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GUSTAVO JOSÉ DE GUIMARÃES E SOUZA

Essays on Monetary Policy under Inflation Targeting Framework

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Tese apresentada ao Programa de Pós-Graduação em Economia da Faculdade de Economia, Administração e Contabilidade da Universidade de Brasília como requisito parcial para obtenção do Título de Doutor em Economia.

Orientador: Prof. Joaquim Pinto de Andrade;

Coorientador: Prof. Helder Ferreira de Mendonça.

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Brasília, DF, 04 de Junho de 2013.

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4 - Resultado

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- [ ] Pela aprovação da **Tese**, com revisão de forma, indicando o prazo de até 30 dias para apresentação definitiva do trabalho revisado.
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À Santíssima Trindade: o PAI, o FILHO e o ESPÍRITO SANTO.

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“The best way to destroy the capitalist system is to debauch the currency. By a continuing process of inflation governments can confiscate, secretly and unobserved, an important part of the wealth of their citizens.”

John Maynard Keynes (1883–1946),
British economist. Essays in Persuasion, Ch. 2 (1931).

"When I stand before God at the end of my life, I would hope that I would not have a single bit of talent left, and could say, 'I used everything you gave me'."

Erma Louise Bombeck (1927-1996),
U.S. humorist and author.

Resumo

Esta tese é composta por quatro ensaios sobre o Regime de Metas de Inflação (RMI). O primeiro capítulo estuda a credibilidade e a reputação da autoridade monetária sob este arcabouço de política monetária. O principal objetivo ao se adotar o regime é criar um ambiente no qual as expectativas de inflação convirjam para a meta. Assim, reputação e credibilidade são características essenciais no contexto do RMI. Maior confiança e conhecimento conduzirão a menores custos de desinflação. Sob esta perspectiva, o capítulo ilustra quais são os melhores índices de credibilidade e reputação no que tange à explicação das variações nas taxas de juros. A evidência indica que os tradicionais índices de credibilidade e os novos índices propostos, baseados na reputação, confirmam a hipótese que maior credibilidade implica em menores variações nas taxas de juros para controlar a inflação. O segundo capítulo examina se os países que adotam o regime têm sucesso no atingimento de seus dois principais objetivos: convergir a inflação aos níveis internacionalmente aceitos e reduzir a volatilidade da inflação. A metodologia de *Propensity Score Matching* é a análise empregada neste capítulo por considerar a teoria dos contrafactuais. A amostra global é dividida em dois grupos de países - avançados e em desenvolvimento - no qual propicia, usando a mesma base de dados, distintos e comparáveis resultados. Desta forma, baseado em uma metodologia única, é possível avaliar se os resultados para os países sob RMI são os mesmos quando economias avançadas e em desenvolvimento são analisadas separadamente. Os resultados sugerem que a adoção do RMI é benéfica para os países em desenvolvimento enquanto não aparenta representar uma estratégia vantajosa para economias avançadas. Em síntese, os resultados empíricos indicam que a adoção do RMI é útil para países que necessitem de melhorar a credibilidade na condução da política monetária. O terceiro capítulo, por sua vez, investiga o desempenho econômico sob o RMI e compara o resultado com países que utilizam regimes diferentes. Esse ponto é especialmente importante, dado que a crise financeira internacional recente desafia a capacidade do RMI de criar um ambiente macroeconômico que permita a recuperação da atividade econômica. Para o intento, três amostras são usadas: países avançados, países em desenvolvimento e a amostra global. Um relevante resultado das várias estimações empregadas é que existe um efeito constante e positivo sobre o produto após a adoção do RMI, especialmente para as economias em desenvolvimento. Essa observação sugere a existência de uma possível mudança estrutural capaz de modificar o crescimento econômico. Finalmente, no quarto capítulo, é mostrado um novo arcabouço teórico que assume o efeito sobre o crescimento econômico como derivado da mudança institucional ocasionada pela adoção do RMI. Em termos gerais, os resultados denotam que o RMI gerou um aumento do produto e do crescimento econômico para os países que optaram por esta estratégia de condução da política monetária, como sugerido no capítulo anterior.

Palavras-chave: Política Monetária, Regime de Metas de Inflação, Credibilidade, Reputação, Crescimento Econômico, Mudança Estrutural.

Classificação JEL: E42, E52, O42, O43.

Abstract

This thesis is comprised of four chapters about monetary policy under Inflation Targeting (IT). The first one studies the credibility and reputation in this monetary regime. The main aim in the adoption of IT is to create an environment where inflation expectations converge to inflation target. Hence, reputation and credibility of monetary authority are essential to this regime. Higher trustworthiness and expertise will lead to lower disinflation costs. Under this perspective, the first chapter illustrates which measures of credibility and reputation are most useful in predicting variations of interest rates. The evidences indicate that the traditional credibility indices and the ones based on reputation confirm the hypothesis that higher credibility implies lower variations in the interest rates for controlling inflation. The second chapter examines whether inflation targeters are successful in meeting their two leading goals: driving inflation to internationally acceptable levels and decreasing inflation volatility. The analysis in this chapter employs the Propensity Score Matching methodology, which take into consideration the choice of counterfactuals. The world sample is split into two sets of countries (advanced and developing countries), which provide, using the same database, distinct and comparable results. Based on the same methodology, it is therefore possible to evaluate whether the outcomes for countries under IT remain the same even when advanced and developing countries are analyzed separately. The findings suggest that the adoption of IT is an ideal monetary regime for developing economies and it does not appear to represent an advantageous strategy for advanced economies. In a few words, the empirical results indicate that the adoption of IT is useful for countries that must enhance their credibility for the management of monetary policy. The third chapter investigates the economic performance under IT and compares to non-targeting regimes. This point is especially important since the global financial crisis challenges the capacity of this monetary regime to create a macroeconomic environment that permits a recovery in economic activity. To this end, three samples are used: advanced countries, developing countries and whole sample. An important result of the several estimations in this study is that there is a positive constant effect on the output after the adoption of IT, especially to developing countries. This observation suggests that there is a possible institutional change capable of shifting the economic growth. Finally, in the fourth chapter, a new theoretical framework that assumes the effect on economic growth regarding the structural change due to the adoption of IT is shown. In general, the findings denote that IT has provided an increase in output and economic growth in countries that have adopted it, as suggested in the previous chapter.

Key words: Monetary Policy, Inflation Targeting, Credibility, Reputation, Economic Growth, Institutional Change.

JEL Classification: E42, E52, O42, O43.

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Prologue

In the last years, several countries, which differ in development level, social, political, cultural and economic features, have selected Inflation Targeting (IT) as their preferred framework for pursuing an effective monetary policy. IT is a monetary policy approach that can be characterized by three aspects: i) an announced numerical inflation target; ii) a monetary policy that gives a major role to an inflation forecast (forecast targeting); and iii) a high degree of transparency and accountability (Svensson, 2008). Henceforth, IT has become the natural complement of flexible exchange rate regimes.

The IT's theory and practice have advanced together over the past few decades, and there is now a great academic literature and central bank experiences on features of this regime. By the early 2000s, both academic research and the experience at policymakers, led to almost unanimous support for this monetary policy design, also known as "flexible inflation targeting"[1]. As noted by Svensson (2010, p. 1239),

> "In practice, inflation targeting is never 'strict' but always 'flexible', because all inflation-targeting central banks ('central bank' is used here as the generic name for monetary authority) not only aim at stabilizing inflation around the inflation target but also put some weight on stabilizing the real economy; for instance, implicitly or explicitly stabilizing a measure of resource utilization such as the output gap; that is, the gap between actual and potential output. Thus, the 'target variables' of the central bank include inflation as well as other variables such as the output gap".

