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Inflation Targeting and Public Deficit in Emerging Countries: A Time Varying Treatment Effect Approach*

Mohamed Kadria¹, Mohamed Safouane Ben Aissa²

ABSTRACT

Several studies including Minea, Tapsoba and Villieu (2012) and Lucotte (2012) claim that in emerging countries, the adoption of inflation targeting (IT) monetary policy and its discipline character allow intensifying their efforts to collect tax revenue and/or expenditure rationalization, and allows the reduction of their budget deficits (Kadria and Ben Aissa, 2014). But, the lag in the effect of monetary policy contains vital information for the policy evaluation (Fang and Miller, 2011). Hence, our contribution to the previous literature is then to evaluate the time varying treatment effect of the IT's adoption by emerging countries on their budgetary discipline in terms of reducing or mastering the public deficit. To do this, we used the propensity score matching approach in order to take account of this "lag effect" or from this effect throughout time. Our empirical analysis, conducted on a sample of 41 economies (20 IT and 21 non-IT economies) for the period from 1990 to 2010, shows that the lag in effect of IT on public deficit performance proves to be shorter and gradual for emerging countries that have adopted this monetary policy framework and our conclusions corroborate the literature disciplining effect of IT on fiscal policy.

Keywords: Time lag, inflation targeting, public deficit, time varying treatment effect evaluation, propensity score matching, emerging countries.

JEL Classification: C5, E5, E6, H6

1. INTRODUCTION

In recent decades, an extensive literature has focused on further analyzing the interactions that may exist between monetary and fiscal policies, in particular the link between public deficit and inflation phenomenon. Amato and Gerlach (2002), Fischer et al. (2002), Vu (2004), Catao and Terrones (2005), Wimanda, Turner, and Hall (2011) argue that the high rate of inflation, observed especially in many developing countries, is associated with important deficits, mainly financed by seigniorage revenue. Even more interesting, Alesina and Tabellini (1987), Obstfeld (1991), Jensen (1994), Van der Ploeg (1995), Van Arle et al. (1995) and Minea et al. (2011) agree on the fact that if the central bank decides to grant significant weight in its loss

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function to the price stability objective, it will reduce seigniorage revenue and compel the State to increase tax revenues through tax mobilization effort. Otherwise, valuable theoretical studies (see, e.g., Bernanke and Mishkin, 1997; Svensson, 1997; Bernanke et al., 1999) were motivated by the common finding in many empirical studies (see, e.g., Goncalves and Salles, 2008; Lin and Ye, 2009), for, the inflation targeting (thereafter IT) policy has helped emerging inflation targeters to have a significant improvement in macroeconomic performance which is mainly measured through the behavior of inflation, output and interest rates. But, this monetary strategy requires a process of economic and institutional reforms which have a relatively large disciplining effect on the conduct of fiscal policy in avoiding seigniorage revenue and therefore opting for a tax mobilization/government expenditure rationalisation and public deficit reduction. However, developed inflation targeters (thereafter ITers) have become more fiscally disciplined in order to reach the target and in the framework of the economic policies coordination³.

Recently, some empirical studies are focused to verify this link between the adoption of IT and the performance of fiscal policy indicators in emerging and developing countries. Indeed, works like Miles (2007), Tapsoba (2010) have sought to test whether the IT policy, as a monetary policy framework aimed at stabilize the inflation especially in emerging countries, could act positively on fiscal discipline. In the first time, Minea and Villieu (2008) and Minea, Tapsoba and Villieu (2012) show that IT does produce an incentive for governments to improve institutional quality and this monetary strategy should encourage the government to reinforce its tax collection system and rationalize its public expenditures. Lucotte (2012) conducted an empirical analysis of 59 countries (40 non-inflation targeters and 19 are targeters) covering the 1980-2009 period and that using the method of propensity score matching. He concluded that on average, the adoption of IT, which involves strengthening the independence of the central bank and maintaining a low level of inflation, had a large and significant effect on the effort of tax revenue mobilization or collection. In the second time, few empirical works have sought to investigate the effect of the adoption of inflation targeting on budgetary discipline in terms of the budget deficit performance. Abo-Zaid and Tüzemen (2011), using data from developed and developing countries covering the period from 1980-2007, with an econometric specification

