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Does inflation targeting improve fiscal discipline?

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A B S T R A C T

We explore the performances of inflation targeting (IT) adoption in terms of fiscal discipline (FD), while most existing studies focus exclusively on the role of FD as a precondition for IT adoption. Using a sample of developing and developed countries, we show that IT adoption exerts a positive and significant effect on FD, a result robust to a wide variety of alternative specifications. In addition, this effect is statistically significant only in developing countries, a result that may fuel the current debate regarding the relevance of IT adoption in general, and particularly for developing countries.

1. Introduction

Two decades ago, the Reserve Bank of New Zealand adopted a new framework for the conduct of its monetary policy, namely inflation targeting (IT). IT is mainly characterized by 5 criteria, namely (i) public announcement of a medium-term inflation target, (ii) institutional commitment to price stability as the primary goal of monetary policy, (iii) forward-looking strategy for inflation forecasts, (iv) enhanced transparency, and (v) greater accountability of central bank in achieving its inflation target (for an extensive discussion, see, e.g., Svensson, 1997; Mishkin, 2000; or Truman, 2003). Since its first adoption, the popularity of IT has grown considerably, to the point where 30 central banks use it currently as their operational framework for conducting monetary policy, and many others, especially

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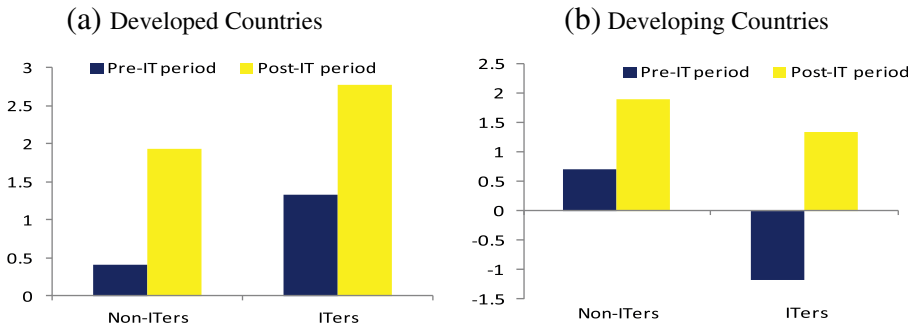

Fig. 1. The evolution of the average primary fiscal balance in IT and non-IT countries.

developing countries, are planning to move towards it.[1] This increased popularity of IT stems mainly from its alleged macroeconomic benefits. For example, IT adoption was found to bring down inflation levels and its volatility (Vega and Winkelried, 2005; Mishkin and Schmidt-Hebbel, 2007; Lin and Ye, 2009), output volatility (Levin et al., 2004; Petursson, 2005; Gonçalves and Salles, 2008), or interest and exchange rates volatility (Batini and Laxton, 2007; Rose, 2007; or Lin, 2010).[2]

The present paper extends this literature by focusing on the linkage between IT and fiscal policy. In addition to the traditional view defending an exclusive role for monetary policy regarding inflation dynamics, an influential strand of literature, inspired by the seminal contribution of Sargent and Wallace (1981), points out that fiscal policy can equally be a source of inflation. Indeed, in a context of "fiscal dominance",[3] a loose fiscal policy can drive inflation because the central bank must ultimately monetize the public debt, consistently with the unpleasant monetarist arithmetic (Sargent and Wallace, 1981). An alternative rationale, which is the heart of the Fiscal Theory of the Price Level (see, e.g., Leeper, 1991; Sims, 1994; Woodford, 1995; Cochrane, 1999; Gordon and Leeper, 2005; or Sims, 2011) or more broadly of the literature on the price level determinacy (see, e.g., Aiyagari and Gertler, 1985; Sims, 1988; or Woodford, 1994), is that under fiscal dominance, newly issued nominal government bonds will cause the price level to rise to meet the government's intertemporal budget constraint.[4]

These findings, emphasizing the limits of inflation targeting in the presence of fiscal dominance and/or loose fiscal policies, led to the widespread recognition that a sound fiscal stance is, in addition to the monetary preconditions,[5] a key prerequisite for a credible implementation of inflation targeting (see, e.g., Masson et al., 1997; Mishkin, 2000; Sims, 2005; or Bernanke and Woodford, 2005).

However, contrary to a potential role of fiscal discipline (FD) as a prerequisite for IT implementation, little is said about the eventual effect of IT adoption on FD. Fig. 1 illustrates the change in the average

[1] According to Batini et al. (2006), more than 35 developing countries explore the possibility of adopting an inflation targeting monetary regime.

[2] Note however that some studies challenged these macroeconomic benefits of IT (see, e.g., Ball and Sheridan, 2005; Ball, 2010; or Brito and Bystedt, 2010).

[3] A regime wherein the government sets fiscal balances in a way that does not allow meeting its intertemporal budget constraint.

[4] The impact of these strands of literature is considerable, as recently emphasized by Sims (2011, page 55): "There is no excuse for econometric models intended for monetary policy analysis to continue to omit serious treatment of fiscal behavior. It is clear from the theoretical analysis that fiscal policy can be a primary transmission mechanism or a primary source for changes in the inflation rate". Leeper (2009, page 21) adds that "…in the realm of inflation control,…, it is generally true that it is the *joint* behavior of monetary and fiscal policy that matters, even in normal times".

[5] Such preconditions are discussed by, e.g., Amato and Gerlach (2002), Mishkin (2004), or Batini and Laxton (2007), and include a sufficient degree of central bank operational independence, a sound financial system, resilience to changes in exchange and interest rates, absence of dollarization, absence of price regulation, and a developed technical infrastructure for forecasting the inflation process and the transmission mechanism.

primary fiscal balance, for countries having adopted IT (ITers) relative to non-ITers.[6] If the evidence is less clear for developed countries, wherein the primary balance changed somewhat similarly between the pre-IT and the post-IT period for both ITers and non-ITers, in the group of developing countries the improvement in the primary balance between the pre-IT and the post-IT period was as high as twice for ITers compared to non-ITers.

Building on these simple descriptive statistics, which tend to indicate that the adoption of inflation targeting matters for fiscal performances, chiefly in developing countries, the aim of the present paper is to investigate such a possible reversed effect, i.e. could IT adoption improve the fiscal stance? Three main sets of arguments may support such a potential favorable effect of inflation targeting adoption on the fiscal discipline.

First, as pointed out by Sargent and Wallace (1981), a government that runs persistent deficits must sooner or later finance them by seigniorage, which is likely to be inflationary and hence endangers strongly the viability of an inflation targeting regime. Accordingly, IT adoption may encourage fiscal authorities to improve FD, to back up the credibility of the central bank's commitment to the inflation target. This point is documented by Bernanke and Woodford (2005), Sims (2005), and more recently by Sims (2011) in his analysis on the causes of inflation in the 1970s. They conclude that the absence of supportive fiscal policy will result in losing the control of inflation by the monetary authorities under an IT framework.[7] The idea is that following an inflationary shock, an increase in the nominal interest rate will tend to increase the probability of debt default, should the government have a high initial debt and predominantly denominated in foreign currency. This will render the government's debt less attractive, thus leading to exchange rate depreciation, and, in turn, to higher inflation. As a result, a rise in the nominal interest rate will increase inflation, rather than decrease it. Several studies, including Blanchard (2005) and Favero and Giavazzi (2004) find evidence supporting such a fiscal view of inflation in the case of Brazil. More broadly, Catao and Terrones (2005) and Lin and Chu (2013) confirm the fiscal view of inflation by showing that deficits and inflation are positively correlated in most countries. Since IT may thus fail to credibly anchor inflation expectations in the presence of bad fiscal stance, IT adoption should induce fiscal authorities to run sounder fiscal policies, including through a strengthening of public financial management, to send strong signals on the support of fiscal policy to the central bank in hitting its inflation target.[8]

