)$_{t-1}$	4.220	4.220	0.000	-0.009	0.993
Log(total population)$_{t-1}$	17.623	17.612	-0.011	-0.115	0.908
Log(private credit)$_{t-1}$	3.718	3.710	-0.008	-0.223	0.823
Real GDP growth$_{t-1}$	5.459	5.436	-0.023	-0.145	0.885
Polity score$_{t-1}$	4.314	4.311	-0.003	-0.009	0.993
Fixed exchange rate$_{t-1}$	0.246	0.246	0.000	0.009	0.993
Agriculture value added$_{t-1}$	13.273	13.299	0.026	0.064	0.949
Inflation rate$_{t-1}$	7.169	7.310	0.141	0.320	0.749
External debt$_{t-1}$	45.648	45.906	0.258	0.206	0.836
Financial openness$_{t-1}$	-0.456	-0.457	-0.001	-0.024	0.981
Observations	162	162			

Notes: This Table presents the sample means matching covariates after weighting across the treated group in column [1] and the synthetic control group obtained from entropy balancing in column [4]. Column [5] shows the differences in means, the t-test statistics and the associated p-values.

where non-domestic BM were in place (the potential control group) in column [2]. Column [3] reports the differences in means between the treated and control groups, the corresponding t-

test statistics and p-values. It results from Table 1 that country-year observations where domestic BM were in place differ from country-year observations where non-domestic BM were in place. The pre-weighting descriptive statistics reveal that the economic, political, financial, and environmental conditions in domestic BM countries are generally better as these countries are characterized by (a) a larger GDP per capita, (b) a larger population, (c) a higher private credit-to-GDP, (d) a higher GDP growth, (e) a higher degree of democracy, (f) a relatively flexible exchange rate regime, (g) a lower share of agriculture in GDP, (h) a lower level of inflation rate, (i) a lower external debt-to-GDP, and (j) a higher financial openness index. These differences across domestic BM and non-domestic BM countries clearly demonstrate the importance of selecting an appropriate control group when computing the treatment effect of domestic BM introduction in order to avoid incorrectly estimated treatment effect.

In Table 2, we also report the sample means of matching covariates after weighting across the treated group in column [1] and the synthetic control group obtained from entropy balancing in column [4]. Column [5] shows the differences in means, the t-test statistics, and the associated p-values. Looking at the means pre-treatment matching covariates for the treated and the synthetic control groups clearly reveals the effectiveness of entropy balancing. It appears clearly that all covariates are perfectly balanced between the two groups and no significant difference remains after weighting. Consequently, the entropy balancing allows the building of a perfect control group that is closely similar to domestic BM countries in terms of means values of pretreatment covariates.

5.2. Baseline results

Based on the synthetic control group from Table 2, we estimate the effect of domestic BM participation on financial dollarization using weighted least square regressions. The results based on different specifications are reported in Table 3. In the first specification, we present the second step result of the entropy balancing, excluding the matching covariates employed to compute weights (column [6]). Second, we gather the matching covariates to the regression in order to increase the efficiency of the estimation (column [7]).[107] Third, we control for unobservable time-specific factors (column [8]). In the last specification, we bring country-specific factors to the regression (column [9]). Irrespective of the specification, the results are strong and robust: the

[107] Including covariates employed in the first step of entropy balancing in the regression step is similar to introducing control variables in a randomized experiment (Neuenkirch and Neumeier, 2016).

estimated effects of domestic BM on financial dollarization are all found to be negative and highly statistically significant. The magnitude of the effects ranges from -5.2 to -7.1 pp. Taking the benchmark result controlling for matching covariates, time and country-specific factors in column [9], the finding means that, when domestic BM are in place, the degree of financial dollarization is 7.1 percentage points lower in domestic BM countries compared to non-domestic BM countries that are as similar as possible in terms of pretreatment characteristics. Consequently, we find that, on average, domestic BM have a quantitatively large and significant impact on lowering financial dollarization in developing countries.

Table 3. The impact of domestic BM on financial dollarization

	[6]	[7]	[8]	[9]
Domestic BM	-0.052***	-0.061***	-0.058***	-0.071***
	(0.012)	(0.009)	(0.009)	(0.009)
R-squared	0.021	0.438	0.537	0.545
Covariates in the second step	No	Yes	Yes	Yes
Year fixed effect in the second step	No	No	Yes	Yes
Country fixed effect in the second step	No	No	No	Yes
Observations	902	902	902	902

Notes: This Table presents the effect of domestic BM participation on financial dollarization obtained by weighted least squares regressions. The treatment variable is domestic BM dummy. The outcome variable is financial dollarization. The control variables include the lagged values of real GDP per capita, trade openness, total population, domestic credit to private sector, real GDP growth, polity score (a measure of autocracy/democracy), fixed exchange rate regime dummy, agriculture value added, inflation rate, external debt, and financial openness. We include year fixed effect in the first step of entropy balancing. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.3. Robustness checks

The previous findings show that the presence of domestic BM significantly reduces financial dollarization in developing countries. While these initial findings are encouraging, we investigate in this sub-section the robustness of the results, using alternative specifications of the entropy balancing approach and providing additional evidence based on alternative econometric methods.

5.3.1 Alternative specifications

We provide alternative specifications as follows. First, we take a closer look at the definition of the treatment variable. Following Balima et al. (2016), we consider the existence of a BM with at least 5-year maturity as my treatment variable, which leaves us with 38 domestic BM countries. The results are reported in columns [10] of Table 4. The estimated effect of domestic BM participation is negative and statistically significant but lower in magnitude. Using a 5-year BM

maturity does not alter the main finding that domestic BM significantly reduces financial dollarization in the developing world.