A major benefit is that IT combines elements of 'rules' and 'discretion' - in the context of a rules versus discretion paradigm, first codified by Kydland and Prescott (1977) - and is consequently characterized as 'constrained discretion' (Bernanke *et al*., 1999). As stated by Hammond (2012), within this rule-like framework, the monetary authority has discretion in reacting to shocks, e.g., in how quickly to bring inflation back to target.

The main goal in the adoption of IT is to produce an environment where

[1] Flexible inflation targeting is discussed in Svensson (1997), Bernanke, *et al* (1999), Mishkin (2007), Mishkin and Schmidt-Hebbel (2007a).

inflation expectations converge to inflation target. Hence, credibility of central banks are crucial to manage the monetary policy and the measurement of credibility and reputation is fundamental for the analysis of countries that adopted this framework. According to Svensson (2010), a central bank is credible when private inflation expectations are consistent with the central bank's goal. In fact, establishment of "credibility" is a priority for IT regimes.

Under this perspective, the first objective of this thesis is to illustrate which measures of credibility and reputation are most useful in predicting variations of interest rates and whether higher credibility decreases the cost of disinflation under IT. Given a specific inflation target, this relationship is valuable for central bankers as well as for private agents trying to predict the central bank's policies.

Because Brazil is part of an important group of developing countries (BRICS – Brazil, Russia, India, China and South Africa) and represents a potential laboratory experiment in which the effects of an adoption of IT since 1999 can be observed, an analysis through several credibility indices and its relation with the basic interest rate is made in the first chapter of this thesis.

In hindsight, since the 90s, IT in various forms has been adopted as a strategy to reduce and control inflation and inflation volatility. Concerning the effectiveness for these two key goals, some important questions remain unanswered: (i) How successful is IT in reducing and stabilizing the inflation rate? (ii) Are effects caused by IT sufficiently homogeneous when both developing and industrialized countries are taken into consideration?

To shed light on these questions, the second chapter looks at countries that adopted IT, henceforward, inflation targeters (ITers) to see whether the changes with respect to inflation / volatility observed over time are indeed due to the adoption of this framework.

In comparing inflation to medicine, inflation can be seen as an analogy for a typical illness in capitalist economies. In general, inflation is an illness without a cure. With that being said, the illness could still be treated in order to control the symptoms. Consequently, IT can be understood as a remedy for stabilizing and controlling inflation, the disease. Hence, just as in medicine, this study involves a quasi-natural experiment in which it is analyzed whether the remedy leads to the desired effects, or whether observed outcomes derive from other factors. This part of the thesis is concerned with these issues and makes use of the Propensity Score Matching methodology on a sample of 180 countries for the period from 1990 to 2007.

On the one hand, if IT can be understood as a medication, on the other hand, is important to know whether the treatment by IT can cause any side effects. A heated debate has taken place over the last years regarding the adverse effects of IT. Some critics have a skeptical view on IT and argue that it causes the central bank to focus excessively (or exclusively) on inflation, at the cost of output growth. Namely, central banks possibly will sacrifice other objectives in their pursuit of low and stable inflation (Friedman 2002, 2004). Moreover, the debate on the advantages and disadvantages of the IT has received new impetus after the subprime crisis. The recession observed in several countries demands a more accurate analysis of the inflation control on output. These criticisms has sparked much debate and attention among economists, researchers and central bankers about the impact of IT on economic growth.

Regarding this discussion, the third chapter shows empirical evidence concerning the collateral effects of IT on economic growth taking into account cross-dependence among the countries. The idea is to examine the economic performance under IT and in comparison to non-targeting regimes.

To this end, a set of 128 countries (ITers and non-ITers) for the period from 1970 to 2007 is considered and a new econometric approach is implemented. It is important to note that this approach allows one to observe some characteristics that are not detected in the traditional econometric specification to treatment effects. Initially, we can verify whether, for the period preceding the adoption of IT, the public anticipated the effects - or a possible endogenous effect - where the output affects the decision for adoption of IT. Moreover, if the effects are not immediate or if there is some delay in the process. Finally yet importantly, if the collateral effect on output growth is decreasing, increasing, constant, or random.

An intriguing finding of the several estimations in the third chapter is that there is a positive and *constant* effect on the output after the adoption of IT. This observation suggests that there is a possible structural change capable of shifting the economic growth. Finally, in the fourth chapter, we present a new framework that assumes the effect on economic growth regarding the structural change due to the adoption of IT. As highlighted by North (1990) and Acemoglu, Johnson and Robinson (2005a, 2005b), the institutions define the rules of the game of a society such as regulations, policies, cultures, and norms. Hence, in an innovative way the adoption of IT as an institutional change in the conduct of monetary policy is considered.

This approach is only possible because of recent improvements and advances in panel time-series methodology, the increasing number of countries that adopted IT and the growing experience of the same over the years. Different methods of analysis of macroeconomic and information of 30 countries that adopted IT for three different periods (1970-2007, 1960-2007, and 1950-2007) are considered.

Chapter

1. Credibility and Reputation under Inflation Targeting: a new perspective

1.1. Introduction

During the 1990s the argument that the monetary policy must have as main objective the search for price stability became consolidate. Moreover, the necessity for finding mechanisms that avoid the dynamic inconsistence problem became fundamental in the analysis of credibility in the conduction of the monetary policy. The basic idea is that an increase in central bank credibility contributes to an increase in credibility of the monetary policy, that is, the belief by the public in the probability of a successful execution of the policy (Drazen, 2000).

Since the collapse in the use of the exchange rate as a nominal anchor in the second half of the 1990s, the adoption of inflation targeting emerged as an alternative monetary regime. The main characteristic in the adoption of inflation targeting is the price stabilization as a way for creating an environment, which promotes a convergence between inflation expectations and inflation target. Due to the essential role that public expectations have in this framework, reputation and credibility are essential to this monetary regime. Therefore, the measurement of credibility and reputation is fundamental for the analysis of countries that adopted inflation targeting.

With the objective to illustrate which measures of credibility and reputation are most useful in predicting variations of interest rates, the Brazilian case is used. Given a specific inflation target, this relationship is valuable for central bankers as well as for private agents trying to predict the central bank's policies. The justification for the use of Brazil in the analysis is that this country is still building its credibility and it is one of the most important developing countries that have adopted inflation targeting. In particular, the adoption of inflation targeting in Brazil (June 1999) was due to the necessity of finding a new nominal anchor for stabilizing prices after the change in the exchange rate regime in January 1999.

In the last years, taking into consideration the argument presented by Agénor and Taylor (1992, 1993) and Svensson (2000) that series of inflation expectations could be used in the creation of credibility indices, the literature has shown some advances. Under this view, the present chapter analyzes the Brazilian monetary credibility through several indices and its relation with the basic interest rate (defined by financial market and the target defined by Monetary Policy Committee). This chapter is organized as follows: the next section shows the several indices which are used in this study, section 3 makes an analysis of the indices for the Brazilian economy, section 4 shows empirical evidence between credibility and inflation taking into account the interest rate, and section 5 concludes the chapter.

1.2. Credibility indices

The appointment of the monetary authority in each contract with the society is used by the economic agents for planning its strategies. In this sense, a high credibility in the policy adopted by the monetary authority contributes to a stable economic environment, which permits the public to plan the future. The objective of this section is to show the credibility indices which are used in this chapter. Two indices Cecchetti and Krause (2002) and de Mendonça (2007b) are based on the idea that credibility is defined as negatively related to the distance between the private sector's inflation expectations and the bank's announced inflation target (Faust and Svensson, 2001). Thus, any deviation of inflation in relation to the central target implies a credibility loss. Besides these measures of credibility, an index that takes into consideration departures from interval fluctuation of inflation in relation to the inflation target, and another three indices derived from reputation are shown.