³ Aktas et al. (2010) don't share this idea in the case of emerging market economies (in particular the Turkish economy as reference) and their results seem to validate the arguments of Blanchard (2004) and Favero and Giavazzi (2004).

inspired by Ball and Sheridan (2005) and by adopting the strategy of "Diff in -Diff", have come to the conclusion which showed that the developed ITers were leading a more disciplined manner their fiscal policy after the adoption of IT. Furthermore, improvements in budgetary imbalances in some developing ITers may be partly due to attempts for achieving the inflation target. They conclude that these imbalances are significantly improved when countries, especially developed, explicitly target inflation. Thus, the non-ITers will greatly benefit by adopting the IT policy. More recently, Kadria and Ben Aissa (2014) tried to examine whether the implementation of IT monetary policy and its discipline character allow reducing the budget deficit in emerging countries. To do this, they used the propensity score matching methodology to evaluate the treatment effect of IT on fiscal discipline, in terms of budget deficit performance, in emerging countries has adopted this monetary policy framework. Their empirical analysis, conducted on a sample of 41 economies (20 IT and 21 non-IT economies) for the period from 1990 to 2010, shows that on average IT adoption has had a considerable and significant effect in reducing the budget deficit. The results are confirmed by the robustness tests and corroborate the literature of disciplining effects of IT regime on the fiscal policy performance.

But it must be noted, based on Brun et al. (2008), that the fiscal effort is indirectly influenced by monetary policy. More precisely and to the extent that there exists for many taxes a time lag between the date of taxation and the date of tax collection by the state, the real value of tax revenue collected is eroded by inflation (Keynes-Tanzi-Oliveira effect). When inflation reached high levels, this effect constitutes a constraint for the mobilization of fiscal resources. The contemporary fiscal policy can be constrained by the monetary policy of previous years. Moreover, the lag in effect of monetary policy contains vital information for the policy evaluation (Fang and Miller, 2011). Thus, time lags play an important role in evaluating this policy and its interaction with the other policies.

Hence, our contribution to the previous literature is then to evaluate the time varying effect of the IT's adoption by emerging countries on their budgetary discipline in terms of reducing or mastering the budget deficit, using the dynamic PSM used by Fang and Miller (2011)⁴ to take account of "the lag effect" and the time varying effect of the IT's adoption on

⁴ These authors have sought, through the PSM method but takes into account the duration (in terms of years), to assess the impact of the IT's adoption on inflation performance, but assuming that this effect is not immediate.

budget deficit performance in emerging countries and to stand out from the existing empirical literature while providing additional responses elements of economic policy.

This paper is organized as follows. The second section presents the data used and a few stylized facts. The methodology is described in section 3. Section 4 discusses our econometric results. Section 5 concludes, highlighting the main policy implications of our empirical findings.

2. DATA AND STYLIZED FACTS

We start from a set of annual data, a heterogeneous sample of 41 emerging countries, 20 are inflation targeters (treatment group) and 21 non-inflation targeters (control group), covering the 1990-2010 period. We retain here all emerging countries that have pursued an IT regime in the treatment group. In fact, we are based on the sample used in Lin and Ye (2009) and we added as targeters Guatemala, Romania, Slovakia and Turkey that have adopted IT between 2005 and 2006 and they were considered as non-IT countries (the control group) for these authors. Noting that Serbia and Ghana have implemented the IT between 2006 and 2007 and are not included in the list of inflation targeters in Lin and Ye (2009). In addition, our control group was selected relying on the criteria defined by Lin and Ye (2009), based on the level of economic development and the size of the country⁵. Table 1 (see appendix 1) shows the sample of countries selected for this study, as well as the respective adoption(s') dates for the ITers.