Second, we want to check if the result is sensitive to different sample groups. To do so, we redefine the sample of domestic BM and non-domestic BM as follows. In column [11] of Table 4, we exclude from the non-domestic BM group countries with real GDP per capita below that of the poorest domestic BM country or with population size below that of the smallest domestic BM country. Similarly, in column [12], we exclude from the domestic BM group countries that have a real GDP per capita above that of the richest non-domestic BM country and with a population size above that of the largest non-BM country. Lastly, column [13] combines these changes performed in columns [11] and [12]. The estimated effects of domestic BM in columns [11]-[13] remain negative and statistically significant, suggesting that focusing the analysis on a more homogenous sample does not alter the previous findings.

Third, to account for the fact that domestic BM in African countries remain underdeveloped, we exclude them from the sample study. The result is reported in column [14] of Table 4. Excluding African countries does not change the results, as the estimated effect of domestic BM participation is again found to be negative and statistically significant.

Fourth, we look for the potential role of financial dollarization outliers since some countries (mainly non-domestic BM ones) in the sample are witnessing high levels of financial dollarization (defined as 50% or higher, as in Lin and Ye, 2013). For this purpose, we drop country-year observations with high levels of financial dollarization. The new result is reported in column [15] of Table 4. Excluding high financial dollarization episodes does not change the results since the estimated effect remains negative and statistically significant.

Finally, we check the robustness of the results for different sample periods by excluding post-2006 crisis periods to isolate the impact of the recent financial crisis. The result is reported in column [16] of Table 4. The estimated effect of domestic BM is negative and statistically significant. Excluding post-crisis periods does not affect the finding that domestic BM reduces financial dollarization in domestic BM countries.

5.3.2. Alternative econometric methods

Are the results sensitive to the particular choice of the econometric method? To answer this important question, we performed alternative methods, namely propensity score matching, bias-corrected matching, and standard panel regressions.

- Propensity Score Matching

Propensity score matching (PSM) has been widely used in previous studies to address the self-selection and endogeneity issue of policy evaluation. For instance, in a very recent application, Subrahmanyam et al. (2017) used this methodology to study the impact of credit default swap initiation on the liquidity management of firms. We first test the sensitivity of the effect of domestic BM introduction on financial dollarization to the use of alternative econometric

Table 4. The impact of domestic BM on financial dollarization

	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Domestic BM (5-years)	-0.037***						
	(0.011)						
Domestic BM		-0.091***	-0.061***	-0.084***	-0.075***	-0.049***	-0.040***
		(0.010)	(0.010)	(0.010)	(0.010)	(0.008)	(0.011)
R-squared	0.521	0.615	0.539	0.607	0.622	0.635	0.523
Covariates in the second step	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect in the second step	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect in the second step	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	902	718	896	712	605	713	801

Notes: This Table presents the effect of domestic BM participation on financial dollarization obtained by weighted least squares regressions. The treatment variable is domestic BM dummy. The outcome variable is financial dollarization. The control variables include the lagged values of real GDP per capita, trade openness, total population, domestic credit to private sector, real GDP growth, polity score (a measure of autocracy/democracy), fixed exchange rate regime dummy, agriculture value added, inflation rate, external debt, and financial openness. We include year fixed effect in the first step of entropy balancing. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

methods using PSM methodology. The implementation of PSM follows two consecutive steps. In the first step, we estimate the propensity scores to introduce a domestic BM for each country-year observation, using the same control variables utilized in the entropy balancing approach to predict these scores. Based on these scores, we then compute in the second step the average treatment effect on the treated (ATT) of domestic BM participation on financial dollarization. Following Balima et al. (2017), we use different varieties of PSM methods: the N-nearest-neighbor (with N=1, 2, 3), the radius matching (with a radius of 0.005, 0.01, and 0.05), the kernel matching, the local linear matching, and stratification matching [for a discussion on the difference between these matching algorithms, see Caliendo and Kopeinig (2008)].

Table 5 reports the first step probit estimation of the propensity scores. Most estimated coefficients are statistically significant with the signs consistent with the theory. We find that GDP per capita, trade openness, population, private credit, and polity score are all positive and statistically significant, meaning that countries with higher GDP per capita, higher level of openness to trade, larger population, higher level of private credit, or higher level of democracy

are more likely to introduce a domestic BM. The estimated coefficients on inflation rate, external debt, and financial openness are negative and significant, meaning that countries with a higher level of inflation, a higher proportion of external debt, or a higher capital openness are less likely to introduce domestic BM. The overall goodness-of-fit of the model is adequate with a pseudo-R2 of about 0.41.

Based on these propensity scores, we estimate the ATT of domestic BM of financial dollarization in Table 6. We present in the first three columns the results from N-nearest-

Table 5. Estimation of Propensity Scores for Domestic Bond Market Participation

Dependent variable	Domestic BM dummy
Log real GDP per capita (t-1)	0.353***
	(0.116)
Log trade openness (t-1)	0.701***
	(0.119)
Log total population (t-1)	0.441***
	(0.0418)
Log private credit/GDP (t-1)	0.539***
	(0.0911)
Real GDP growth (t-1)	0.0107
	(0.0120)
Polity score (t-1)	0.0591***
	(0.00855)
Fixed exchange regime dummy (t-1)	-0.487***
	(0.126)
Agriculture added value/GDP (t-1)	0.00403
	(0.00904)
Inflation rate (t-1)	-0.0247***
	(0.00926)
External debt/GNI (t-1)	-0.00420***
	(0.00159)
Financial openness index (t-1)	-0.238***
	(0.0461)
Constant	-15.46***
	(1.551)
Pseudo-R2	0.4154
Observations	1,629

Notes: This table presents the estimation of propensity scores for domestic BM participation. The dependent variable is domestic BM dummy. All explanatory variables are lagged by one year to insure that the matching are based on pretreatment characteristics. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

neighbor (with N=1, 2, 3). The next three columns present the results from radius matching, with a radius of 0.005, 0.01, and 0.05. The last three columns show the results from kernel matching, local linear matching, and stratification matching. The results from these different PSM algorithms are strong and consistent. The estimated effect of domestic BM on financial dollarization are all negative, statistically significant and of comparable magnitude compared to the benchmark results. The average effect is about 6.05 pp. Consequently, using PSM supports the previous findings based on entropy balancing.