Second, as pointed out by Amato and Gerlach (2002) and Batini and Laxton (2007), most IT countries, and especially developing countries, did not satisfy the prerequisites for a credible IT adoption, including in terms of FD. Accordingly, to convince the private agents and the financial markets that such a bad fiscal stance prior to inflation targeting adoption will not be an impediment toward hitting the inflation target, a discipline-enhancing effect on the conduct of fiscal policy may have followed IT adoption in these countries. Indeed, even though inflation targeting is not primarily devoted to fiscal goals, the fear of missing the inflation target may however be sufficiently binding for monetary as well as fiscal authorities, so that it will have a side effect on fiscal discipline.[9] On this point, Roger (2009) and Freedman and Ötker-Robe (2010) stressed out that IT adoption may catalyze the

[6] Regarding non-ITers, we follow Mishkin and Schmidt-Hebbel (2007), and define the cut-off date as the mid-year of the period running from the first adoption of full-fledged IT (1990 in New Zealand for developed countries, and 1997 in Israel for developing countries) to the sample end-year (2007). It results that 1999 and 2002 are the dates separating the pre-IT and post-IT periods for non-ITers in the group of developed countries and developing countries respectively. For ITers, their full-fledged IT starting dates are considered as cut-off dates.

[7] Such supporting fiscal schemes include adopting fiscal policy rules or principles that do not conflict with monetary policy rules or objectives (see Leeper, 2009).

[8] In addition, in light of Tinbergen's rule and given the overriding goal of price stability assigned to monetary policy under IT, nominal interest rates can no longer be used to achieve both price stability and fiscal solvency. Consequently, inflation targeting adoption is likely to leave the government with the improvement of fiscal discipline as the main instrument to meet its intertemporal budget constraint, including through a strengthening of the tax collection system and a better rationalization of public spending.

[9] For example, IT may act as a "tying your own hands" mechanism and rule out the so-called "deficit bias" (see Buchanan and Richard, 1977; Kydland and Prescott, 1977; or Cukierman and Meltzer, 1986), by preventing fiscal authorities from manipulating fiscal policy for electoral purposes.

implementation of FD for preserving the viability of the inflation targeting regime itself. For example, according to Mishkin (2000), IT may constrain fiscal policy if the government plays a role in defining the inflation target.[10] This joint commitment of the central bank and the government in achieving inflation targeting may arise through adopting legislation measures prohibiting the monetization of public debt (see, for example, Brazil, Israel or UK) or through the joint definition by the central bank and the government of the inflation target (such as in Australia, Indonesia or South Africa), in order to send a clear signal about their joint willingness to meet the inflation target (see Freedman and Ötker-Robe, 2010).[11]

Finally, IT adoption may have a positive side effect on fiscal performances through the lower inflation associated with its implementation (see, e.g., Vega and Winkelried, 2005; Petursson, 2005; Batini and Laxton, 2007; Mishkin and Schmidt-Hebbel, 2007; Gonçalves and Salles, 2008; or Lin and Ye, 2009). Indeed, low inflation rates mitigate the negative Oliveira-Keynes-Tanzi effect, as the erosion in the real value of taxes between the date of imposition and the date of collection will decrease (see Tanzi, 1992). Moreover, the decrease in inflation volatility engendered by IT adoption (see, e.g., Mishkin and Schmidt-Hebbel, 2007; Gonçalves and Salles, 2008; or Lin and Ye, 2009) should help stabilizing and making more predictable the tax base. As a result, a better tax collection may be associated with IT adoption, which, if combined with a good public financial management should lead to better fiscal performances. Altogether, these arguments could support a possible increase in FD following IT adoption.

To explore the possible existence of an effect from IT adoption to FD, we follow the recent contributions of Vega and Winkelried (2005), Lin and Ye (2007, 2009), Lin (2010), Flood and Rose (2010) or Frappa and Mésonnier (2010), and draw upon a variety of propensity scores-matching methods (PSM). The PSM allows addressing the issue of *self-selection* in policy adoption by pairing ITers with comparable non-ITers in terms of observable characteristics (including in terms of past FD) that influence both inflation targeting adoption and fiscal discipline. IT adoption is therefore likened to a randomized experiment, so that any difference in current FD between the matched ITers and non-ITers is attributable to the switching to IT. In addition, employing the PSM allows comparing our findings with previous evidence on the macroeconomics effects of IT.[12] Evidence based on a sample of both developing and developed countries shows that IT adoption exerts a positive and significant effect on FD. Besides, our result is found to be extremely robust when considering (i) different measures of FD, (ii) alternative specifications for computing propensity scores, or (iii) alternative IT adoption dates (conservative or default).

Moreover, we extend our analysis by studying the relation between inflation targeting and fiscal discipline on the group of developed and developing countries, respectively. Unlike Abo-Zaid and Tuzemen (2012), we find that IT adoption does not seem to exert a robust effect on FD in developed countries, but worked as a good device for improving significantly fiscal discipline in developing countries. A possible explanation is that developed countries were judged by financial markets as presenting a sustainable fiscal stance when they adopted IT, so their efforts to increase FD following IT adoption are not significant, while developing countries adopted IT despite the presence of potential risks on their fiscal stance, but were forced to improve their FD following IT adoption to maintain the durability of the IT regime.

Section two presents the dataset and discusses the methodology, section three shows the matching results, and then illustrates the influence of IT adoption on FD for the full sample and for developed and developing countries respectively, and section four concludes.

[10] Even if the monetary and fiscal tasks are assigned to two different institutions, fiscal policies should play an appropriate supporting role for monetary policy, since newly issued government debt is inflationary (Leeper, 2009; or Sims, 2011).

[11] Mishkin (2000) and Leeper (2009) provide extensive evidence on three countries in which IT adoption was followed by the implementation of sound fiscal reforms, namely Chile, New Zealand and Sweden.

[12] We did not resort to the methodology used by Abo-Zaid and Tuzemen (2012), namely the Difference-in-Difference (DID), since performing DID estimations in the presence of serial dependence in both the dependent variable (FD in our case, which is persistent) and in the treatment variable (no country abandoned IT yet due to economic duress pattern, for example) leads to misleading standard errors and are therefore inappropriate (Bertrand et al., 2004).

2. Dataset and methodology

2.1. Dataset

Our dataset consists of 84 countries, of which 62 developing and 22 developed countries, examined over the 1985–2007 period. Among the 84 countries, 30 countries (called ITers or *treatment* group) adopted IT by the end of 2007. Given that our sample ends up in 2007, we still treat the new ITers as non-ITers,[13] which leaves us with 23 ITers (see Appendices 1 and 2 for the list of countries). In addition, to ensure that non-ITers (called *control* group) are a good counterfactual of the *treatment* group, i.e. that the two groups are reasonably comparable, we follow Lin and Ye (2009) and include in the control group only non-ITers that have a real per capita GDP at least as large as that of the poorest ITer, and with a population size at least as large as that of the smallest ITer.[14]

Data on starting dates of IT come from Rose (2007), who distinguishes two starting dates, namely *default* and *conservative*. The difference between the two dates captures the fact that some central banks first adopted "soft or informal" IT (Vega and Winkelried, 2005), in which the central bank's reaction, following a deviation of inflation from its targeted level, is slower compared to its reaction under an explicit "full-fledged or formal" IT. Consequently, default (or soft IT) starting dates are those declared by central banks themselves, while conservative (or full-fledged IT) starting dates are those considered by academia as the genuine dates from which the central bank began meeting the required criteria to be classified as an ITer (see Appendix 1). For robustness issues, we perform our analysis on both dates.