To examine in a preliminary manner whether the adoption of the IT policy has reduced the public deficit in the emerging targeters, we identified two key variables namely: the inflation rate calculated on the basis of the CPI and the budget deficit (% of GDP) as the state revenue (including grants) minus expense, minus net acquisition of non-financial assets. The data were obtained through various sources, including, particularly, the World Development Indicators (WDI) of the World Bank. The other(s) variables so called "conditional" will be presented in the third subsection, (but) after the explanation of the methodology of the work, noting that the definitions/sources of these variables and the descriptive statistics are in the appendices.

Figures 1 (a) and (b) provide respectively the average public deficit in emerging ITers before and after the adoption of IT well as the time varying of their average budget deficit and

⁵ Given these two criteria, the authors do not include in the control group that countries with a GDP/capita at least as high as the poorest targeting country and having a population at least as important as the least populated targeting country.

this, since the date of IT's adoption⁶ (PD0) and four consecutive years (either PD1,...,4) well as the level at the end date of the study period (PD2010). These figures are emerge two preliminary results. Firstly, we note that the average budget deficit (% of GDP) was reduced at the emerging ITers after the application of IT, down 0.55%. Secondly and more interesting, we find that there has been no improvement in the fiscal balance in emerging countries after one year of its adoption and, more specifically, there have been an average slight deterioration of 0.5 percentage points. But from the second year following their adoption, we note that the level of the average budget deficit gets better over time attenuating low levels that can go up to (-1.5%) and (-1.8%) respectively in the fourth year of adoption and the last 2010. Therefore, we can appreciate, statistically, the effect of the IT adoption on reducing the public deficit in emerging countries have adopted this monetary policy framework and that this feedback effect is not immediate but rather comes with a delay of two years from the date of adoption.

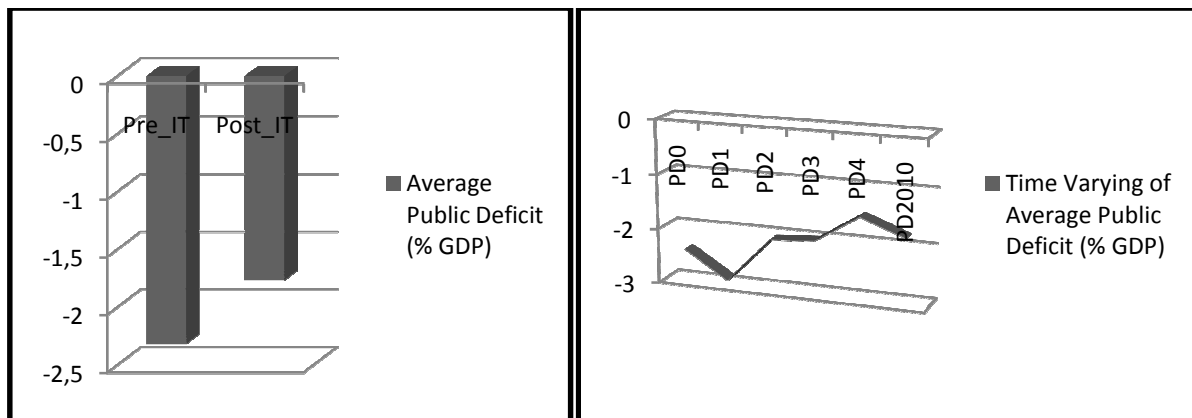


Figure 1 (a)

Figure 1 (b)

3. METHODOLOGY

In this section and in particular, we will try to define the econometric methodology to be used in order to empirically test the impact of the adoption of the IT policy on the performance of fiscal policy in emerging states, in terms of mastery or even budget deficit reduction. More specifically, our objective is to evaluate the time varying treatment effect of IT on the budget deficit in emerging countries that have adopted this monetary policy framework.