- *Bias-corrected Matching*

In addition to the PSM method, we propose a bias-corrected matching. This method has the advantage of predicting the level of financial dollarization of domestic BM countries if they had not introduced domestic BM—the counterfactual outcome—using a regression function based on the control group. By doing so, it helps reduce potential bias in the finite sample due to matching discrepancies [see Abadie and Imbens (2006) for more details]. Consequently, we estimate the effect of domestic BM on dollarization using bias-corrected matching and using the same control variables employed in the entropy balancing.

The results are reported in Table 7, with N the number of matched running from 1 to 10. We find that the effect of domestic BM on financial dollarization is negative and statistically significant, independent of the number of matched N used. Moreover, the average effect is about 4.5 pp. Using a bias-corrected matching does not affect the estimated effect of domestic BM participation on financial dollarization.

- *Standard Panel Regressions*

We finally employ standard panel techniques to estimate the effect of domestic BM participation on financial dollarization. To overcome potential endogeneity issues of BM introduction due, for instance, to simultaneity bias, we introduce the binary domestic BM variable with one-year lag and then successfully add the same control variables used in the entropy balancing approach. The results are reported in Table 8.

The results in Table 8 are consistent with the benchmark findings. The coefficients for domestic BM dummy are all negative and statistically significant. The estimated effect ranges from approximately 3 pp. to 4 pp. Consequently, using a standard panel regression approach does not affect the previous findings of the effect of domestic BM participation on financial dollarization.

Table 6. ATT of domestic BM participation on financial dollarization using propensity scores matching

Dependent variable: Financial Dollarization	N Nearest Neighbor Matching			Radius Matching			Local linear Matching	Kernel Matching	Stratification Matching
	N=1	N=2	N=3	r=0.005	r=0.01	r=0.05			
ATT	-0.0547**	-0.0525*	-0.0558**	-0.0638**	-0.0684***	-0.0629***	-0.0588***	-0.0635***	-0.0640***
	(0.0268)	(0.0276)	(0.0263)	(0.0281)	(0.0245)	(0.0237)	(0.0226)	(0.0222)	(0.0180)
Treated/Untreated/Total observations	159/757/916	159/757/916	159/757/916	127/757/884	138/757/895	159/757/916	159/757/916	159/757/916	227/1335/1562

Notes: This table presents the average treatment effect of the treated (ATT) of domestic BM participation on financial dollarization using propensity scores matching method. Bootstrapped standard errors based on 500 replications are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. ATT of domestic BM participation on financial dollarization using bias-corrected matching

Dependent variable: Financial Dollarization	Number of matched N									
	N=1	N=2	N=3	N=4	N=5	N=6	N=7	N=8	N=9	N=10
ATT	-0.0465***	-0.0425***	-0.0470***	-0.0464***	-0.0446***	-0.0455***	-0.0453***	-0.0454***	-0.0430***	-0.0415***
	(0.0093)	(0.0112)	(0.0099)	(0.0110)	(0.0121)	(0.0130)	(0.0138)	(0.0142)	(0.0147)	-0.0154
Number of observations	902	902	902	902	902	902	902	902	902	902

Notes: This table presents the average treatment effect of the treated (ATT) of domestic BM participation on financial dollarization using bias-corrected matching method. Heteroscedasticity-consistent standard errors are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

VI. Sensitivity

The previous section showed that domestic BM participation significantly reduces financial dollarization in developing countries. However, developing domestic government BM would be more successful when a consistent macroeconomic policy framework involving monetary, exchange rate, and fiscal policies is in place. In this section, we first investigate the composition effect of BM participation (i.e. the effect of domestic versus foreign currency BM) and then explore the potential heterogeneities depending on several macroeconomic policy frameworks.

6.1. Domestic BM versus foreign BM

We begin by making a direct comparison of the effect of domestic versus foreign currency BM on financial dollarization. Indeed, contrary to domestic BM, which provides a saving option in local currency, the presence of a foreign currency BM provides to a resident economic agent a saving option in foreign currency. Besides, only holders of local-denominated bonds are directly affected by inflation and its dynamics and may constitute potential anti-inflationary policy forces (Rose and Spiegel, 2015). As a result, the effect of foreign BM on financial dollarization, if any, may differ from the effect of domestic BM participation. To carry out this interesting exercise, column [21] of Table 9 brings domestic and foreign BM dummies to the second step regression approach of entropy balancing. Consistent with the previous findings, the results suggest that the presence of domestic BM significantly reduce financial dollarization in domestic BM countries. However, the estimated effect of foreign BM is positive, statistically significant, and important in magnitude suggesting that, contrary to domestic BM, the presence of foreign-currency BM deepens financial dollarization in foreign-currency BM countries.