Let us discuss our outcome variable, namely FD. Even though there is no accurate definition of the concept of FD, a simple rule of thumb in public finance is that a government can be viewed as fiscally disciplined if its fiscal policy and its public debt are sustainable (see Bartolini and Cottarelli, 1994; IMF, 2011).[15] When it comes to performing econometric analysis with FD, Blanchard et al. (1990) suggest measuring it with indicators derived from the accounting relationships between public debt and fiscal balances, namely the *annual change in the fiscal balance* (overall balance and/or primary balance) and the *annual change in the debt-to-GDP ratio*.

Nevertheless, the relevance of these indicators as actual measures of FD is subject to debate. As acknowledged in the literature (see, e.g., Gali and Perotti, 2003; Fatás and Mihov, 2003; or Debrun et al., 2007), fiscal balances are the result of fiscal policymakers' decisions (structural component) and of business cycle fluctuations (cyclical component). Since the latter is not directly controlled by the government (at least in the short term), we filter out its impact on the primary and/or overall fiscal balance to better capture fiscal behavior. Accordingly, we measure FD by the Cyclically-Adjusted Primary Fiscal Balance (CAPB), computed as the difference between General Government revenue and non-interest expenditure, adjusted for the effect of business cycle fluctuations, as percentage of GDP. We measure this way discretionary fiscal behavior, i.e. fiscal policy changes really attributable to current fiscal policymakers, in that it not only excludes the effects of past fiscal policy decisions (interest payments), but also filters out the impact of automatic stabilizers on the primary balance. We followed a *residual-based* approach, close to Fatás and Mihov (2003), which consists of capturing the

[13] New ITers are countries having adopted IT after 2005, namely Indonesia (2005), Slovak Republic (2005), Guatemala (2005), Turkey (2006) and Ghana (2007). In addition, due to lack of data on FD, Romania and Serbia, which adopted IT in 2005 and 2006 respectively, do not appear in our sample. Finally, Finland and Spain, which adopted IT respectively in 1993 and 1995, abandoned it in 1999 to join the Euro area. Thus, we treat them as ITers between 1993–98 and 1995–98 respectively, and as non-ITers after 1999.

[14] The poorest ITer in our sample is Philippines with a real per capita GDP of 3994 USD in 2004 (the year just before the starting date of the new ITers), while the smallest ITer in terms of population size is Iceland, with around 0.3 million inhabitants in 2004.

[15] Note that from an operational viewpoint, FD can be defined and measured in terms of meeting numerical thresholds on key fiscal aggregates, namely the *fiscal balance* and the *debt-to-GDP ratio* (Tornell and Velasco, 2000). Such measures of FD appear in some monetary unions, including the EMU or the WAEMU. In the former case, FD is regarded as the ability of a government to maintain a fiscal balance (as percentage of GDP) and a debt-to-GDP ratio lower than 3% and 60% respectively, while in the latter these thresholds are set to 0% (for the basic fiscal balance) and 70% respectively.

CAPB through the estimated residuals ($\widehat{\varepsilon}^i$) of the following country-specific fiscal policy reaction function (with i the country and t the time period)[16]

$$PB_t^i = \alpha + \beta\, PB_{t-1}^i + \gamma\, OG_t^i + \delta\, W_t^i + \varepsilon_t^i, \quad (1)$$

where PB denotes the primary fiscal balance in % of GDP, OG the output gap and W a vector of control variables, including inflation and a time trend. The output gap is computed as $OG_t = (y_t - \overline{y})/\overline{y}$, where y_t stands for real per capita GDP in the year t, and $\overline{y}$ for the Hodrick-Prescott filtered trend of y_t.[17] Coefficient γ measures the cyclical response of fiscal policy to business cycle fluctuations, and the error term ε_t measures the unsystematic component of fiscal policy. The predicted value of the latter captures the discretionary component of fiscal policy, i.e. the part of the primary fiscal balance unexplained by economic conditions, and is our main measure of FD (CAPB). In addition, we address potential endogeneity of output gap in (1) using the two-stage least squares (2SLS) estimator, in which we instrumented OG by its lagged value and the growth rate of the terms of trade.[18]

Finally, for the sake of robustness check, we equally employ the Cyclically-Adjusted overall Fiscal Balance (CAB), the relative change in the debt-to-GDP ratio, and the overall fiscal balance (OFB), all in % of GDP, as alternative measures of FD. Regarding OFB, in addition to the robustness check, its use allows comparing our results to existing studies, including Lin (2010) and de Mendonca & de Guimaraes e Souza (2012). Appendices 3 and 4 present the definitions, sources and descriptive statistics of all variables used in our analysis.

2.2. Methodology

To make our results comparable with the existing literature on the performances of IT, we draw on the method used by Lin and Ye (2007). While the reader can consult Lin and Ye (2007) or our Appendix 5 for a detailed presentation, we remind here its main principles. The bottom line is to consider IT adoption as a *treatment* and then isolate the effect of IT on the outcome variable (FD), namely the so-called average *treatment* effect on the *treated* countries (ATT). To this end, a key issue is to find the best counterfactual or *control group* to the *treatment group* (countries having adopted IT, or ITers) and assess the ATT as the difference of the average values of FD between the *treatment* group and the *control* group. In this regard, the average value of FD that a targeting country would have should it had not adopted IT is undoubtedly the best counterfactual. Unfortunately, such a counterfactual is not observable, which refers to the well-know identification problem.

The main advantage of the propensity score matching (PSM) method employed in this study is therefore to retain in the *control* group countries that are similar to ITers in terms of observable characteristics (including in terms of past FD) that influence IT adoption as well as FD. These observable characteristics are synthesized into the propensity scores (i.e. the estimated probability for a country to switch into IT conditional on the aforementioned observable characteristics), which are ultimately used for carrying out the *matching* (Rosenbaum and Rubin, 1983). As a result, IT is likened to a

[16] Some international organizations (OECD, IMF or the European Commission, see Girouard and André, 2005) compute the CAPB using a three-step procedure. First, they calculate a measure of potential GDP. Second, to estimate the fiscal balance that is due to business cycle fluctuations, they apply the elasticity of government revenue and expenditure to the deviation between effective GDP and potential GDP. Finally, they deduct the CAPB by subtracting the fiscal balance estimated in the second step, from the primary fiscal balance actually observed. Although very attractive, this methodology is very intensive in detailed data, namely in the estimation of revenue and expenditure elasticities. Since such detailed information lacks in developing countries, we focus on a "residual-based" approach adapted from Fatás and Mihov (2003).

[17] When applying the HP filter, despite a certain consensus for the use of a smoothing parameter of for quarterly data (see Hodrick and Prescott, 1997; for a discussion), the related literature emphasized different values for λ for annual data. According to Ravn and Uhlig (2002), if we consider that quarterly data are of frequency 1, then annual data are of frequency 1/4, and the smoothing parameter for $\lambda = 1600$ annual data can be computed as $\lambda = (1/4)^n * 1600$, with n an integer. In our computations we follow Ravn and Uhlig (2002), who recommend $n = 4$, leading to a smoothing parameter of $\lambda = 6.25$ for annual data (results for $\lambda = 100$, corresponding to $n = 2$ as suggested by Backus and Kehoe, 1992; are not qualitatively different and are available upon request).