⁶ The date of 2000 is taken as a period of demarcation and more specifically, it is about the average dates of IT's adoption in emerging economies (see, e.g., Coulibaly and Kempf, 2010).

3.1. The time varying treatment effect

Using propensity score matching⁷, the intertemporal average treatment effect on the treated (ATT^t) of every period at and after the adoption year of IT depends on the following equation used by Fang and Miller (2011):

$$ATT^t = 1/N_t * \sum_{i \in T \cap S_p} [PD_{it} - \sum_{j \in C} w(P_i, P_j) PD_{jt}]$$

Where PD_i and PD_j equal the values of the public deficit for countries i in the targeting group T and j in the control group C , respectively. P_i and P_j equal the predicted probabilities of adopting IT for countries i and j . N_t equals the number of treated units. The match for each treated unit $i \in T \cap S_p$ equals a weighted average of the outcomes of non treated countries, S_p is the region of common support, and $w(P_i, P_j)$ equals the weight function.

In this study, t equals 0, 1, 2, 3, 4, denoting the adopting year⁸ ($t=0$) and four years after ($t=1\dots4$). We are also interested in the final year of our study period, either $t = 2010$.

Moreover, the process of estimating the average treatment effect on the treated includes four steps referring in particular to Caliendo and Kopeinig (2008) and Khander et al. (2010). Indeed, the first step consists in estimating the propensity scores⁹ relying on the conditioning variables X_{it} retained (and) which will be described in the next section. Once the estimated propensity scores, we proceed to the determination of the area of the common support densities of the two groups of countries propensity scores (targeters and non-inflation targeters) inside which will be calculated the ATT, (and) relying on the "Min-Max" technique developed by Dehejia and Wahba (1999) and detailed by Smith and Todd (2005). The third step is to estimate the ATT, specifically the average effect of the IT's adoption on the budget deficit (as a percentage of GDP) of economies that have adopted this monetary policy framework. To do this, we have chosen to retain three among four propensity score matching methods which there are

⁷ This approach is initiated by Rubin (1977) and recently developed by Heckman et al. (1998) in the aim to solve the problem of selection on observables. That may be mentioned recent macroeconomic studies using this method such as Vega and Winkelried (2005), Lin and Ye (2007, 2009), Walsh (2009), De Mendonca and Guimaraes e Souza (2011), etc. Note that this approach is widely used in micro-econometrics well as in different areas such as health, education, etc.

⁸ Recall that the average date of IT's adoption in emerging economies is 2000.

⁹ According to Caliendo and Kopeinig (2008), the use of probit/logit models, where the treatment variable is a dichotomous variable, provide almost the same results.

four types¹⁰. First, it refers to the estimator of N nearest neighbor (Nearest-neighbor matching) paired with replacement and consists of matching each treated or treatment observation with N control units (or the N non- treated observations) having the scores of the nearest propensity (We consider N = 1, N = 2 and N = 3). The second method is the Local linear regression matching (LLRM) developed by Heckman et al. (1998). Finally, we use the method of Kernel matching (Tricube¹¹) which consists to be retained all untreated units (non_ITers) (of retaining all the untreated units) belonging to the common support for the construction of the counterfactual; i.e. where each observation being weighted untreated so decreasing in function of its distance to the considered treated observation. In other words, this method proposed by Heckman et al. (1998) allows matching a treatment unit (an ITer) to all control units (non-ITers) proportionally weighted in function to their proximity (in terms of propensity scores) to the treated unit. The last step is to calculate the standard deviation which allows the assessment of the statistical significance of the ATT using the bootstrap technique proposed by Lechner (2002) and detailed by Brownstone and Valletta (2001); noting that the retained number of replications is 500.