Cecchetti and Krause (2002) built an index for measuring credibility (CI_K) which considers the difference between the expected inflation ($E(\pi)$) and the target (π_t). This index assumes values between "0" (without credibility) and "1" (full credibility). When the expected inflation is lower than the target this case represents maximum credibility. While the expected inflation departs from the target, the index decreases in a linear way until it arrives at "0" where the expected inflation crosses 20%.[2] Hence,

[2] The creators of this index believe that an expected inflation higher than 20% implies a loss in the control of inflation by the monetary authority.

$$CI_{CK} = \begin{cases} 1 & if \quad E(\pi) \leq \pi_t \\ 1 - \frac{1}{0.2 - \pi_t}\left[E(\pi) - \pi_t\right] & if \quad \pi_t < E(\pi) < 0.2 \\ 0 & if \quad E(\pi) \geq 0.2 \end{cases}. \tag{1.1}$$

Taking into account a similar framework to that presented by Cecchetti and Krause (2002), de Mendonça (2007b) - CI_M - developed a credibility index that considers the inflation target and the tolerance intervals. The credibility index has a value equal to 1 when the annual expected inflation ($E(\pi)$) is equal to the target inflation and decreases in a linear way while inflationary expectation deviates from the announced target. Therefore, the credibility index shows a value between 0 and 1 strictly if the expected inflation is situated between the maximum and minimum limits (π_t^*) established for each year and assumes a value equal to 0 when the expected inflation exceeds one of these limits. Hence,

$$CI_M = \begin{cases} 1 & if \quad E(\pi) = \pi_t \\ 1 - \frac{1}{\pi_t^* - \pi_t}\left[E(\pi) - \pi_t\right] & if \quad \pi^*_{t\ Min} < E(\pi) < \pi^*_{t\ Max} \\ 0 & if \quad E(\pi) \geq \pi^*_{t\ Max} \quad or \quad E(\pi) \leq \pi^*_{t\ Min} \end{cases}. \tag{1.2}$$

A well-known cause for the failure in the achievement of the inflation target is the imperfect control over inflation by the monetary authority. In an attempt to eliminate this problem, the adoption of tolerance intervals gives more flexibility to the conduction of the monetary policy increasing the transparency and thus avoiding the necessity to justify few deviations of the inflation in relation to the target (Brunilla and Lahdenperä, 1995). Under this perspective, assuming that the public has rational expectations, a loss in credibility due to the deviation of inflation in relation to the target while the inflation is within the tolerance interval is too severe.

Taking into consideration the idea above, a different credibility index is elaborated (CI_A), which assumes a loss in credibility when the public expects that the central bank is not capable of bringing the inflation to the tolerance interval. Therefore, when the inflation expectation is found between upper bound ($\pi^*_{t\,Max}$) and lower bound ($\pi^*_{t\,Min}$) the credibility is full. The justification for this procedure is that the obligation of the monetary authority is the convergence of inflation for the interval and not for a specific value. On the other hand, there is no credibility in two cases: (i) when the inflation expectation is higher than 20%; or (ii) when the inflation expectation is null/negative. Moreover, when the inflation expectation is found between $\pi^*_{t\,Max}$ and 20% or between $\pi^*_{t\,Min}$ and 0% the credibility index varies between]0, 1[. Therefore, the loss in credibility is due to any deviation of the inflation in relation to the expected interval. That is,

$$CI_A = \begin{cases} 1 & if \quad \pi^*_{t\,Min} \le E(\pi) \le \pi^*_{t\,Max} \\ 1 - \dfrac{1}{0.2 - \pi^*_{t\,Max}}\left[E(\pi) - \pi^*_{t\,Max}\right] & if \quad \pi^*_{t\,Max} < E(\pi) < 0.2 \\ 1 - \dfrac{1}{-\pi^*_{t\,Min}}\left[E(\pi) - \pi^*_{t\,Min}\right] & if \quad 0 < E(\pi) < \pi^*_{t\,Min} \\ 0 & if \quad E(\pi) \ge 0.2 \quad or \quad E(\pi) \le 0 \end{cases}. \quad (1.3)$$

The value of 20% adopted by CI_A as a limit for the loss in credibility is extracted from CI_{CK}. It is important to note that the adoption of an inflation of two digits is not adequate as a limit. A good example is the Brazilian case in 2002. Although the inflation reached 12.53% (much higher than the upper bound, which was 5.5%) the Central Bank of Brazil (CBB) was capable of neutralizing the public expectation in respect to the increase in inflation. The value of 0% being considered critical for a loss in credibility is based on the argument that a null or negative inflation implies the risk of reducing output or increasing unemployment (Svensson, 2000).

The combination of fixed critical values with flexibility in the definition of the interval defined by the monetary authority creates an asymmetrical framework that is useful in the measurement of credibility. When the limit of interval is close to the critical point, more sensitivity is associated with the variation of the credibility for values that exceed this limit. In other words, if the central bank defines a tolerance interval where the upper limit is too close to 20%, any variation in the expectation above this limit will be strongly punished with a loss in credibility.

Due to the unavailability of the series relative to inflation expectation for some periods and for most countries, there is a difficulty in the application of the above-mentioned indices. Hence, instead of analyzing credibility through expectation, an alternative method, which takes into consideration the observed performance and thus the reputation obtained over time, is proposed. As reputation is essentially backward looking (depends on past behavior of the monetary authority) while the credibility is forward-looking, the reputation can be fundamental for developing credibility. In short, central banks with little or no reputation would suffer limitations in the conduction of the monetary authority because their policies would not be credible ex-ante.

The next three indices are based on the premises that credibility can be measured by the sum of reputations over time. For the calculation of reputation (R) a framework, which is similar to that applied for the CI_A, is used. The main difference is that the deviations are calculated taking into account the observed inflation and not the expected inflation. It is important to note that credibility is a result of the state of expectation while reputation is given by departures of inflation from the target. Therefore,

$$R = \begin{cases} 1 & if \quad \pi^*_{t\ Min} \leq \pi_{tOBS} \leq \pi^*_{t\ Max} \\ 1 - \dfrac{1}{0.2 - \pi^*_{t\ Max}} \left[\pi_{OBS} - \pi^*_{t\ Max} \right] & if \quad \pi^*_{t\ Max} < \pi_{OBS} < 0.2 \\ 1 - \dfrac{1}{-\pi^*_{t\ Min}} \left[\pi_{OBS} - \pi^*_{t\ Min} \right] & if \quad 0 < \pi_{OBS} < \pi^*_{t\ Min} \\ 0 & if \quad \pi_{OBS} \geq 0.2 \quad or \quad \pi_{OBS} \leq 0 \end{cases} . \quad (1.4)$$

Based on the measurement above three new indices of credibility are presented: (i) a credibility index based on average reputation (CI_{AR}); (ii) a credibility index based on weighted reputation (CI_{WR}); and a credibility index based on reputation by moving average (CI_{MAR}).

The CI_{AR} is only the arithmetic average of reputation, that is, the sum of reputation over time on number of reputation (n),

$$CI_{AR} = \left\{ \frac{\sum_{i=1}^{n} R_i}{n} \right\}. \tag{1.5}$$

For the calculus of CI_{WR}, the weight of reputation is decreasing while the time departs from the current period (t). In other words, the weight (p_i) is given by the ratio between k_i (decreasing in relation to t) and n which in turn implies that the variation of the weight is in interval]0, 1]. Therefore,

$$CI_{WR} = \left\{ \frac{\sum_{i=1}^{n} (R_i \times p_i)}{\sum_{i=1}^{n} p_i} \right\}, where \quad p_i = \frac{k_i}{n} \cdot \tag{1.6}$$

The CI_{MAR} calculates the current credibility based on moving average of reputation in the last l (lags) periods,

$$\begin{aligned} CI_{MAR_t} &= \left\{ \frac{R_t + R_{t-1} + \ldots + R_{t-l+1}}{l} \right\}, or \\ CI_{MAR_t} &= \left\{ CI_{MAR_{t-1}} + \frac{R_t - R_{t-l}}{l} \right\}. \end{aligned} \tag{1.7}$$

Credibility can be understood as the level of confidence that the economic agents give in the feasibility of an announced policy to be implemented and to be achieved. In other words, a policy will inspire more credibility if it indicates to the public a small chance of time inconsistency. Thus, for example, if the monetary authority had success in the control of inflation over time (which implies gains in reputation) the public believes that the central bank will have success in the control on future inflation, which in turn denotes a high degree of credibility. In short, credibility is the function that transforms past information (R_{t-l}) and current information (R_t) of the reputation for identifying the public expectation relative to the success of an announced policy.