[18] Strength and over-identification diagnosis tests show that in more than 70% of cases (recall that estimations are run on a country-by-country base) the instruments are valid. These results are available upon request.

randomized experiment, in that, within the retained sample, countries' decision to shift into IT is random. In other terms, the *self-selection* problem which occurs when assignment into the *treatment* (IT adoption) is not random is ruled out (see Dehejia and Wahba, 2002; or Heckman et al., 1998). Accordingly, the difference between the average FD in the *treatment* group and the average FD in the *control* group is attributable to the *treatment* (IT adoption), and as such is the ATT of IT on FD.

Following Lin and Ye (2007), we consider four commonly used propensity score-matching methods. First, the *nearest-neighbor* matching with replacement, which matches each treated unit to the n control units having the closest propensity scores (we consider $n = 1$, $n = 2$ and $n = 3$). Second we draw on *radius* matching, which matches a treated unit to the control units with estimated propensity scores falling within a radius (or caliper) of length r (we consider a large radius $r = 0.10$, a medium radius $r = 0.05$, and a small radius $r = 0.01$).[19] The third method is the *regression-adjusted local linear matching* developed by Heckman et al. (1998), which consists of matching covariates-adjusted outcomes for the *treatment* group (ITers) with the corresponding covariates-adjusted outcomes for the *control* group (non-ITers), using local linear regression weights; put differently, it is a combination of the local linear matching on the propensity score with regression adjustment on covariates. Finally, we employ (Epanechnikov) *kernel* matching, which matches a treated unit (an ITer) to all control units (non-ITers) weighted proportionately by their closeness (in terms of propensity scores) to the treated unit. Since the matching estimator has no analytical variance, we follow Dehejia and Wahba (2002) and compute standard errors by bootstrapping (i.e. by re-sampling the observations of the control group).

3. The influence of IT adoption on fiscal discipline (FD)

3.1. The estimation of propensity scores

We estimate the propensity scores using a *probit* model,[20] in which the dependent variable is a binary variable, taking the value 1 if in a given year a country operates under an IT framework and zero if not. We consider two sets of explanatory variables, namely one to account for the fact that a country should reasonably adopt IT after having met some preconditions, and the other to account for the likelihood for a country to adopt an alternative framework for monetary policy (for example, exchange rate or money growth targeting).

The precondition variables include lagged inflation rate, broad money growth and central bank governors' turnover rates (reverse proxy for independence of the central bank), lagged debt-to-GDP ratio, GDP growth rate, a fiscal rule dummy and CAPB (or alternatively CAB, the change in the debt-to-GDP ratio, or the OFB). We expect a negative correlation between the probability of IT adoption and the first four variables and a positive correlation with the last two variables (except for the coefficient of the change in the debt-to-GDP ratio which is expected to be negative). Concerning the second set of controls, we consider a fixed exchange rate regime dummy and trade openness. We expect a negative correlation between the probability of IT adoption and these two variables.[21]

Before going any further, let us point out that past FD is included in the *probit* model in order to control for the fact that even though IT can improve FD (as we intend to show in this paper), past fiscal stance could also be a determinant of IT adoption. Indeed, on the one hand, larger past fiscal balances (CAPB, CAB or OFB), or a past reduction in the debt-to-GDP ratio, may influence positively the probability of IT adoption in that they would have helped paving the way for a credible IT adoption. On the other hand, past fiscal performances can also affect current fiscal outcomes. First, poor past FD may be associated with high interests on the issued debt, which worsens current FD. Second, poor past FD can stimulate the government to proceed to adjustments for ensuring solvency, which improves current

[19] As in Lin (2010), the medium radius is set equal to the standard deviation of the estimated propensity scores, while the large and the small radius are set equal to the double and the half of the medium radius respectively.

[20] In an Appendix available on request, we show that all the estimations presented in the paper are unaffected by the use of a *logit* model, confirming that the assumption about normality of the *probit* is fulfilled.

[21] Recall that, when estimating PS, the goal is not to find the best statistical model to explain the probability of IT adoption; according to the conditional independence assumption, omitting in the *probit* regression variables that systematically affect the IT probability, but do not affect FD, has little influence on results (Persson, 2001).

Table 1
Probit estimates of the Propensity Scores (Full Sample).

Dependent variable: inflation targeting (*Conservative* starting dates)				
	[1]	[2]	[3]	[4]
Inflation (lagged one year)	−0.072*** (0.015)	−0.072*** (0.015)	−0.074*** (0.016)	−0.082*** (0.008)
Broad money growth	−0.005 (0.005)	−0.005 (0.005)	−0.008 (0.005)	−0.008** (0.004)
GDP growth rate	−0.005 (0.022)	−0.007 (0.021)	−0.015 (0.019)	0.022 (0.013)
Fixed exchange rate	−1.252*** (0.162)	−1.240*** (0.161)	−1.233*** (0.157)	−1.370*** (0.112)
Trade openness	−0.003** (0.001)	−0.003** (0.001)	−0.002 (0.001)	−0.004*** (0.001)
Governors' turnover rate	−1.083** (0.429)	−1.076** (0.429)	−1.179*** (0.425)	
Fiscal rule dummy	0.561*** (0.181)	0.641*** (0.174)	0.659*** (0.163)	
Debt/GDP (lagged one year)	−0.007** (0.003)	−0.007*** (0.003)	−0.007*** (0.003)	
CAPB (lagged one year)	0.023 (0.024)			
CAB (lagged one year)		0.007 (0.024)		
Debt change (lagged one year)			−0.566 (0.514)	
OFB (lagged one year)				0.014* (0.008)
Number of observations	766	810	917	1174
Pseudo R^2	0.356	0.366	0.369	0.301

Robust standard errors in brackets. *, **, and *** indicate the significance level of 10%, 5%, and 1%. Unreported constant included. CAPB and CAB refer to the Cyclically-Adjusted Primary, and respectively overall, fiscal Balance, and OFB stands for Overall Fiscal Balance, all as GDP percentage.

FD. Consequently, past fiscal aggregates, as measured by lagged CAPB, lagged CAB, lagged change in the debt-to-GDP ratio or lagged OFB, may affect IT adoption as well as current FD, and their inclusion in the *probit* model allows ruling out polluting effects on the estimated ATT that would arise from a likely two-way relationship between IT and FD.