3.2. Treatment, result and conditioning variables

3.2.1. Treatment versus outcome variables

In our study, the treatment variable as it was already described above is the IT (IT_{it}). It is considered as a dummy variable, taking the value 1 if a country led an IT strategy during the considered year, and 0 if not. In addition, we have chosen to study the treatment variable (IT_{FF}) for "accomplished" adoption (fully-fledged adoption), counter to the works of Levya (2008) and others who have considered two dates corresponding to a "partial" adoption and another "accomplished". These two dates may differ if a country does not meet all the criteria or prerequisites characterizing an IT policy. Concerning the outcome variable, we have retained the budget deficit ($B_{DEFICIT}$) as % of GDP presented in the previous section.

3.2.2. The conditioning variables

Finally, the departure conditioning variables applied in our study to estimate the propensity scores and expected to affect both the outcome indicator and the treatment variable are eight in number, thus satisfying the conditional independence hypothesis developed in the

¹⁰ Nearest-Neighbor Matching, Radius Matching, Local Linear Regression Matching and Kernel Matching.

¹¹ There are others types of functions aside from tricube namely Gaussian, Epanechnikov, biweight, uniform.

methodology section. In fact, four of these variables refer to the institutional and economic preconditions theoretically required for the adoption of IT (see, e.g. Batini and Laxton, 2006). These variables are the lagged inflation rate of one period (*INF_1*), the rotation rate of Governors at the head of the central bank calculated by sub-periods of five years (*TOR_5*) as a reverse proxy of the monetary authority independence, the degree of de facto flexibility of the exchange rate (*EXCH*) and, the domestic credit for the private sector to GDP ratio (*CRED*) measuring the level of financial development. We expect, on the basis of the literature results, a negative correlation between the probability of IT adoption and inflation, the rate of rotation variables, while the two other variables are supposed to act positively on this probability. In addition, following Lin and Ye (2007, 2009), we consider the degree of trade openness (*OPEN*) as a conditioning variable that reflects the "fear of floating"¹², and which is measured by the sum of exports and imports as a percentage of GDP. We can therefore theoretically expect a negative effect for this variable on the probability of IT adoption. The sixth conditioning variable, according to Truman (2003), is the rate of real GDP per capita growth (*GDPpc_G*). We expect a negative effect for this variable on the probability of the IT adoption (Truman, 2003; Samaryna and De Haan, 2011), knowing that a high rate of real GDP per capita growth can be considered as the result of the macro-economic policies success, which does not necessarily imply an alternative framework of IT. The two other conditioning variables that theoretically affect both *IT_FF* and *B_DEFICIT* variables and whose objective is to satisfy the conditional independence assumption, are the total public debt as a percentage of GDP (*PUB_DEBT*) and the democracy indicator of polity IV (*POLITY2*). We expect that the public debt has a negative effect on the probability of IT adoption while the democracy indicator impacts positively this probability.

4. RESULTS

4.1. Intertemporal estimation of propensity scores

We estimate the propensity scores using a probit model¹³ and the results of the probit estimates with time varying presented in Table 2 (where the considered endogenous variable is the accomplished adoption (*IT_FF*)) shows that apart from the turnover rate of central bank governors and the domestic credit, the intertemporal estimated coefficients associated with the

¹² See Calvo and Reinhart (2002).

¹³ Logit model does not change the results significantly.

other retained conditioning variables such as *GDPpc_G*, *INF_1*, *EXCH*, *OPEN*, *PUB_DEBT* and *POLITY2* are statistically significant at 1%, 5% and 10% especially from the second year of adoption and have the expected sign, except for the real GDP per capita growth. This result is nonetheless consistent with those found by Lin and Ye (2009). In addition, the explanatory power of the model is high, with an average pseudo-R² of McFadden equal to 75%.