1.3. Application of indices for the Brazilian case

With the objective of analyzing the behavior of the indices presented in the previous section for the Brazilian economy, the National Consumer Price Index (extended) – IPCA (official price index) was adopted as a measure of inflation. Moreover, taking into consideration the information available by CBB, the annual inflation target and the respective tolerance intervals defined by the Brazilian National Monetary Council (CMN) were used in the analysis.

The strategy planned by the CMN in the launch of the monetary regime assumed a fast disinflation process. However, adverse shocks implied a necessity to revise the original strategy, which culminated in changes in inflation targets for 2003, 2004, and 2005 (see Table 1.1).[3] A good example is the inflation target for 2003 that was changed several times. The inflation target center was increased to 0.75% and also the tolerance interval to 1%. Notwithstanding, the change was not sufficient and in January of 2003 the CBB announced as the new target (adjusted) an inflation of 8.5% without tolerance intervals.

Due to the fact that the adjusted target for 2003 represents a break in the framework based on intervals (only in that year), the credibility calculus in 2003 took into consideration the target of 4% and its respective interval in January and the target of 8.5% with a tolerance interval of ±0.5% for the other months. The inclusion of an interval tolerance of ±0.5% is considered reasonable due to the target magnitude.[4]

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[3] The justification for the use of the adjusted targets, instead of inflation targets defined by CMN, is due to the public's behavior, which takes into consideration for its forecasts the target that must be achieved by CBB.

[4] Indeed, the distinction between the adoption of tolerance intervals or a single inflation point has a secondary role in the cases where the economic agents have rational expectation and know the central bank limitation for determining inflation (Brunilla and Lahdenperä, 1995).

The daily inflation expectations (annual reference) were extracted from the CBB's site. Due to the fact that the frequency adopted in this study is monthly, the monthly average of inflation expectation was calculated (INFEXP). With the intention of calculating the credibility indices based on reputation, the inflation measured by IPCA is considered in the analysis. Moreover, it is important to note that the inflation is annualized for comparison with the annual targets.

Table 1.1 - *Inflation targets and observed inflation*

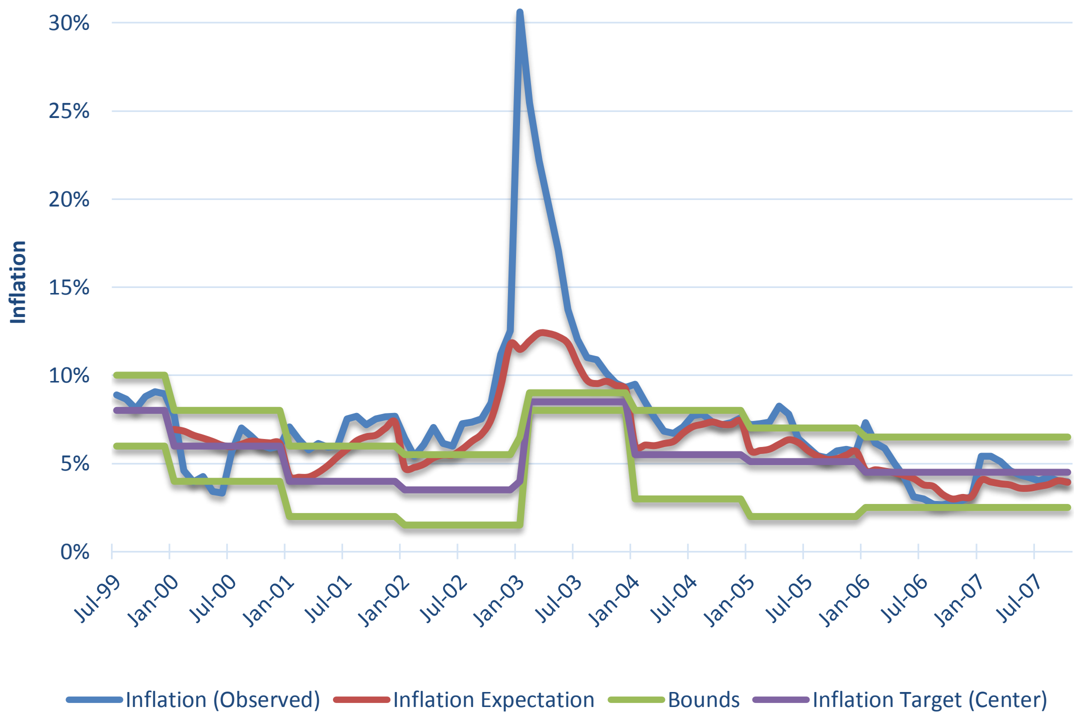
Year	Inflation target (%)	Tolerance intervals ± (%)	Normative	Observed inflation (%)
1999	8.00	2.0	2615 of June 1999	8.94
2000	6.00	2.0	2615 of June 1999	5.97
2001	4.00	2.0	2615 of June 1999	7.67
2002	3.50	2.0	2744 of June 2000	12.53
2003	3.25 4.00 8.50	2.0 2.5 0.0	2842 of June 2001 2972 of June 2002 Open letter of January of 2003	9.30
2004	3.75 5.50 5.50	2.5 0.0 2.5	2972 of June 2002 Open letter of January of 2003 3108 of June 2003	7.60
2005	4.50 5.10	2.5 +1.9/-3.1	3108 of June 2003 100ª Copom minutes of September 2004*	5.69
2006	4.50	2.0	3210 of June 2004	3.14
2007	4.50	2.0	3.291 of June 2005	4.46

Notes: Source - Central Bank of Brazil. (*) Copom is the Monetary Policy Committee.

It is important to highlight that the inflation annualization takes into consideration the inflation from the beginning of the year until the month when the information is gotten. This procedure is adequate for the calculation of the monthly reputation because it considers the whole inflation during the contract (the annual inflation target). Therefore, the method adopted permits the evaluation of performance in the achievement of the contract over the period under consideration. Thus, in each month the reputation is built based on the current contract. It is assumed that the observed inflation for the months that do not belong to the current year must be related with the inflation target for the correspondent year. Hence, the use of the inflation accumulated in the last 12 months would not be adequate because during the disinflation process it is normal that each year (which represents a contract of the monetary authority with the society) there is a different inflation target. Thus, for the Brazilian case, the presence of a structural break and the change in the observed inflation trend each year is expected which in turn makes the uses of this methodology inadvisable.[5]

The behavior of the above-mentioned variables after the adoption of inflation targeting is shown in Figure 1.1. It is observed that both inflation expectation and inflation (from the second semester of 2001 until the beginning of 2004) are above the upper bound of the tolerance interval during almost the entire period.