6.2. The monetary policy regimes

Second, we analyze the effect of domestic BM on financial dollarization depending on the monetary policy regimes. It is obvious that the existence of a well-managed and independent central bank, with a credible commitment to maintaining price stability, may play an important role in determining the effectiveness of domestic BM participation on financial dollarization (World Bank, 2001). Indeed, a credible and independent central bank may play an important role in containing inflation expectations, counterbalancing potential fiscal excesses, and avoiding

Table 8. Panel estimation of the effect of domestic BM participation on financial dollarization

Dependent variable: Financial dollarization	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
Domestic BM dummy (t-1)	-0.0463***	-0.030**	-0.0283**	-0.0302**	-0.0269*	-0.0267*	-0.0364**	-0.0471***	-0.0408***	-0.0426***	-0.0318*	-0.0363**
	(0.0140)	(0.0141)	(0.0141)	(0.0141)	(0.0142)	(0.0142)	(0.0149)	(0.0160)	(0.0156)	(0.0148)	(0.0166)	(0.0168)
Log real GDP per capita		-0.127***	-0.124***	-0.132***	-0.126***	-0.138***	-0.154***	-0.203***	-0.201***	-0.243***	-0.246***	-0.258***
		(0.0188)	(0.0189)	(0.0202)	(0.0213)	(0.0213)	(0.0228)	(0.0271)	(0.0270)	(0.0292)	(0.0306)	(0.0314)
Log trade openness			0.00953	0.0107	0.00914	0.00386	-0.0315*	-0.0237	-0.0371**	-0.0149	-0.000110	-0.0128
			(0.0132)	(0.0133)	(0.0140)	(0.0140)	(0.0165)	(0.0184)	(0.0186)	(0.0187)	(0.0194)	(0.0194)
Log total population				-0.0523	-0.0213	-0.0189	-0.00817	-0.0533	-0.0525	-0.177**	-0.216***	-0.113
				(0.0462)	(0.0483)	(0.0482)	(0.0570)	(0.0692)	(0.0675)	(0.0707)	(0.0819)	(0.0870)
Log private credit/GDP					-0.000940	0.00167	0.00835	0.0150*	0.00715	0.0215**	0.00879	0.0287***
					(0.00751)	(0.00749)	(0.00792)	(0.00849)	(0.00842)	(0.00882)	(0.00909)	(0.00979)
Real GDP growth						0.00263***	0.00250***	0.00243***	0.00195***	0.00191***	0.00260***	0.00165**
						(0.000488)	(0.000539)	(0.000633)	(0.000623)	(0.000715)	(0.000746)	(0.000775)
Polity score							-0.000196	0.000417	0.00131	0.000839	4.50e-05	0.000654
							(0.00119)	(0.00131)	(0.00128)	(0.00126)	(0.00129)	(0.00125)
Fixed exchange regime dummy								0.0355***	0.0470***	0.0380***	-0.00392	-0.0163
								(0.0123)	(0.0125)	(0.0122)	(0.0127)	(0.0131)
Agriculture added value/GDP									-0.00410***	-0.00467***	-0.00436***	-0.00298***
									(0.000833)	(0.000876)	(0.000888)	(0.000923)
Inflation rate										0.000212***	0.000202***	0.000283***
										(4.80e-05)	(5.01e-05)	(6.51e-05)
External debt/GNI											0.000471***	0.000394***
											(0.000122)	(0.000123)
Financial openness index												0.00386
												(0.00445)
Constant	0.174***	1.071***	1.009***	1.870**	1.364*	1.409*	1.431	2.460**	2.618**	4.816***	5.343***	3.746**
	(0.0222)	(0.135)	(0.148)	(0.775)	(0.806)	(0.803)	(0.979)	(1.210)	(1.184)	(1.250)	(1.437)	(1.529)
Observations	1,631	1,582	1,552	1,552	1,522	1,515	1,274	1,076	1,052	1,024	901	881
R-squared	0.155	0.175	0.177	0.178	0.170	0.186	0.226	0.259	0.254	0.261	0.300	0.290
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents panel regressions of the effect of domestic BM participation on financial dollarization. The dependent variable is financial dollarization. The principal variable of interest (domestic BM dummy) is lagged by one year to avoid potential endogeneity concerns. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

fiscal dominance, all the more important in building credibility with domestic BM participants. In particular, a credible monetary policy should contribute to dispelling the doubts on the government temptations to inflate away its local currency debt. We test the hypothesis that the impact of domestic BM on financial dollarization would be more important in domestic BM countries with well-managed and independent central banks and consider the presence of an inflation targeting framework as a proxy for well-managed and independent central banks. More specifically, we make the distinction between (i) domestic BM countries under an inflation targeting regime and (ii) domestic BM countries under non-inflation targeting regime (namely money or exchange rate targeting). We then estimate the effect of domestic BM participation on financial dollarization for each group, using the entropy balancing approach. The results reported in column [22] of Table 9 confirm our expectations. Although domestic BM significantly reduce financial dollarization in inflation targeting and non-inflation targeting countries, the estimated effect is stronger in inflation targeting regime compared to non-inflation targeting regime.

Table 9. Heterogeneity of the impact of domestic BM on financial dollarization

	[21]	[22]	[23]	[24]
Domestic BM	-0.069***			
	(0.009)			
Foreign BM	0.076***			
	(0.014)			
Domestic BM and inflation targeting		-0.085***		
		(0.016)		
Domestic BM and non-inflation targeting		-0.060***		
		(0.010)		
Domestic BM and fixed exchange rate regime			0.023	
			(0.016)	
Domestic BM and flexible exchange rate regime			-0.077***	
			(0.011)	
Domestic BM and fiscal rule				-0.108***
				(0.017)
Domestic BM and non-fiscal rule				-0.026*
				(0.016)
R-squared	0.556	0.517	0.514	0.494
Covariates in the second step	Yes	Yes	Yes	Yes
Year fixed effect in the second step	Yes	Yes	Yes	Yes
Country fixed effect in the second step	Yes	Yes	Yes	Yes
Observations	902	902	902	902

Notes: This Table presents the effect of domestic BM on financial dollarization obtained by weighted least squares regressions. The treatment variable is domestic BM dummy. The outcome variable is financial dollarization. We include year fixed effect in the first step of entropy balancing. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6.3. The exchange rate regimes

In this sub-section, we explore the effect of domestic BM on financial dollarization, depending on the exchange rate regimes. The starting point is that a fixed exchange rate regime may, in some sense, discourage financial dollarization since the fixity of the regime provides immunity for exchange rate fluctuations given the governments' commitments to defend the peg. However, a floating exchange rate regime can increase dollarization due to the fear of exchange rate depreciation and volatility. We expect that domestic BM may play a significant role in helping to reduce financial dollarization, particularly in countries with flexible exchange rate regimes. Using Reinhart and Rogoff (2010) de facto exchange rate regime classification, we make the distinction between (i) domestic BM in pegged regime and (ii) domestic BM in floating or intermediate exchange rate regime. We then estimate the effect of domestic BM in (i) and (ii). Results in column [23] of Table 9 suggest that domestic BM significantly reduce financial dollarization exclusively in non-pegged regimes, consistent with theoretical insights.