Table 1 reports the *probit* estimates of propensity scores on the full sample, which includes both developing and developed countries, based on *conservative* starting dates of IT.[22] As expected, better monetary conditions (namely, lower inflation) increase the IT adoption probability. The same also holds when the central bank is more independent, or in the presence of good fiscal and macroeconomic performances, while differences in the GDP growth rate do not explain why some countries adopted IT and others did not. Moreover, countries under a fixed exchange rate regime are found not to be interested in IT, confirming the conclusions of Amato and Gerlach (2002) regarding the incompatibility of IT with a rigid exchange rate regime. Finally, the stronger the (trade) openness, the lower the probability for a country to adopt an IT monetary system, since a more open economy would favor a fixed exchange rate to foster trade integration (see, for example, Frankel and Rose, 2002).[23]

Let us now take a closer look at the extent to which past fiscal performances may impact the targeting probability. For robustness issues, we assume in each column alternative measures of FD, namely lagged CAPB (column [1]), lagged CAB (column [2]), lagged change in the debt-to-GDP ratio (column [3]), and lagged OFB (column [4]). Despite having the expected sign, the coefficients of FD variables are not statistically significant in columns [1]–[3]. However, this may be explained by the fact that the effect of FD is captured through the fiscal rule dummy and/or the lagged debt to GDP ratio (which are significantly positive and negative, respectively), since a credible adoption of IT may require the implementation of strong fiscal reforms, including binding rules-based fiscal frameworks (Roger, 2009; or Freedman and Ötker-Robe, 2010). Indeed, when we drop the fiscal rule dummy and the debt to GDP ratio, the FD measure in column [4], namely the OFB, positively and significantly increases the probability of IT adoption, suggesting that, on the average and in line with Lin (2010) and de Mendonca & de Guimaraes e Souza (2012), FD mattered for the decision of switching to IT for the countries in our sample.[24]

[22] See Appendix A for results based on default starting dates for IT adoption. Appendices A to F are available on-line.
[23] In addition, the price level is highly subjected to movements in external prices in economies with a high openness degree, making the control of the price level by the central bank more difficult, and the adoption of an IT regime less appropriate.
[24] Nevertheless, the effect of FD variables on IT adoption is quite different for developed compared to developing countries, as emphasized in subsection 3.3.

3.2. The results from matching

Results depicted on line [1] in Table 2 show that IT adoption worked as a good device for improving fiscal discipline, as measured by the CAPB. Indeed, whatever the matching estimator, the ATT is positive, and this positive effect is found to be statistically significant in 7 out of the first 8 cases presented.[25] Moreover, robustness results presented on lines [2], [3] and [4] reveal that IT adoption has equally increased the CAB and the OFB, and decreased the growth rate of the public debt-to-GDP ratio (the ATT is significant in at least 7 out of the first 8 cases). Therefore, irrespective of its measure, FD is found to have benefited from IT adoption.

In addition to alternative measures of FD, we check the robustness of our result in two ways. First, we implement the strategy of Caliendo and Kopeinig (2008), which consists of performing matching by stratification.[26] To this end, we divide the common support of the propensity score (PS) into five equal strata, so that in each PS stratum there is no statistically significant difference between ITers' PS and non-ITers' PS.[27] The ATT is therefore the mean of the stratum-specific estimated treatment effect, weighted by the number of cases in the treatment strata. The ATT based on stratification matching are depicted in the last column of Table 2, and confirms that IT improved FD, irrespective of the way FD is measured. Second, our findings still hold when computing ATT scores based on *default* starting dates of IT, as emphasized by Appendix A. Consequently, we show that IT worked as a good device for improving FD.[28] The magnitude of this favorable effect is quite important, ranging between 0.49/0.59/0.74 and 1.10/1.00/1.45 percentage points for CAPB/CAB/OFB,[29] and between 6.1 and 8.7 percentage points for the change in the debt-to-GDP ratio.

We investigate in the following the relevance of our results by accounting for possible heterogeneity in the group of developed, compared to the group of developing countries.

3.3. The effect of IT on FD: developed versus developing countries

We first analyze the effect of IT adoption on FD in the group of *developed* countries, which consists of 22 countries, namely 10 ITers and 12 non-ITers. The results of the *probit* equations used to compute propensity scores, presented in Appendix B, are close to those performed on the full sample (see Table 1), in terms of sign and significance of the estimated coefficients. In particular, we find that past fiscal performances, including the CAPB or the debt to GDP ratio, seem not to have exerted a significant effect on the probability of adopting IT in developed countries. These results remain robust when using alternative measures for FD or when using default IT starting dates (see regressions [1]–[4] in Appendix B). Based on these propensity scores, Table 3 illustrates the ATT of IT adoption on FD.

Compared to our findings for the full sample, results on line [1] of Table 3 show that the ATT of IT on FD is not statistically significant for the group of developed countries. Using different measures of FD (see lines [2], [3] and [4]) or default starting dates (see Appendix C), does not affect our results. Moreover, irrespective of the measure of FD, the use of strata matching does not lead to statistically significant ATT. Finally, for a proper ATT estimation, the control group should follow a distinct monetary regime from ITers; this is rather problematic for the group of developed countries, in which, according to Gertler (2005), Euro area countries have a hybrid inflation targeting system and the US is an "implicit

[25] It is worth noting that we checked the quality of the *matching* by carrying out the *standardized bias*-based diagnosis test of the *balancing* properties of the *matches* (Rosenbaum and Rubin, 1985). Results in Appendix F reveal that *standardized bias* values for *matched* data are all below the 3% or 5% rule of thumb (see Lechner, 1999; Sianesi, 2004; or Caliendo and Kopeinig, 2008). This indicates that the *balancing* condition within the *matched* data has been satisfied, namely there is no significant difference between ITers' and non-ITers' observable characteristics within the retained *common support*.

[26] We thank an anonymous Referee for suggesting this robustness test.

[27] Note that five strata are enough to remove 95% of the bias associated with covariates (Cochran and Chambers, 1965). We retain the level of significance commonly used in the literature, namely 0.01.

[28] In addition, our results are qualitatively unchanged when considering a *logit* model to compute propensity scores (results are available upon request).

[29] The larger magnitude of the discipline-enhancing effect of IT when using the OFB as a measure of FD compared to cyclically adjusted indicators reflects to some extent the fact that changes in the OFB result not only from structural factors such as policy switching (e.g., IT adoption), but also from other temporary factors, including business cycle fluctuations.

Table 2
The Influence of IT adoption on fiscal discipline (FD) (Full sample).

Dependent variable: CAPB (GDP %)	Nearest-neighbor matching			Radius matching			Local linear regression matching	Kernel matching	Stratification matching
	$n = 1$	$n = 2$	$n = 3$	$r = 0.03$	$r = 0.05$	$r = 0.10$			
Treatment effect of IT on CAPB, using the *conservative* starting dates									
[1]: ATT	1.024**	0.984**	1.097***	0.449	0.594**	0.604**	0.529*	0.559*	0.487*
	(0.522)	(0.484)	(0.426)	(0.389)	(0.299)	(0.302)	(0.308)	(0.336)	(0.279)
Number of treated obs.	92	92	92	92	92	92	92	92	92
Number of controls obs.	657	657	657	657	657	657	657	657	449
Total observations (obs.)	749	749	749	749	749	749	749	749	541
Robustness checks									
Using alternative measures of fiscal discipline (FD) (instead of CAPB)									
[2]: Using CAB (GDP %)	0.998**	0.779*	0.764*	0.728**	0.698**	0.696**	0.620*	0.714**	0.590*
	(0.496)	(0.472)	(0.463)	(0.337)	(0.332)	(0.273)	(0.336)	(0.338)	(0.322)
[3]: Using the relative change of Debt/GDP	−0.087*	−0.073*	−0.073**	−0.061**	−0.077***	−0.068***	−0.071**	−0.071**	−0.065***
	(0.052)	(0.043)	(0.037)	(0.031)	(0.029)	(0.021)	(0.032)	(0.035)	(0.022)
[4]: Using OFB (GDP %)	1.447**	0.853	1.021*	0.737*	0.765**	0.869**	0.752**	0.752*	0.748*
	(0.722)	(0.606)	(0.599)	(0.434)	(0.390)	(0.399)	(0.424)	(0.456)	(0.438)

Note: bootstrapped standard errors (via 500 replications) in brackets. *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively. For stratification matching, the number of strata is five and the level of significance is 0.01.