Figure 1.1 - *Inflation, Inflation Expectation and Inflation targets*

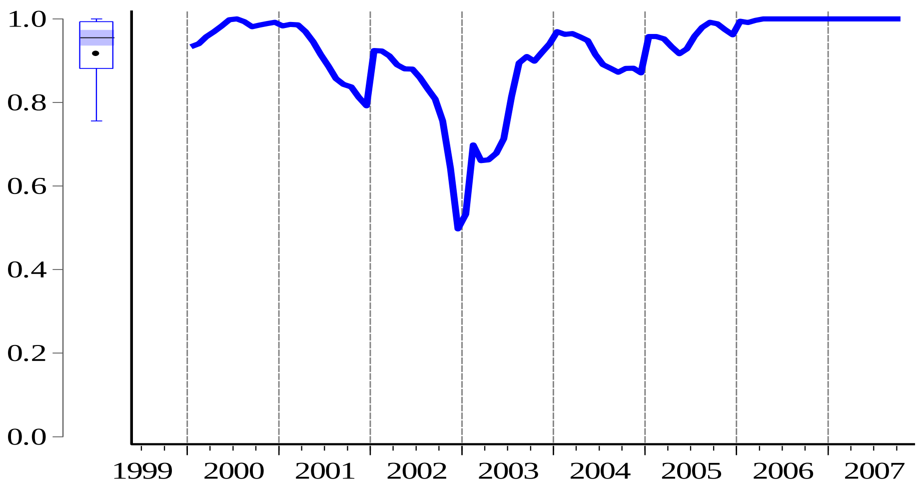


The credibility measured refers to the monetary policy based on the inflation targeting adopted in June 1999. Therefore, the indices based on reputation were calculated since the introduction of the monetary regime. On the other hand, the market expectation for the inflation is available only from January 2000. Consequently, the indices of credibility based on expectation are calculated starting at 2000.

[5] Figure 1.1 reveals that the main oscillation in the series under consideration occurs in the changes each year, that is, the transactions of contracts between the CBB and the society.

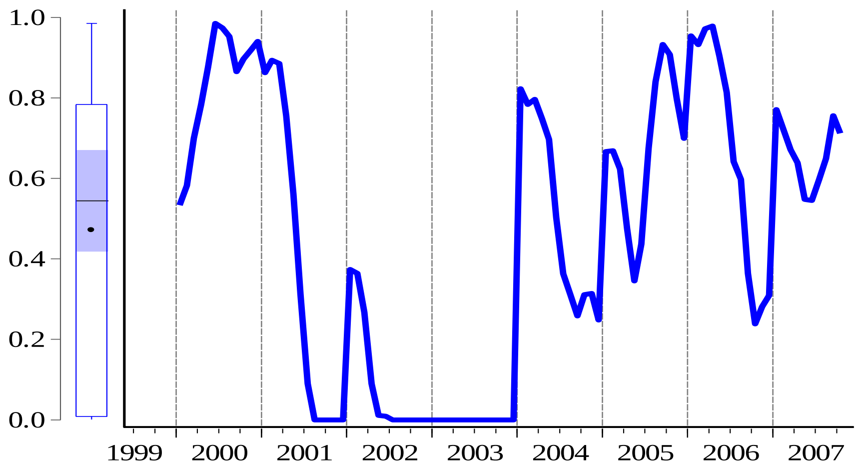
The CI_{CK} reveals a high credibility (greater than 0.90 in average) for almost the whole period with a value under this level only between 2002 and 2003 (see Figure 1.2). It is important to note that this index does not punish the credibility if the expectation is under the inflation target (center). Moreover, the framework of this index with a large interval between the center of the inflation target and the critical point for the credibility loss (20%) is a justification for the high average credibility in the period (0.92).

Figure 1.2 - *CI_{CK} path*



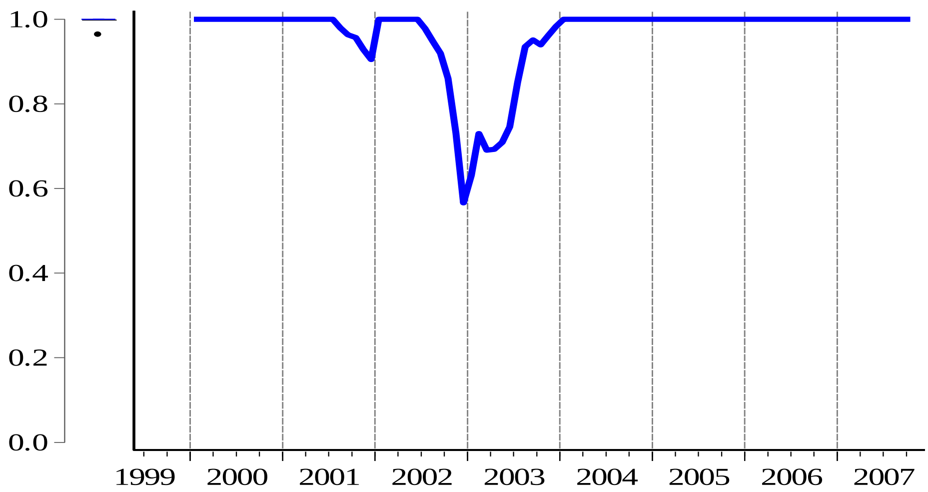
Contrary to the observed for CI_{CK}, the CI_M shows an unsatisfactory performance for credibility over the period under analysis. Null values are present for a long period (from the second quarter 2001 to the end of 2003), and the remainder of the period exhibits a high volatility (see Figure 1.3). The punishment with whole loss credibility when the inflation crosses the bounds of the tolerance interval justifies the low average credibility in the period ($CI_M=0.47$).

Figure 1.3 - CI_M *path*



Due to the fact that CI_A indicates full credibility when the inflation expectation is within the tolerance interval, the years 2000, 2004, 2005, 2006 and 2007 are marked by a stability in the maximum level ($CI_A=1$). On the other hand, a credibility under the maximum level (inflation expectation out of the tolerance interval) is observed in large part for the years 2001, 2002, and 2003 (see Figure 1.4). The fact that the credibility index reveals a loss in credibility only in extreme conditions, the average credibility in the period corresponds to 0.96.

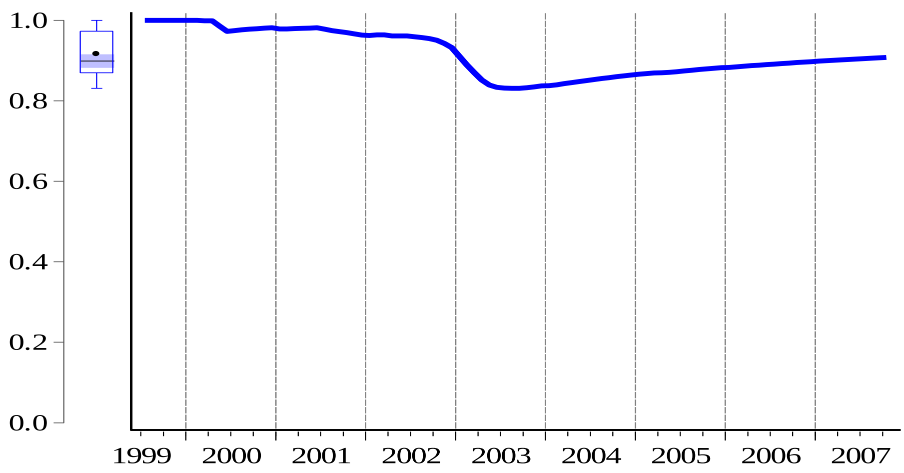
Figure 1.4 - CI_A *path*



In each period of new contract for inflation target (one year in the Brazilian case), the inflation expectation and thus the above-mentioned credibility indices represents a break in the standard of the previous year. Therefore, in the beginning of each year the inflation expectation is adjusted to the target taking into consideration the performance of the monetary authority based on the past contract, which in turn strengthens the idea that the past is relevant.