6.4. The fiscal policy framework

Fourth, we take a closer look at the fiscal policy framework by distinguishing between (i) domestic BM country-year observations with the presence of a fiscal rule and (ii) domestic BM country-year observation without a fiscal rule. Indeed, the existence of an institutional and legal framework aimed at ensuring proper economic governance and building a record of accomplishment of fiscal prudence may be critical for building overall credibility on investors' perceptions of the government's ability to honor long-term obligations. Such a reasonably robust fiscal regime may play a decisive role in allowing the markets to count on substantial predictability in government actions. Moreover, the existence of long-term BM may be a particularly effective means to exert further fiscal rules compliance since the fiscal authorities must react credibly by cutting expenditures or raising taxes if debt borrowing cost rises in response to structural shocks to the economy. We expect that the presence of fiscal rules may help the government in building credibility with bondholders, thus increasing domestic BM depth and reducing financial dollarization. The results are presented in column [24] of Table 9. Interestingly, we find that the presence of domestic BM plays a significant role in reducing financial dollarization exclusively in countries with fiscal rules, confirming the theoretical expectation.

VII. Transmission mechanisms

In this section, we investigate the transmission mechanisms through which domestic BM may have an effect on financial dollarization in developing countries. We explore the relevance of four potential transmission mechanisms: a decrease in (i) inflation rate, (ii) inflation variability, (iii) nominal exchange rate variability, and (iv) seigniorage revenue. As already discussed in the introduction of this paper, all these variables are important determinants of financial dollarization.

To evaluate these potential transmission channels, we follow Neuenkirch and Neumeier (2016) and compute the mean of these variables for (a) the BM group during times when domestic BM were in place, (b) the BM group focusing only on years before domestic BM introduction, and (c) the synthetic control group obtained via entropy balancing. Results are reported in Table 10. The descriptive statistics indicate a significant difference between the control group obtained via entropy balancing and the BM group before domestic BM introduction. Indeed, the latter is characterized by (i) a higher level of inflation rate (13.21% vs. 7.89%), (ii) a higher degree of inflation variability (10.34 vs. 3.85%), (iii) a higher nominal exchange rate variability (177.47% vs. 85.06%), and (iv) a higher ratio of seigniorage to GDP (115.03% vs. 2.19%).

Table 10 also shows that the introduction of domestic BM is associated with a significant drop of the four potential transmission channel variables in domestic BM countries. The level of inflation is much smaller in the years during which domestic BM were in place (6.88%) compared with the years before (13.21%), with the difference being highly significant (t = 4.64; p-value = 0.00). Regarding inflation variability, we also observe a lower level during domestic BM period (2.85%) compared with the period before (10.34%), and the difference is statistically significant (t = 3.71; p-value = 0.00). In the case of nominal exchange rate variability, we observe a very lower level of exchange rate variability during the BM period (11.15) compared with the period before (77.47), and the difference is also significant (t = 3.78, p-value = 0.00). Finally, looking to seigniorage revenue, we observe a sharp and significant decrease (t = 2.78; p-value = 0.00) once domestic BM are introduced (115.03% of GDP vs. 15.44%). Moreover, countries under domestic BM period experience a lower inflation rate, inflation variability and nominal exchange rate variability compared to the synthetic control group, even if the level of seigniorage revenue remains higher in post-treatment observations of domestic BM countries. Putting all these stylized facts together, it can be concluded that domestic BM introduction induced drop in

inflation rate and its variability, nominal exchange rate variability, and seigniorage revenue, and that is the root of decreased financial dollarization.

Table 10. Transmission channels

	[25] Inflation rate	[26] Inflation variability	[27] Nominal exchange rate variability	[28] Seigniorage revenue-to-GDP
Treated group				
before domestic BM	13.209	10.336	177.478	115.029
during domestic BM	6.886	2.855	11.150	15.437
Control group	7.894	3.853	85.067	2.196

Notes: This Table presents the transmission channels of the effect of domestic BM participation on financial dollarization.

VIII. Conclusion

We analyze in this paper the impact of domestic BM participation on financial dollarization, using a large sample of 114 developing countries. Econometrically, we employ the entropy balancing approach to account for differences in countries' economic, political, financial, and environmental conditions. The results contribute to the related literature in different ways.

First, we show that the presence of domestic BM significantly reduces financial dollarization. The magnitude of the estimated effect is economically meaningful. On average, domestic BM reduces dollarization by 7.1 percentage points in domestic BM countries compared with non-domestic BM countries that are as similar as possible in terms of pre-domestic BM introduction characteristics. This finding is widely robust to different specifications of the entropy balancing method, and the use of alternative econometric methods.

Second, we reveal that the impact of domestic BM on financial dollarization (i) is larger for inflation targeting countries compared with non-inflation targeting countries, (ii) is apparent exclusively in a non-pegged exchange rate regime, and (iii) is larger when there is a fiscal rule that constrains the conduct of fiscal policy.

Finally, we find that the induced drop in inflation rate and its variability, nominal exchange rate variability, and seigniorage revenue are potential transmission mechanisms through which the presence of domestic BM reduces financial dollarization in domestic BM countries.