Table 3
The Influence of IT on fiscal discipline (FD) (*Developed* countries subsample).

Dependent variable: CAPB (GDP %)	Nearest-neighbor matching			Radius matching			Local linear regression matching	Kernel matching	Stratification matching
	$n = 1$	$n = 2$	$n = 3$	$r = 0.03$	$r = 0.05$	$r = 0.10$			
Treatment effect of IT on CAPB, using the *conservative* starting dates									
[1]: ATT	0.266	0.619	0.893	0.597	0.204	0.272	0.217	0.230	0.458
	(1.181)	(1.208)	(1.023)	(0.985)	(0.951)	(1.066)	(1.121)	(0.972)	(0.286)
Number of Treated Obs.	48	48	48	35	46	48	48	46	38
Number of Controls Obs.	95	95	95	95	95	95	95	95	92
Total Observations (Obs.)	143	143	143	130	141	143	143	141	120
Robustness checks									
[1.a]: Excluding Euro area and US	−0.326	0.425	0.604	0.248	0.391	−0.333	−0.354	0.280	0.883
	(1.216)	(0.970)	(1.006)	(1.305)	(1.027)	(1.054)	(1.162)	(1.170)	(0.559)
[1.b]: Including Euro area and US as ITers	0.382	0.861	0.715	0.568	0.250	0.262	0.411	0.334	0.156
	(1.050)	(0.980)	(0.944)	(1.038)	(1.039)	(0.890)	(1.004)	(1.065)	(1.039)
Using alternative measures of fiscal discipline (FD) (instead of CAPB)									
[2]: Using CAB (GDP %)	0.297	0.774	0.758	0.157	0.117	0.203	0.177	0.171	0.377
	(0.782)	(0.705)	(0.776)	(0.896)	(0.816)	(0.698)	(0.875)	(0.888)	(0.236)
[3]: Using the relative change of Debt/GDP	−0.052	−0.056	−0.078	−0.043	−0.043	−0.056	−0.067	−0.043	−0.027
	(0.048)	(0.049)	(0.044)	(0.035)	(0.041)	(0.034)	(0.047)	(0.038)	(0.044)
[4]: Using OFB (GDP %)	−0.923	−0.565	−0.565	−1.031	−0.775	−1.041	−0.622	−0.782	−1.052
	(1.203)	(1.164)	(1.053)	(1.023)	(1.091)	(0.797)	(1.175)	(0.935)	(0.731)

Note: bootstrapped standard errors (via 500 replications) in brackets. *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively. For stratification matching, the number of strata is five and the level of significance is 0.01.

targeter" (see Gertler, 2005; for a discussion). To tackle this point, we consider two specifications: on line [1.a] in Table 3 we exclude Euro area countries and the US from the control group, while on line [1.b] we include Euro area countries and the US in the ITers group.[30] In line with previous results, we do not unveil significant ATT in neither case.

Consequently, FD was not improved following IT adoption in developed countries. One possible explanation for the lack of a robust effect of IT on FD is that, at the time the IT regime was adopted, developed countries presented already strong fiscal institutions and a fiscal stance that was judged as sustainable by financial markets. Since the fiscal stance prior to IT adoption was strong enough to support the good functioning of, and the commitment to the IT framework, the pressure for performing important FD reforms following IT adoption is weak in these countries.

Let us now focus on the effect of IT adoption on FD for the group of *developing* countries, covering 62 countries, namely 18 ITers and 44 non-ITers. The analysis of *probit* regression [1] in Appendix D shows that, contrary to results for developed countries, preconditions were found to be crucial for IT adoption. On the monetary side, central bank independence and a lower broad money growth were key drives of IT adoption. On the fiscal side, not only the fiscal rule dummy and the debt to GDP ratio are significant IT adoption determinants, but this is equally the case for some of our FD measures. In particular, although current FD measures, such as the debt change and the OFB are not found to influence IT adoption, the opposite holds for cyclically-adjusted FD measures, such as CAPB and CAB, suggesting that while adopting IT, developing countries embraced a medium-term perspective over the stance of their public finance.[31]

Based on these propensity scores, we display on line [1] of Table 4 the ATT of IT on the FD (measured by the CAPB), which we find to be significantly positive in all 8 considered cases. In addition, subsequent results reported on lines [2]–[4] confirm that our findings are robust to alternative measures of FD. Moreover, the significance and the size of these favorable effects remains remarkably stable when accounting for default, instead of conservative IT starting dates (see Appendix E), when providing ATT based on stratification matching (the last column), or when excluding hyperinflation episodes, namely annual inflation rates above 40% (see Lin and Ye, 2009), as emphasized by line [1.a]. According to our estimations, the adoption of full-fledged IT regimes increased the CAPB by a value ranging between 0.86 and 1.41 percentage points, the CAB by at least 1.12 and up to 1.82 percentage points, the OFB by a value between 0.76 and 1.37 percentage points, and decreased the change in the public debt-to-GDP ratio by a range between 7.8 and 15.6 percentage points. The magnitude of these figures is quite important if compared with descriptive statistics for fiscal balances presented in the introduction and with the current levels of public debt in developing countries.

The fact that IT adoption has a significant effect on FD only in developing countries is undoubtedly related to their specific structural characteristics. Of particular importance, institutional quality is weak and seigniorage revenue still represent a substantial share of government revenues therein. Monetary policy is therefore more likely to be subordinated to fiscal policy objectives, making any commitment of the central bank to an IT regime less credible than in developed countries (see Masson et al., 1997; Calvo and Mishkin, 2003; or Jonas and Mishkin, 2005). In addition, as showcased by Amato and Gerlach (2002) or Batini and Laxton (2007), the fiscal stances recorded by developing countries at the starting date of their IT regime were not perceived by private agents and financial markets as sound enough, given that public debt has predominantly a short-term maturity and is denominated in foreign currency in these economies. Consequently, these countries had stronger incentives to be more fiscally disciplined following IT adoption, for sending strong signals regarding authorities' commitment to withstand any pressure for a monetary financing of the public debt, and hence back up the credibility of their central bank with regard to hitting the inflation target.

[30] Euro area countries are treated as ITers from the date of their adhesion to the Euro area, and the US as an ITer from 1990, as suggested by Goodfriend (2005).

[31] Notice that our results hold when considering default IT starting dates (see Appendix E) or abstracting from hyperinflation episodes (see column [1.a]).

Table 4
The influence of IT on fiscal discipline (FD) (*Developing* countries subsample).