The indices CI_{AR}, CI_{WR}, CI_{MAR} are variants of a same function with the objective of measuring credibility. The basic difference among the above-mentioned indices is the sensitivity in relation to the past information and current information. The CI_{AR} does not consider the distance of the reputation in relation to the current period (t). The CI_{WR} is more sensitive to the recent reputation while the CI_{MAR} assumes that the economic agents have short memory and thus, for the evaluation of credibility, take into consideration only the recent period.

Figure 1.5 - *CI_{AR} path*



The credibility indices calculated through reputation (see figures 1.5, 1.6, and 1.7) exhibit a behavior less unstable than the previous indices. Due to the standard that recognizes the past and current reputation for calculating credibility, these indices take more time to reveal the loss and gain of credibility. It is observed that the paths are smoothed specially for CI_{AR} and CI_{WR}. This effect is more visible for CI_{AR} because this index considers the same weight for all reputations. In other words, lagged reputation has the same influence in the credibility as well as current reputation. The CI_{WR} weights differently each reputation taking into consideration the premises that past information is less relevant than current information. The average credibility measured by both indices has little difference. While CI_{AR} corresponds to 0.92, the CI_{WR} is 0.89.

Figure 1.6 - *CI_{WR} path*

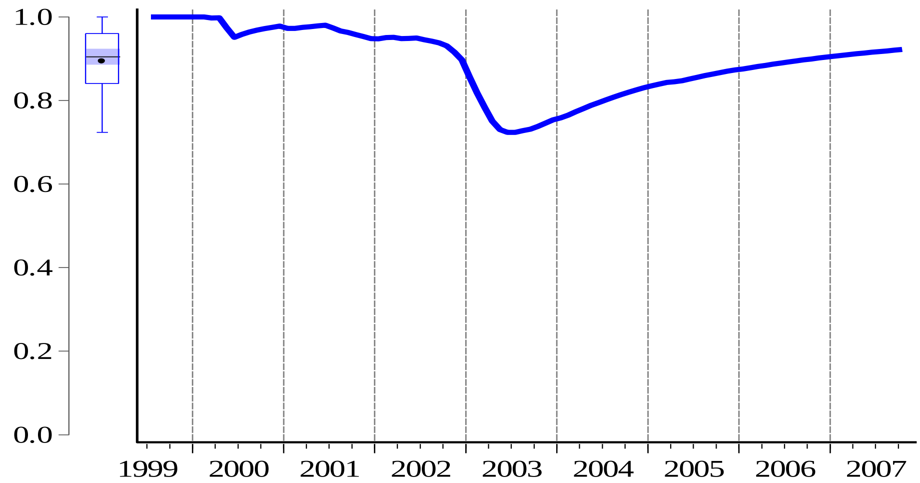
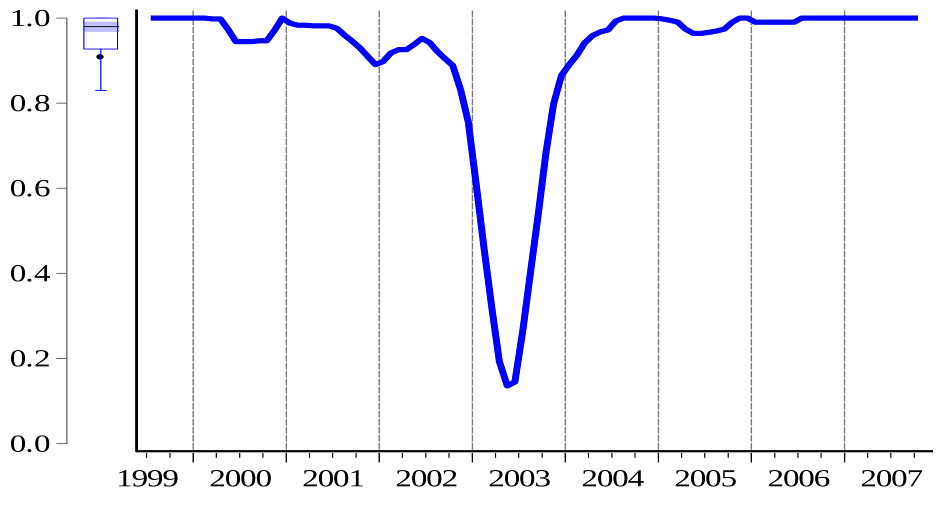


Figure 1.7 - *CI_{MAR} path*



For the calculation of CI_{MAR}, the last 6 months were adopted, that is, only the last six reputations (monthly) are considered in the measurement of current credibility. The behavior of this index (more volatility) is close to those indices that adopt expectation due to the framework with weights. The CI_{MAR} had an average credibility that corresponds to 0.91. However, the CI_{MAR} between 2002 and 2003 revealed a significant fall in credibility due to the weak performance of the monetary policy in the control of inflation.

In short, all indices revealed a non-negligible fall in credibility for 2001, 2002, and 2003. The year of 2001 was marked by the announcement of electrical energy rationing, the expected crisis in Argentina, and the fall of economic activity in the world. In 2002, the adverse environment was not different because the loss of US$ 27.8 billion due to a strong increase in risk aversion in the international markets, the difficulty in the management of the public debt, and the uncertainty in relation to the continuity of the current macroeconomic policy damaged the economic performance. In relation to 2003, the bad performance is focused on the first quarter reflecting the adversities of the previous year.

The difficulties and the fall in credibility observed between 2001 and 2003 implied a bad performance of the inflation targeting (see Figure 1.1). Taking into consideration all indices of credibility, the average during 2002 and 2003 is the lowest in comparison with the other years in the sample (see Table 1.2). Hence, the years that exhibit the highest fall in credibility correspond to that where the inflation target were not achieved.

Table 1.2 - *Credibility indices – annual average **

Indices	1999	2000	2001	2002	2003	2004	2005	2006	2007
CI_{CK}	-	0.98	**0.90**	**0.82**	**0.78**	0.92	0.96	1.00	1.00
CI_{M}	-	0.83	**0.36**	**0.09**	**0.00**	0.51	0.67	0.67	0.66
CI_{A}	-	1.00	**0.98**	**0.92**	**0.82**	1.00	1.00	1.00	1.00
CI_{AR}	1.00	0.99	0.97	0.96	**0.85**	**0.85**	**0.87**	0.89	0.90
CI_{WR}	1.00	0.98	0.97	0.94	**0.76**	**0.80**	**0.85**	0.89	0.91
CI_{MAR}	1.00	0.97	**0.96**	**0.90**	**0.45**	0.97	0.98	0.99	1.00
Average	1.00	0.96	0.86	**0.77**	**0.61**	**0.84**	0.89	0.91	0.91

* The values in bold indicate the lowest three average for each index in the period.

1.4. Empirical analysis

The main instrument to the disposition of the CBB for the convergence of inflation to the target is the basic interest rate (over/Selic rate). A credible monetary policy implies less effort by the CBB for the achievement of the inflation target due to the increased capacity of affecting the public expectation. Therefore, it is expected that a high credibility, *ceteris paribus*, is associated with a lower volatility of the interest rate for the achievement of the inflation target. Hence, this section shows empirical evidence between credibility and inflation taking into consideration the interest rate. In other words, the relations between each credibility index and the basic interest rate are analyzed. For the basic interest rate, two concepts are used: the target announced by Copom (IR_T) and the interest rate practiced in the market (IR_M) both with monthly frequency and annualized.