This analysis has some policy recommendations. On the one hand, developing deeper domestic BM in developing countries is an effective means of fighting against financial dollarization. On

the other hand, the results reveal that the greater effectiveness of domestic BM in reducing dollarization arises when associated with an inflation targeting regime or a flexible exchange rate regime and in an established fiscal rule framework. Under such circumstances, domestic BM participation can reduce financial dollarization and then set the bases for the greater effectiveness of monetary and fiscal policies in developing countries.

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SUPPLEMENTARY MATERIAL

Appendix 1. List of treated countries and number of observations obtained via entropy balancing (316 country-year observations).

Armenia (12), Bangladesh (11), Botswana (13), Bulgaria (13), China (11), Colombia (14), India (10), Indonesia (17), Kazakhstan (11), Malaysia (9), Mexico (18), Morocco (10), Nigeria (10), Pakistan (19), Peru (17), Philippines (24), South Africa (14), Tanzania (16), Thailand (24), Tunisia (10), Ukraine (12), Vietnam (6), Zambia (15).

Appendix 2. List of synthetic control countries and number of observations obtained via entropy balancing (586 country-year observations).

Albania (13), Algeria (10), Azerbaijan (12), Belarus (12), Bhutan (16), Bolivia (22), Cambodia (6), Cameroon (1), Cape Verde (9), Congo, Dem. Rep. (15), Costa Rica (18), Ecuador (10), Egypt (24), El Salvador (11), Gambia, The (1), Georgia (11), Ghana (14), Guatemala (7), Guinea (14), Guinea-Bissau (7), Honduras (18), Jamaica (11), Jordan (19), Kenya (13), Kyrgyz Republic (11), Lao PDR (13), Lebanon (3), Macedonia (11), Madagascar (9), Malawi (14), Mauritius (17), Moldova (12), Mongolia (11), Mozambique (13), Nepal (7), Nicaragua (14), Papua New Guinea (15), Paraguay (13), Romania (11), Rwanda (2), Sierra Leone (6), Sri Lanka (11), Sudan (17), Syria (23), Tajikistan (10), Turkey (23), Turkmenistan (3), Uganda (16), Zimbabwe (7).

Appendix 3. Sources and Definitions of variables

Variable	Definitions	Sources
Domestic Bond Market (at least 5-year)	Dummy variable equal 1 if a country i at period t has a publicly-traded government bond market with at least 5-year maturity; 0 otherwise	Global Financial Database, Rose and Spiegel (2015), Balima et al. (2016)
Domestic Bond Market (at least 10-year)	Dummy variable equal 1 if a country i at period t has a publicly-traded government bond market with at least 10-year maturity; 0 otherwise	
Financial dollarization	Ratio of foreign currency bank deposits to total deposits	Levy Yeyati (2006), updated
Inflation targeting	Dummy variable equal to 1 if a country is under IT regime in a given year; 0 otherwise	Rose and Spiegel (2015)
Fiscal rule	Dummy variable equal to 1 if a country i at period t has a fiscal rule; 0 otherwise	IMF fiscal rules dataset
Log real GDP per capita	Gross domestic product per capita, constant 2005 US$	World Development Indicators
Log trade openness/GDP	Volume of imports and exports divided by GDP	
Agriculture added value/GDP	Net output of forestry, hunting, and fishing, as well as cultivation of crops and livestock production after adding up all outputs and subtracting intermediate inputs, over GDP	
Log total population	Facto definition of population, which counts all residents regardless of legal status or citizenship except for refugees not permanently settled in the country of asylum.	
Log private credit/GDP	Financial resources provided to the private sector by financial corporations, in percentage of GDP	
Real GDP growth	Annual growth rate of GDP	
External debt/GNI	General government external debt to GNI	
Inflation rate	Annual growth rate of average consumer price index, expressed in end of the period	World Economic Outlook Database
Polity score	Political regime characteristics in democratic and autocratic "patterns of authority". Polity ranges from -10 that correspond to extreme autocracy, to +10 for extreme democracy	Polity IV project
Fixed exchange rate	Dummy variable equal 1 if a country i at period t has a fixed exchange rate regime; 0 otherwise	Reinhart and Rogoff (2004), updated
Financial openness	Index measuring the extent of openness in capital account transactions based on the information from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions	Chinn and Ito (2013)
Globalization index	KOF index of economic, social and political globalization	Dreher (2006)

General Conclusion

Results Summary

This thesis has examined some critical issues of the access to international financial markets in developing and emerging market economies. It consists of three parts. The first part provides a general overview of the macroeconomic consequences of one of the most market-friendly monetary policy regime—inflation targeting—using a meta-regression analysis framework. The second part analyses government bond market risk and stability. The third and last part of this thesis investigates the disciplining effects of government bond market participation—*bond vigilantes*.

The meta-regression analysis of the macroeconomic consequences of inflation targeting provides several interesting new insights to the existing literature. First, it shows that the literature of the macroeconomic effects of inflation targeting adoption is subject to two types of publication bias. On the one hand, authors, editors and referees favor a particular direction of results when analyzing the relationship between inflation targeting and inflation volatility, or inflation targeting and real GDP growth; and on the other hand, they generally promote results that are statistically significant. Second, after purging these two types of publication bias, the true effect of inflation targeting appears to be statistically and economically meaningful both on the level of inflation and the volatility of economic growth, but not statistically significant on inflation volatility or real GDP growth. Third, differences in the impact of inflation targeting found in primary studies can be explained by differences in studies characteristics including the sample characteristics, the empirical identification strategies, the choice of the control variables, inflation targeting implementation parameters, as well as the study period and some parameters related to the publication process.