Table 2: Time varying probit estimates of propensity scores

IT_FF (1)	(t₀)	(t₁)	(t₂)	(t₃)	(t₄)	(t₂₀₁₀)
<i>GDPpc_G</i>	-0.012 (0.262)	0.368*** (0.170)	0.232** (0.096)	0.176** (0.071)	0.176** (0.071)	0.176** (0.071)
<i>INF_1</i>	-0.478 (0.350)	-0.353*** (0.159)	-0.244*** (0.069)	-0.247*** (0.058)	-0.247*** (0.058)	-0.247*** (0.058)
<i>TOR_5</i>	-5.606 (6.376)	1.252 (2.983)	-0.667 (1.622)	-0.676 (1.372)	-0.676 (1.372)	-0.676 (1.372)
<i>EXCH</i>	1.985* (1.193)	0.950*** (0.357)	0.674*** (0.178)	0.588*** (0.133)	0.588*** (0.133)	0.588*** (0.133)
<i>CRED</i>	-0.166 (0.142)	-0.014 (0.023)	-0.002 (.016)	0.002 (0.012)	0.002 (0.012)	0.002 (0.012)
<i>OPEN</i>	-0.029 (0.026)	-0.013 (0.012)	-0.016** (0.008)	-0.015** (0.006)	-0.015** (0.006)	-0.015** (0.006)
<i>PUB_DEBT</i>	0.042 (0.041)	-0.010 (0.014)	-0.009 (0.008)	-0.012* (0.007)	-0.012* (0.007)	-0.012* (0.007)
<i>POLITY2</i>	3.927 (2.976)	0.981 (0.617)	0.781*** (0.388)	0.698*** (0.270)	0.698*** (0.270)	0.698*** (0.270)
Nb. of obs.	142	165	192	222	222	222
Pseudo-R ²	0.833	0.772	0.735	0.717	0.717	0.717

Note: Values in parentheses are standard deviations.

***, **, * represent respectively the statistical significance at threshold of 1%, 5% and 10%.

4.2. The results of matching

The time varying estimation results for different matching methods (which are shown in Table 3) are generally satisfactory and considerable enough to observe a significant impact of the IT adoption on reducing the budget deficits of economies having implemented this monetary policy framework. More precisely, we observe as of the adoption year a significant and (but) low impact of IT's adoption on reducing the budget deficit of these economies. This impact is on the order of 0.285 percentage points. But in the years following the adoption, we observe the same effect but on a larger scale that stabilizes in the medium term around 1.8% absolute, except for the second year after the policy adoption. This result emanating of the treatment effect study in dynamic mode seems therefore very interesting. Indeed, the low performance in terms of reducing the public deficit in emerging economies during the early years following the adoption of IT is due in large part to non full compliance prerequisites considered as essential to the viability of IT, but this situation is changing over time with the strengthening of the economic and institutional conditions, it will have a significant effect in reducing the budget deficit. This result proves that emerging ITers become more disciplined after the implementation of the IT strategy, which has been intensifying their efforts to collect tax revenue and/or expenditure rationalization, allowing the reduction of their budget deficits. This corroborates the theoretical and empirical literature review that puts in evidence the disciplining effect of the IT on the tax policy.

Table 3: Intertemporal matching estimates of treatment effect on the public deficit (in % of GDP)

	Algorithms of matching				
	Nearest-neighbor matching			LLRM	Kernel matching
	N=1	N=2	N=3	(Tricube)	(Tricube)
	IT_FF				
(2) ATT_0	-0.285** (0.134)	-0.658 (1.075)	-1.166 (2.450)	- (-)	-0.337 (1.709)
(3) ATT_1	-2.713 (1.686)	-2.991** (1.297)	-2.50** (1.260)	-2.394** (1.025)	-3.647** (1.782)
(4) ATT_2	-1.579 (1.144)	-1.620 (1.131)	-1.375 (1.008)	-1.365 (1.003)	-1.475 (1.337)
(5) ATT_3	-1.878**	-1.647**	-1.623***	-1.565**	-1.886*

	(0.886)	(0.843)	(0.558)	(0.665)	(1.060)
(6) ATT_4	-1.878***	-1.647**	-1.623**	-1.565**	-1.886
	(0.730)	(0.794)	(0.739)	(0.708)	(1.189)
(7) ATT_{2010}	-1.878***	-1.647**	-1.623**	-1.565**	-1.886**
	(0.680)	(0.708)	(0.781)	(0.666)	(0.825)

Note: Bootstrapped standard errors on the basis of 500 replications are in parentheses.