The models of multiple regressions estimated through the OLS method show the following variations:

$$\Delta IR_{T_i} = \alpha + \beta\Delta\left[E(\pi) - \pi_t\right]_i - \Delta CI_i + \varepsilon_i, \tag{1.8}$$

$$\Delta IR_{M_i} = \alpha + \beta\Delta IR_{M_{(t-1)_i}} - \Delta CI_i + \varepsilon_i, \tag{1.9}$$

For avoiding the deviation of the inflation in relation to the target, the CBB uses as its main mechanism the variation in the basic interest rate. Due to the lag for the effect of the monetary policy on inflation, deviations in the inflation expectation in relation to the target imply changes in the basic interest rate. However, this change in basic interest rate occurs in an indirect way. It is important to note that the Copom defines the target for the basic interest rate and it is the responsibility of the CBB to maintain this rate close to the target. The equation (1.8) evaluates the relation between credibility and the inflation target and controlling the effect of the average variation in the basic interest rate target through deviations of expectations due to the inflation target.

It is expected that a monetary authority that has reputation and conducts the monetary policy in a credible manner will be capable of achieving its objectives implying a lower social loss (considering unemployment and output). Thus, it is assumed that a high credibility implies a low cost in the control of inflation (represented by an increase in the interest rate). Consequently, the credibility affects the definition of the basic interest rate by Copom as well as the interest rate in the market. The equation (1.9) estimates the variation of the basic interest rate average in the market through the variation in the credibility and assuming as constant the effect caused by its own interest rate lagged one period.

For the empirical analysis, a first step is the examination of behavior of the stochastic process of the series over time, that is, the integration order of the series. The justification is that with this procedure spuriousness in the results can be avoided. Besides the visual analysis of the series through correlograms of series, the following unit root tests were performed: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and the DF-GLS. Based on Maddala (2001) the Kwiatkowski-Phillips-Schmidt-Shin's stationary test (KPSS) to confirmatory analysis was used. The number of lags for each series was defined according to the Schwarz criterion and the Newey-West Bandwidth (see Table 1.3).[6]

Table 1.3 - *Unit root tests and stationary test**

Series	*Level*			
	ADF	**PP**	**DF-GLS**	**KPSS**
CI_{CK}	Unit root	Unit root	Unit root	Unit root
CI_M	Unit root	Unit root	Unit root	Unit root
CI_A	Stationary	Unit root	Unit root	Unit root
CI_{AR}	Unit root	Unit root	Unit root	Unit root
CI_{WR}	Unit root	Unit root	Unit root	Unit root
CI_{MAR}	Unit root	Unit root	Unit root	Stationary
IR_T	Stationary	Unit root	Stationary	Unit root
IR_M	Stationary	Unit root	Stationary	Unit root
$E(\pi)-\pi_t$	Stationary	Stationary	Unit root	Unit root
	First difference			
$D(CI_{CK})$	Stationary	Stationary	Stationary	Stationary
$D(CI_M)$	Stationary	Stationary	Stationary	Stationary
$D(CI_A)$	Stationary	Stationary	Stationary	Stationary
$D(CI_{AR})$	Stationary	Stationary	Stationary	Stationary
$D(CI_{WR})$	Stationary	Stationary	Stationary	Stationary
$D(CI_{MAR})$	Stationary	Stationary	Stationary	Stationary
$D(IR_T)$	Stationary	Stationary	Stationary	Stationary
$D(IR_M)$	Stationary	Stationary	Stationary	Stationary
$D[E(\pi)-\pi_t]$	Stationary	Stationary	Stationary	Stationary

* Level of significance used is 10%.

[6] The results of each model are in appendix (Table A.1.1).

It is important to note that in the cases where the results are not clear (IR_T, IR_M, [$E(\pi)$-π_t]), a graphical analysis of the correlograms from the original values of the series based on the idea that non-stationary series have strong autocorrelation is made (Vandaele, 1983). It is observed that in all cases the autocorrelation decreases slowly and gradually while lags increase. In other words, it can be seen that the present values depend on past values suggesting a presence of unit root in the series. Therefore, all series in this analysis are I(1).

The hypotheses adopted by models suggest that the $E(\pi)$-π_t must precede the IR_T and this precedes IR_M. In other words, departures of inflation expectations from inflation target imply a variation of basic interest rate target, which in turn changes the interest rate practiced in the market.

With the objective of verifying the assertions above, pairwise Granger causality tests were made (see Table A.1.2 – appendix). Although the variables $D(IR_T)$ and $D(IR_M)$ show a bilateral causality, the probability of rejecting the hypothesis that $D(IR_T)$ does not Granger cause $D(IR_M)$ is lower than the opposite. The analysis for the relation between $D[E(\pi)$-$\pi_t]$ and $D(IR_T)$ confirms the hypothesis that departures of inflation expectations from inflation target must precede the interest rate target defined by the central bank.

In relation to the credibility indices, the hypothesis that changes in credibility imply (in the Granger sense) variation in interest rate ($D(IR_T)$ and $D(IR_M)$) is tested. The results denote that the $D(CI_A)$ and $D(CI_{MAR})$ precede $D(IR_T)$ and $D(IR_M)$ (both cases show statistical significance at 1% level). The $D(CI_{CK})$ reveals that the causality on $D(IR_T)$ and $D(IR_M)$ is statistically significant at 5%. The credibility indices $D(CI_{AR})$ and $D(CI_{WR})$ reveal precedence on $D(IR_M)$ taking into consideration a statistical significance at 5% level. In relation to the remaining credibility indices, there is no evidence.

Due to the objective of verifying the relation between the credibility (measured by the presented indices) and the central bank's effort (measured by variation in the interest rate) to achieve the main objective (control on inflation), the empirical relation between credibility and the interest rate target announced by Copom and the relation between credibility and the interest rate practiced in the market are analyzed (see tables 1.4 and 1.5). The models have the following frameworks:[7]

$$IR_T = f(E(\pi) - \pi_t, CI), \qquad (1.10)$$

$$IR_M = F(IR_{M_{(-1)}}, CI), \qquad (1.11)$$

where $\partial f / \partial [E(\pi)\text{-}\pi_t] > 0$, $\partial f / \partial CI < 0$; and $\partial F / \partial IR_{M_{-1}} > 0$, $\partial F / \partial CI < 0$.

The role of the control variables $E(\pi)\text{-}\pi_t$ and $IR_{M_{(-1)}}$ is to show the statistical significance and the sign of coefficients. Therefore, controlling a variable which changes the interest rate (IR_T or IR_M), the expected relation between credibility and interest rate (negative sign and statistical significant for the coefficient of credibility) is tested. A priori, positive (negative) variations in credibility would reduce (increase) the variations in the basic interest rate for controlling inflation.

The process for the choice of the models is based on the analysis of autocorrelations and partial autocorrelations, cross-correlograms, residues, principle of parsimony, taking into account the basic presupposition in a multiple linear regression model, and the economic coherence.[8] The lags were defined based on Schwarz criterion. Table 1.4 shows the estimated regressions for each credibility index taking into account the distributed lag model [equation (1.8)] while Table 1.5 exhibits the estimation for each index based on an autoregressive framework [equation (1.9)].

Due to the fact that the regressions in Table 1.4 were estimated with the same basic specification ($D[E(\pi)\text{-}\pi_t]$ lagged one period as a control explanatory variable) but with a different quantity of parameters, it is possible to compare the degree of explanation of $D(IR_T)$ of each model taking into account the adjusted R^2. Under this perspective, the credibility indices with the best explanation of the average variation in $D(IR_T)$ are: CI_A (53.2%), CI_{CK} (44.34%), and CI_{MAR} (38.73%). The power of explanation of other indices (CI_M, CI_{AR}, and CI_{WR}) is lower than 18%. Furthermore, it is observed that with the inclusion of any credibility index (except CI_M) the adjusted

[7] It is important to note that the Johansen and Engle-Granger cointegration tests were performed and the results indicate that the series are not cointegrated.
[8] The main statistical tests used in the analysis are in Table A.1.3 (appendix).

coefficient of determination is increased. When using the model selection criteria of Akaike and Schwarz, the results above are confirmed. The most parsimonious model is given by CI_A while the worst is given by CI_M.