The analysis of the government bond market risk and stability focuses on the determinants of sovereign risk in emerging market economies (Chapters 2 and 3), and sovereign debt default (Chapter 4). Chapter 2 analyzes risk, measured through debt rating and bond yield spreads. The results show that the choice of the monetary policy regime helps make a difference in terms of sovereign debt risk. More specifically, the adoption of inflation targeting regime helps increase debt ratings by around two rating levels and reduce bond yield spreads by 2-3 percentage points. However, this relative advantage of inflation targeting—compared to money or exchange rate targeting—varies systematically depending on the business cycle, the fiscal policy stance, the level of development, and the duration of countries' experience with inflation targeting. Chapter 3 analyzes whether remittances and

official development aid, two types of wealth transfers and countercyclical capital flows, can help improved international capital market access in emerging countries. It shows that remittances inflows significantly reduced bond spreads, but fails to find a significant economic impact of development aid on spreads. Again, the chapter highlights the importance of countries structural characteristics in explaining the beneficial effect of remittances. Indeed, the effect of remittances on spreads arises in the regimes of lower developed financial system, higher degree of trade openness, lower fiscal space, and exclusively in non-remittances dependent regimes. Chapter 4 provides an analysis of the effect of sovereign credit default swaps trading initiation on the occurrence of sovereign debt crises. The results indicate that countries with credit default swaps contracts on their debt have a higher probability of experiencing a debt crisis, compared to countries without credit default swaps contracts. It also finds that this impact of credit default swaps initiation is sensitive to several structural characteristics including the level of economic development, the country creditworthiness at the timing of credit default swaps introduction, the public sector transparency, the central bank independence; and to the duration of countries' experiences with credit default swaps transactions.

The last part of this dissertation (chapters 5 and 6) focuses on the stabilizing effects of government bond markets participation—*bond vigilantes*. Chapter 5 tests the hypothesis that the access to long-maturity bond markets (in domestic or foreign currency) can encourage a borrowing government in a developing country to substitute its domestic resources by market lending. Using a variety of propensity score matching, the empirical strategy failed to validate this hypothesis. The results show that bond markets participation encourages government in developing countries to increase their domestic tax revenue mobilization. The findings also reveal that the favorable effect of bond markets participation on tax policy behavior is significant exclusively when seigniorage or public debt are relatively low, is larger in pegged compared to floating exchange rate regimes, and is larger in low-income compared to middle-income countries and in high financial openness and financial development regimes. The chapter also extends the analysis to tax revenue composition and instability and shows that bond markets participation improves the mobilization of internal taxes, compared to tax on international trade, and reduces their instability. Finally, Chapter 6 analyzes the effect of *domestic* bond markets participation on the level of financial dollarization in developing world. It shows that the presence of domestic bond markets significantly reduces financial dollarization in domestic bond markets countries. This effect is larger for inflation targeting countries compared to non-inflation targeting countries, is apparent exclusively in a non-pegged exchange rate regime, and is larger when there is a fiscal rule that constrains the

conduct of fiscal policy. Finally, it finds that the induced drop in inflation rate and its variability, nominal exchange rate variability, and seigniorage revenue are potential transmission mechanisms through which the presence of domestic bond markets reduces financial dollarization in domestic bond markets countries.

Policy Implications

The different chapters examined in this dissertation have some policy implications. Chapter 1 provides, on the one hand, useful guidance on the practical implementation of inflation targeting at its effect depends on country-specific factors or inflation targeting implementation forms. On the other hand, the fact that differences across studies regarding the impact of inflation targeting are systematically affected by sample and empirical choice characteristics, and time coverage of the used sample suggests that researchers should report robustness checks with respect of these aspects before drawing any policy recommendations. Chapter 2 reveals that adopting an inflation targeting monetary framework yields positive benefits in terms of both higher ratings and lower spreads in emerging countries. It also reveals insightful evidence on the practical implementation of inflation targeting in these countries: the highest reduction of sovereign debt risk arises when combined with good fiscal stance and in relatively more developed emerging countries, provided that a full-fledged inflation targeting monetary regime is achieved. Under such conditions, inflation targeting adoption can improve emerging market economies' access to international financial markets, and provide an appropriate monetary strategy to finance long-term investment projects and support potential economic growth.

Chapter 3 shows that emerging countries can leverage remittances for international capital market access, calling for policy actions to improve measurement of remittances inflows and to reduce their transfer costs. It also calls for adequate policies and strategies for enabling the development of remittances' securitization and diaspora bonds.

Chapter 4 contributes to the policy design and the implementation of credit default swaps trading initiation. It provides some first insights for limiting the effects of sovereign credit default swaps trading on sovereign debt crises, as this detrimental effect is found to be weaker in developed countries, in countries with high public sector transparency, and in countries with high Central Bank independence, and even statistically not significant in countries with investment grades at the moment of their credit default swaps trading initiation.

Chapter 5 and 6 provides straightforward and valuable policy recommendations on bond markets participation in developing countries. Chapter 5 shows that the highest effect of bond markets participation in terms of tax revenue mobilization arises when combined with sound monetary or fiscal policy frameworks, and in relatively more open and financially developed contexts. Under such circumstances, bond markets participation can improve tax revenue mobilization in developing countries, and thus provide an adequate framework for the funding of growth-enhancing long-term infrastructures. Chapter 6 points out that developing deeper domestic bond markets in developing countries is an effective means of fighting against financial dollarization. In addition, it reveals that the greater effectiveness of domestic bond markets in reducing dollarization arises when associated with an inflation targeting regime or a flexible exchange rate regime and in an established fiscal rule framework. Under such circumstances, domestic bond markets participation can reduce financial dollarization and then set the bases for the greater effectiveness of monetary and fiscal policies in developing countries.

The thesis provides opportunities for interesting research in various ways. For instance, the meta-analyze on the inflation targeting debate constitutes a useful starting point for the future agenda on rethinking inflation targeting [see for instance Mishkin (2017) for a beginning discussion]. Empirical analyses on the role of remittances securitization and diaspora bonds in the risk management for sovereign entities could also give a wider breath to the results developed in chapter 3. Finally, deep analyses on the determinants of domestic bond market capitalization could provide useful guidance for implementing liquid domestic bond markets in developing countries.