Dependent variable: CAPB (GDP %)	Nearest-Neighbor matching			Radius matching			Local linear regression matching	Kernel matching	Stratification matching
	$n = 1$	$n = 2$	$n = 3$	$r = 0.03$	$r = 0.05$	$r = 0.10$			
Treatment effect of IT on CAPB, using the *conservative* starting dates									
[1]: ATT	1.351*	1.410*	1.115*	1.291**	1.208**	0.857*	0.917*	1.136**	1.032*
	(0.819)	(0.855)	(0.676)	(0.659)	(0.616)	(0.519)	(0.555)	(0.580)	(0.625)
Number of treated obs.	37	37	37	37	37	37	37	37	37
Number of controls obs.	559	559	559	559	559	559	559	559	309
Total observations (obs.)	596	596	596	596	596	596	596	596	346
Robustness checks									
[1.a.]: Excluding hyperinflation episodes	1.351*	1.540**	1.126*	1.293**	1.205**	0.859*	0.984*	1.137*	1.034*
	(0.818)	(0.785)	(0.682)	(0.659)	(0.615)	(0.521)	(0.596)	(0.689)	(0.627)
Using alternative measures of fiscal discipline (FD) (instead of CAPB)									
[2]: Using CAB (GDP %)	1.542*	1.823**	1.600**	1.389*	1.688**	1.227**	1.117*	1.555*	1.532*
	(0.935)	(0.930)	(0.816)	(0.842)	(0.861)	(0.626)	(0.677)	(0.942)	(0.888)
[3]: Using the relative change of Debt/GDP	−0.156*	−0.105*	−0.095*	−0.116**	−0.111*	−0.104*	−0.078*	−0.106*	−0.082*
	(0.095)	(0.064)	(0.058)	(0.059)	(0.067)	(0.063)	(0.047)	(0.064)	(0.049)
[4]: Using OFB (GDP %)	1.369**	1.320**	1.028**	0.930**	0.816**	0.756**	0.786**	0.854**	1.127*
	(0.698)	(0.673)	(0.524)	(0.474)	(0.416)	(0.386)	(0.401)	(0.436)	(0.632)

Note: bootstrapped standard errors (via 500 replications) in brackets. *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively. For stratification matching, the number of strata is five and the level of significance is 0.01.

4. Conclusion

In the beginning of the 90's, a new framework for the conduct of monetary policy emerged, namely Inflation Targeting (IT). Ever since, there has been a spectacular increase in the number of countries having decided to use IT as their monetary system, to the point where Rose (2007) stated that inflation targeting was the cornerstone of the new international monetary system. These ideas find substantial support in a very recent strand of influential papers, emphasizing remarkable performances of IT regimes, regarding both monetary policy variables (inflation, interest rate), and the real economy (growth volatility). The present paper adds to this literature by studying the link between inflation targeting and fiscal discipline (FD). Indeed, although the role of FD as a precondition for IT adoption was previously explored, little is said about the way IT adoption could influence the FD. Using a sample and an econometric method that allow comparability with previous studies focusing on IT performances, we develop the existing literature in several directions.

First, based on matching techniques applied on a sample of both developing and developed countries, we show that IT adoption significantly improved fiscal discipline in IT countries compared to non-IT countries with close observable characteristics. Our result is extremely vigorous, in both sign and magnitude, when performing different robustness tests, including alternative measures of fiscal discipline, alternative specifications for the computation of propensity scores, the use of conservative or default starting dates for inflation targeting adoption, or a wide variety of matching methods.

Second, to deal with the possible heterogeneity in our full sample, we investigate the role of inflation targeting adoption on fiscal discipline by considering alternatively developed and developing countries. Contrary to developed countries where IT adoption seems not to have significantly affected FD, our results show that IT worked as a good device for improving fiscal discipline in developing countries. A possible explanation builds on the idea that, contrary to developed countries, developing countries presented relatively poorer fiscal stances at the time of IT adoption. As a result, they had stronger incentives to improve FD following IT adoption, to rule out pressures for monetizing public debt, which would have undermined the credibility of their central bank's commitment to inflation targeting.

Finally, we provide an evaluation of the contribution of IT adoption to the improvement in FD. According to our analysis, IT adoption led to a statistically significant discipline-enhancing effect on fiscal policy, which we estimate as high as one-third of the standard deviation for the Cyclically-Adjusted Primary Fiscal Balance (in percent of GDP) if we consider the full sample, and half of the standard deviation for the Cyclically-Adjusted Primary Fiscal Balance (in percent of GDP) for the group of developing countries.

To sum up, our results have policy implications that could contribute to the current debate regarding the relevance of inflation targeting adoption in general, all the more that an impressive number of countries (more than 35, according to Batini et al., 2006) are currently exploring the possibility of implementing IT frameworks. Indeed, whilst most existing studies simply point out that FD is a prerequisite for a credible adoption of IT, our findings go beyond it and suggest that inflation targeting adoption could enhance fiscal discipline. Particularly for developing countries, IT appears as a "tool to tie their own hands", and could allow them to create a sound and stable macroeconomic environment, which is, in the current context of globalizing financial markets, a key prerequisite for strong and sustained economic growth. In this regard, inflation targeting could enforce other mechanisms designed to ensure fiscal discipline by establishing durable and permanent constraints on the discretion of fiscal authorities, namely fiscal responsibility laws, fiscal transparency, fiscal accountability, and particularly the so-called fiscal rules (see von Hagen, 1992; Kopits and Symansky, 1998; Alesina and Perotti, 1999; or Schaechter et al., 2012). Future research could explore precisely the eventual link between inflation targeting adoption and the implementation of fiscal rules.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jimonfin.2013.10.002.

Appendix 1. The list of countries that target inflation, together with their starting dates

Countries	Soft IT: default starting dates	Full-fledged IT: conservative starting dates
Australia[b]	March 1993	September 1994
Brazil[a]	June 1999	June 1999
Canada[b]	February 1991	January 1992
Chile[a]	January 1991	August 1999
Colombia[a]	September 1999	October 1999
Czech Republic[a]	January 1998	January 1998
Finland[b]	February 1993	January 1994
Hungary[a]	June 2001	August 2001
Iceland[b]	March 2001	March 2001
Israel[a]	January 1992	June 1997
Mexico[a]	January 1999	January 2001
New Zealand[b]	March 1990	March 1990
Norway[b]	March 2001	March 2001
Peru[a]	January 2002	January 2002
Philippines[a]	January 2002	January 2002
Poland[a]	September 1998	September 1998
South Africa[a]	February 2000	February 2000
South Korea[a]	April 1998	April 1998
Spain[b]	January 1995	January 1995
Sweden[b]	January 1993	January 1995
Switzerland[b]	January 2000	January 2000
Thailand[a]	May 2000	May 2000
United Kingdom[b]	October 1992	October 1992
New ITers (still treated as non-ITers in our study)		
Indonesia[a]	July 2005	July 2005
Romania[a]	August 2005	August 2005
Slovak Republic[a]	January 2005	January 2005
Guatemala[a]	January 2005	January 2005
Turkey[a]	January 2006	January 2006
Serbia[a]	September 2006	September 2006
Ghana[a]	January 2007	January 2007

[a] Developing Countries;
[b] Developed Countries.
Source: Rose (2007) and Roger (2009). Due to lack of data on fiscal discipline, Romania and Serbia do not appear in our sample.

Appendix 2. Control group

Albania[a]	Costa Rica[a]	Georgia[a]	Lithuania[a]	Slovenia[a]
Algeria[a]	Croatia[a]	Ghana[a]	Malta[a]	Spain[b]
Argentina[a]	Cyprus[a]	Greece[b]	Malaysia[a]	Sri Lanka[a]
Austria[b]	Germany[b]	Guatemala[a]	Mauritius[a]	Swaziland[a]
Azerbaijan[v]	Denmark[b]	Ireland[b]	Morocco[a]	Trinidad and Tobago[a]
Belgium[b]	Dominican Republic[a]	Iran[a]	Netherlands[b]	Tunisia[a]
Bulgaria[a]	Ecuador[a]	Italy[b]	Panama[a]	Turkey[a]
Bahrain[a]	Egypt[a]	Indonesia[a]	Paraguay[a]	Ukraine[a]
Bahamas[a]	Estonia[a]	Jamaica[a]	Portugal[b]	Uruguay[a]
Belarus[a]	Finland[b]	Jordan[a]	Russian Federation[a]	United States[b]
Botswana[a]	Fiji[a]	Japan[b]	El Salvador[a]	Venezuela[a]

Cape Verde[a]	France[b]	Kazakhstan[a]	Singapore[a]
China[a]	Gabon[a]	Latvia[a]	Slovak Republic[a]

[a] Developing Countries;
[b] Developed Countries.