***, **, * represent respectively the statistical significance at threshold of 1%, 5% and 10%.

5. CONCLUSION AND POLICY IMPLICATIONS

In this paper, we tried to study the dynamic interaction that may exist between the adoption of IT and the conduct of fiscal policy, in terms of the public deficit performance, in the case of emerging economies. Taking inspiration from previous works having studied the disciplining effect of the IT on tax policy performance and using the propensity score matching approach, we could evaluate the time varying treatment effect (the adoption of IT) on the budget deficit of ITers. Our estimation results show a low performance in terms of reducing the public deficit in emerging countries during the early years following the adoption of IT but (that) this situation is changing over time with the strengthening of the institutional and economic conditions, it will have a significant effect on reducing the budget deficit. This impact is on average in the order of 1.8% percentage points. In sum, the lag in effect of IT on public deficit performance proves shorter for emerging countries having adopted this monetary policy framework. Therefore, we can say that the emerging government can benefit ex-post and gradually from a decline in their public deficits and our conclusions corroborate the literature disciplining effect of IT on fiscal policy.

The policy implication(s) can manifest at this point. The adoption of IT renders monetary authorities more independent vis-à-vis the public authorities and does produce an incentive for governments to improve institutional quality, prompting these to reform their tax systems and therefore to perform their budget deficits.

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APPENDICES

Appendix 1/ Table 1: List of the sample countries with dates of inflation targeting adoption

IT countries	Full-Fledged adoption	Non-IT Countries
Brazil	1999	Algeria
Chile	2000	Angola
Colombia	2000	Argentina
Czech Republic	1998	Bulgaria
Ghana	2007	China
Guatemala	2005	Côte d'Ivoire
Hungary	2001	Dominican Republic
Indonesia	2005	Egypt
Israel	1997	El Salvador
Mexico	2001	Ecuador
Peru	2002	India
Philippines	2002	Malaysia
Poland	1999	Morocco
Romania	2005	Nigeria
Serbia	2006	Pakistan
Slovakia	2005	Russia
South Africa	2000	Senegal
South Korea	1998	Singapore
Thailand	2000	Tunisia
Turkey	2006	Uruguay
		Venezuela

Source: Lin and Ye (2009) and Internet sites of central banks.
Note that Slovakia abandoned the IT in 2009 and joined the euro area.

Appendix 2: Variables definitions and sources

Variables	Definitions	Sources
<i>IT_FF</i>	Fully-fledged adoption of inflation targeting.	Levyra (2008)
<i>B_DEFICIT</i>	Budget deficit as % of GDP.	WDI (2012)
<i>GDPpc_G</i>	Real GDP per capita growth.	WDI (2012)
<i>INF_1</i>	One-year lagged inflation rate (as annual change of the CPI).	WDI (2012)
<i>TOR_5</i>	Turnover rate of central bank governors based on 5-year averages (De facto central bank independence indicator).	Dreher et al. (2008); Lucotte (2012)
<i>EXCH</i>	De facto flexibility indicator of exchange rate, comprised between 1 and 14 from the least to more flexible exchange rate regime.	IMF's AREAR; Reinhart and Rogoff (2004)
<i>CRED</i>	Domestic credit to private sector ratio in % of GDP.	WDI (2012)
<i>OPEN</i>	Trade openness (as the sum of exports and imports of goods and services as a share of GDP).	WDI (2012)
<i>PUB_DEBT</i>	Total public debt as a share of GDP.	Abbas et al. (2010)
<i>POLITY2</i>	Indicator of democracy taking values from -10 (very autocratic) to +10 (very democratic).	Polity IV Project