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Summary of the thesis

This thesis focuses on some critical issues of the access to international financial markets in developing and emerging market economies. The first part provides a general overview of the macroeconomic consequences of one of the most market-friendly monetary policy regime—inflation targeting—using a meta-regression analysis framework. The second part analyses government bond market risk and stability. The third and last part of this thesis investigates the disciplining effects of government bond market participation—*bond vigilantes*. Several results emerged. In **Chapter 1**, the results indicate that the literature of the macroeconomic effects of inflation targeting adoption is subject to publication bias. After purging the publication bias, the true effect of inflation targeting appears to be statistically and economically meaningful both on the level of inflation and the volatility of economic growth, but not statistically significant on inflation volatility or real GDP growth. Third, differences in the impact of inflation targeting found in primary studies can be explained by differences in studies characteristics including the sample characteristics, the empirical identification strategies, the choice of the control variables, inflation targeting implementation parameters, as well as the study period and some parameters related to the publication process. **Chapter 2** shows that the adoption of inflation targeting regime reduces sovereign debt risk in emerging countries. However, this relative advantage of inflation targeting—compared to money or exchange rate targeting—varies systematically depending on the business cycle, the fiscal policy stance, the level of development, and the duration of countries' experience with inflation targeting. **Chapter 3** shows that remittances inflows significantly reduce bond spreads, whereas development aid does not. It also highlights that the effect of remittances on spreads arises in a regimes of lower developed financial system, higher degree of trade openness, lower fiscal space, and exclusively in non-remittances dependent regimes. **Chapter 4** indicates that countries with credit default swaps contracts on their debts have a higher probability of experiencing a debt crisis, compared to countries without credit default swaps contracts. It also finds that the impact of credit default swaps initiation is sensitive to several structural characteristics including the level of economic development, the country creditworthiness at the timing of credit default swaps introduction, the public sector transparency, the central bank independence; and to the duration of countries' experiences with credit default swaps transactions. **Chapter 5** shows that bond markets participation encourages government in developing countries to increase their domestic tax revenue mobilization. It also reveals that the favorable effect of bond markets participation on tax policy behavior is significant exclusively when seigniorage or public debt are relatively low, is larger in pegged compared to floating exchange rate regimes, and is larger in low-income compared to middle-income countries and in high financial openness and financial development regimes. Finally, it finds that bond markets participation improves the mobilization of internal taxes, compared to tax on international trade, and reduces their instability. **Chapter 6** shows that the presence of domestic bond markets significantly reduces financial dollarization in domestic bond markets countries. This effect is larger for inflation targeting countries compared to non-inflation targeting countries, is apparent exclusively in a non-pegged exchange rate regime, and is larger when there is a fiscal rule that constrains the conduct of fiscal policy. Finally, it finds that the induced drop in inflation rate and its variability, nominal exchange rate variability, and seigniorage revenue are potential transmission mechanisms through which the presence of domestic bond markets reduces financial dollarization in domestic bond markets countries.

Résumé de la thèse

Cette thèse s'intéresse aux questions d'accès aux marchés financiers dans les économies émergentes et en développement. La première partie donne un aperçu général des conséquences macroéconomiques de l'un des régimes de politique monétaire le plus favorable au marché - le ciblage d'inflation - en utilisant le cadre d'analyse de la méta-analyse. La deuxième partie analyse le risque et la stabilité des marchés obligataires des États. La troisième et dernière partie examine les effets disciplinaires résultant de la participation aux marchés obligataires souverains. Plusieurs résultats émergent. Au **chapitre 1**, les résultats indiquent que la littérature sur les effets macroéconomiques du ciblage d'inflation est sujette à des biais de publication. Après avoir purgé ces biais, le véritable effet du ciblage d'inflation reste statistiquement et économiquement significatif à la fois sur le niveau de l'inflation et la volatilité de la croissance économique, mais ne l'est pas sur la volatilité de l'inflation ou le taux de croissance économique réel. Aussi, les caractéristiques des études déterminent l'hétérogénéité des résultats de l'impact du ciblage d'inflation dans les études primaires. Le **chapitre 2** montre que l'adoption d'un régime de ciblage d'inflation réduit le risque souverain dans les pays émergents. Cependant, cet effet varie systématiquement en fonction du cycle économique, de la politique budgétaire suivie, du niveau de développement et de la durée dans le ciblage. Le **chapitre 3** montre que les envois de fonds des migrants, contrairement aux flux d'aide au développement, permettent de réduire le risque souverain. Cette réduction est plus marquée dans un pays avec un système financier moins développé, un degré d'ouverture commerciale élevé, un espace budgétaire faible et sans effet dans les pays dépendants des envois de fonds. Le **chapitre 4** montre que les pays ayant des contrats d'échange sur risque de crédit sur leurs dettes sont plus sujets à des crises de dette. Il constate également que cet effet reste sensible aux caractéristiques structurelles des pays. Le **chapitre 5** montre que la participation aux marchés obligataires de long terme (domestiques et internationaux) encourage les gouvernements des pays en développement à accroître leurs recettes fiscales intérieures. Il révèle également que l'effet favorable dépend du niveau des recettes de seigneuriage, d'endettement, du régime de change, du niveau de développement économique, du degré d'ouverture financière, et du développement financier. Le **chapitre 6** montre que la présence de marchés obligataires domestiques, de long terme et liquides réduit considérablement le degré de dollarisation financière dans les pays en développement. Cet effet est plus important dans les pays avec un régime monétaire de ciblage d'inflation ou de change flottant, et à règles budgétaires. Enfin, il constate que la présence de marchés obligataires domestiques réduit la dollarisation financière à travers la baisse du niveau et de la variabilité de l'inflation, de la variabilité du taux de change nominal, et des revenus de seigneuriage.