Appendix 3. Sources and definitions of data

Public debt (% of GDP)	Gross general government debt, in % of GDP	Ali Abbas et al. (2010)
Change in the public debt-to-GDP ratio	Difference between current debt/GDP and lagged debt/GDP, divided by lagged debt/GDP.	Authors' calculations
CAPB (% of GDP)	Cyclically-adjusted primary fiscal balance, as GDP percentage.	Authors' calculations (see the main text), based on general government fiscal balances data from WEO (2010)
CAB (% of GDP)	Cyclically-adjusted fiscal balance, as GDP percentage.	
OFB (% of GDP)	Overall fiscal balance, as GDP percentage	World Economic Outlook (2010)
Inflation rate	Annual growth rate of average CPI	
Full-fledged or Formal IT (conservative starting dates)	Binary variable taking the value 1 if in a given year a country operates formally under IT, zero otherwise. When we use the conservative starting dates of IT, we refer to full-fledged IT.	Rose (2007) and Roger (2009)
Soft or informal IT (default starting dates)	Binary variable taking the value 1 if in a given year a country operates informally under IT, zero otherwise. When we use the default starting dates of IT, we refer to soft IT.	
GDP growth rate	Annual growth rate of gross domestic product	World Development Indicators (WDI, 2010)
Broad money growth	Annual growth rate of money and quasi money (M2)	
Trade openness	Sum of imports and exports divided by GDP	Penn World Table (PWT.6.3)
Fiscal rule dummy	Binary variable taking the value 1 if a country placed, at the national level, a numerical limit on fiscal aggregates (fiscal balance, expenditure, revenue or debt)	Fiscal Rules Database of the IMF's Fiscal Affairs Department, Fiscal Policy and Surveillance Division (2009)
Governors' turnover rate	Central Banks Governors turnover rates. Reverse proxy of central bank independence.	Ghosh et al. (2003), updated
Fixed exchange rate	Dummy variable taking the value 1 if a country is classified as having a de facto fixed exchange rate regime (hard or soft peg).	Reinhart and Rogoff (2004), updated

Appendix 4. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Full-fledged IT	1978	0.111	0.314	0.000	1.000
Soft IT	1978	0.121	0.327	0.000	1.000
Inflation rate	1838	41.444	287.306	−11.374	7481.691
CAPB (% of GDP)	1512	0.045	3.098	−14.006	21.569
CAB (% of GDP)	1587	−0.055	3.546	−24.575	22.274
OFB (% of GDP)	1596	−2.194	6.360	−35.112	36.956
Debt (% of GDP)	1745	53.905	31.464	3.241	289.554
Change in the debt-to-GDP ratio	1633	0.002	0.205	−0.546	3.331
Fixed exchange rate dummy	1816	0.572	0.495	0.000	1.000
Trade openness	1871	80.638	50.651	10.094	456.562
Governor's turnover rates	1478	0.245	0.236	0.000	1.200
GDP growth rate	1910	2.244	4.983	−44.066	33.031
Broad money growth rate	1538	41.076	236.372	−100.000	6384.916
Fiscal rule dummy	1978	0.257	0.437	0	1

Appendix 5. The Propensity Scores Matching (PSM) method used by Lin and Ye (2007)

This method aims at evaluating the effect of a *treatment* (IT adoption in our study) on an outcome variable (FD in our study) in countries assigned to the *treatment* (countries having adopted IT or ITers in our case), namely the so-called *average treatment effect on the treated* (ATT)

$$\text{ATT} = E[(\text{FD}_{i1} - \text{FD}_{i0})|\text{IT}_i = 1] = E[\text{FD}_{i1}|\text{IT}_i = 1] - E[\text{FD}_{i0}|\text{IT}_i = 1], \quad (1)$$

where IT_i is a dummy variable, which equals 1 if the country i is targeting inflation and 0 if not. $\text{FD}_{i1}|.\text{IT}_i = 1$ measures the change in FD if country i has adopted IT, and $\text{FD}_{i0}|.\text{IT}_i = 1$ measures the change in FD that would have been observed if the country i had not adopted IT. Equation (1) therefore compares the outcome value, namely FD, observed in the *treatment* group (ITers), with the outcome value that would have been observed in the same countries if they had not adopted IT. Unfortunately, it is not possible to observe this latter value, and we face here, as it is common in non-experimental studies, an identification problem. A conventional approach to circumvent this difficulty is to compare the mean of the variable FD for the *treatment* group (ITers), with its mean for the *control* group (non-ITers).

However, this solution holds provided the assignment to the *treatment* is random; yet, IT adoption may be non-random, since it may be correlated with a set of observable variables that also affects the outcome variable (FD in our case), leading to the so-called "self-selection" problem.[32] Consequently, a simple comparison of the sample mean value of FD between the two groups would produce biased estimates of the ATT. The propensity score matching method allows overcoming this selection on observables problem.

However, the validity of the ATT estimate depends strongly on the relevance of the counterfactual (control or comparison) group. The propensity score-matching methods allow pairing ITers with non-ITers that have similar observed characteristics, so that the difference between FD in ITers and FD in a matched counterfactual is attributable to the treatment, namely the IT adoption. The technique therefore consists of mimicking a *randomized experiment* on the basis of observable characteristics (X), namely countries with the same observable characteristics face a randomized experiment, as to whether they adopt IT or not. The key assumption underlying this matching method is the conditional independence assumption, namely $\text{FD}_0 \perp \text{IT}|.X$ and $\text{FD}_1 \perp \text{IT}|.X$, which requires for, conditional on observables X, the outcomes FD_0 and FD_1 to be independent of the treatment variable. Under this assumption, Equation (1) can be rewritten as

$$\text{ATT} = E[\text{FD}_{i1}|\text{IT}_i = 1, X_i] - E[\text{FD}_{i0}|\text{IT}_i = 0, X_i], \quad (2)$$

where $E[\text{FD}_{i0}|.\text{IT}_i = 1, X_i]$ is replaced by $E[\text{FD}_{i0}|.\text{IT}_i = 0, X_i]$, which is observable. However, as the number of explanatory variables (X) increases, such a matching on X would be difficult to implement in practice. To overcome this high dimension problem, Rosenbaum and Rubin (1983) suggest carrying out the matching using propensity scores, instead of X, with the propensity score defined as the probability of adopting the IT regime conditional on the observable variables X, namely $p(X_i) = E[\text{IT}_i|.X_i] = \Pr(\text{IT}_i = 1|.X_i)$. Under the additional common support assumption (namely, $p(X_i) < 1$), requiring the existence of some comparable control units (non-ITers) for each treated unit (ITer), the ATT can be estimated as

$$\text{ATT} = E[\text{FD}_{i1}|\text{IT}_i = 1, p(X_i)] - E[\text{FD}_{i0}|\text{IT}_i = 0, p(X_i)]. \quad (3)$$

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[32] See Dehejia and Wahba (2002) and Heckman et al. (1998). Also, note that the selectivity problem here is neither selection on unobservables (omitted variables), nor a Heckman-type sample selection problem (since matching on the propensity scores implicitly assumes that unobservables play no role in the treatment assignment).

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