The regressions show significant F-statistics at 0.01 level for all indices tested. Moreover, the partial coefficients of credibility indices have a coherent sign with the theory and have statistical significance. Taking into consideration the Newey-West matrix due to the presence of autocorrelation in residuals the t-statistics were calculated. Furthermore, it is important to note that the best specification for models regarding indices based on reputation suggests the use of the credibility index without lags. This observation confirms the idea that these indices contain past information and thus the use of lagged terms is not necessary in its specification.

The regressions regarding basic interest rate defined by the financial market (see Table 1.5) also have a common basic specification $D(IR_M)$ lagged one period as a control variable and a different quantity of parameters, which in turn allows making a comparison through the adjusted R^2. Once again, the best specifications are given by the inclusion of CI_A (75.13%) and CI_{CK} (74.66%) as a measurement of credibility. It is important to highlight that the CI_M did not reveal any significant relation in this model.[9] In relation to the indices based on reputation, the performances were similar: CI_{AR} (68.05%), CI_{WR} (68.10%), and CI_{MAR} (66.46%). However, CI_{AR} and CI_{WR} exhibit signals contrary to the expected for the terms lagged one period, which in turn strengthen the idea that these indices contain past information. Moreover, the model selection criteria of Akaike and Schwarz are in accordance with the results of adjusted R^2.

The model without credibility index had a high degree of adjustment (64.38) due to the fact large part of the average variation of $D(IR_M)$ is explained by itself (lagged). Notwithstanding, the inclusion of the credibility index improved the explanation of $D(IR_M)$ for all indices. Such as in the previous case the F-statistics are significant at 0.01 level. Moreover, the inclusion of lagged dependent variable avoids the autocorrelation in the residuals and allows the estimation of t-statistics in a traditional way. The indices with the best general performance were the CI_A and the

[9] The main reason for this result is that the CI_M punishes with full loss any deviation regarding expectations out of a predetermined interval of the inflation target.

CI_{CK}. The CI_A has the best performance in the Granger causality tests as far as in the models with dependent variables $D(IR_T)$ and $D(IR_M)$ are concerned. Therefore, a proposed change in the CI_{CK}, which generates CI_A, besides presenting theoretical coherence, allowed finding the best performance among the indices in this analysis.

Table 1.4 - *Estimations for D(IRT)*

Credib. Index	Estimated Coefficients (Newey-West t-statistics)	N	F-Stat.	Adj. R^2 (%)	AIC	SIC
	Dependent variable - $D(IR_T)$					
Basic Specification	$-0.0008 + 0.3859\, D[E(\pi)-\pi_t]_{t-1}$ *(-0.7152) (1.6424)**	92	12.29***	11.03	-7.07	-7.01
CI_{CK}	$-0.0007 + 0.2567\, D[E(\pi)-\pi_t]_{t-1} - 0.0791\, D(CIck)_t - 0.0673\, D(CIck)_{t-2} - 0.0375\, D(CIck)_{t-3} - 0.0404\, D(CIck)_{t-4}$ *(-0.9274) (4.0663)*** (-3.1951)*** (-4.0537)*** (-3.2156)*** (-2.8418)****	89	15.02***	44.34	-7.46	-7.30
CI_M	$-0.0008 + 0.3821\, D[E(\pi)-\pi_t]_{t-1} - 0.0036\, D(CI_M)_{t-2}$ *(-0.7132) (1.6218)* (-1.5441)**	91	6.29***	10.53	-7.04	-6.96
CI_A	$-0.0008 + 0.1469\, D[E(\pi)-\pi_t]_{t-1} - 0.1120\, D(CI_A)_t - 0.1025\, D(CI_A)_{t-2} - 0.0541\, D(CI_A)_{t-4}$ *(-1.1746) (1.8555)*** (-6.4070)*** (-7.5392)*** (-4,4571)****	89	26.01***	53.20	-7.65	-7.51
CI_{AR}	$-0.0011 + 0.3868\, D[E(\pi)-\pi_t]_{t-1} - 0.3341\, D(CI_{AR})_t$ *(-1.1112) (2.022)** (-2.3015)****	92	9.51***	15.76	-7.11	-7.03
CI_{WR}	$-0.0010 + 0.3785\, D[E(\pi)-\pi_t]_{t-1} - 0.2046\, D(CI_{WR})_t$ *(-0.9588) (2.0905)** (-2.7194)****	92	10.76***	17.67	-7,14	-7.05
CI_{MAR}	$-0.0008 + 0.3119\, D[E(\pi)-\pi_t]_{t-1} - 0.0860\, D(CI_{MAR})_t$ *(-1.0428) (3.0767)*** (-5.8788)****	92	29.77***	38.73	-7.43	-7.35

Note: t-statistics between parentheses. Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.1.

Table 1.5 - *Estimations for D(IRM)*

Dependent variable - D(IR_M)						
Credib. Index	**Estimated Coefficients (Newey-West t-statistics)**	**N**	**F-Stat.**	**Adj. R^2 (%)**	**SIC**	**AIC**
Basic Specification	$-0.0001 + 0.7922\ D(IR_M)_{t-1}$ (-0.2033) (13.2787)***	98	176.32***	64.38	-8.25	-8.20
CI_{CK}	$-0.0002 + 0.7099\ D(IR_M)_{t-1} - 0.0496\ D(CIck)_t - 0.0299\ D(CIck)_{t-2}$ (-0.5608) (11. 6721)*** (-5.0826)*** (-2.7487)***	91	89.40***	74.66	-8.50	-8.39
CI_A	$-0.0002 + 0.7047\ D(IR_M)_{t-1} - 0.0342\ D(CI_A)_t - 0.0432\ D(CI_A)_{t-1}$ (-0.6969) (12.4034)*** (-2.9452)*** (-3.5008)***	98	92.66***	75.13	-8.53	-8.42
CI_{AR}	$-0.00001 + 0.7834\ D(IR_M)_{t-1} - 0.3973\ D(CI_{AR})_t + 0.4973\ D(CI_{AR})_{t-1}$ (0.0261) (11.8684)*** (-2.6646)*** (3.5761)***	98	69.86***	68.05	-8.34	-8.23
CI_{WR}	$-0.0001 + 0.7798\ D(IR_M)_{t-1} - 0.2209\ D(CI_{WR})_t + 0.2618\ D(CI_{WR})_{t-1}$ (-0.1456) (11.5115)*** (-2.8361)*** (3.6294)***	98	70.02***	68.10	-8.34	-8.23
CI_{MAR}	$-0.0002 + 0.6366\ D(IR_M)_{t-1} - 0.0323\ D(CI_{MAR})_t$ (-0.5965) (7.7024)*** (-2.6368)***	98	97.11***	66.46	-8.30	-8.22

Note: t-statistics between parentheses. Marginal significance levels: (***) denotes 0.01.

1.5. Conclusion

This study reveals that the credibility index (CI_A) is that which has the best incremental contribution to the explanation of variations of basic interest rate (defined by financial market and the target defined by Monetary Policy Committee). The indices based on reputation have a worse performance in comparison with the CI_A. However, these indices did have a performance close to the other indices. Among indices based on reputation, CI_{MAR} presented the best performance. This result is important because it is the index (based on reputation) with the highest volatility and is more sensitive to the current events. Therefore, the result suggests a short memory of economic agents in the process of building credibility in Brazil. It is important to note that alternative specifications regarding lags in reputation or even other measurements different from those adopted in this analysis can improve the indices. The credibility indices based on reputation represent an alternative in the cases where the series of inflation expectation are not available. A last important point is that the empirical evidence confirms the hypothesis that a higher credibility implies lower variations in the interest rate for controlling inflation in Brazil.

1.6. Appendix

Table A.1.1 - *Unit root tests (ADF, PP, DF-GLS) and stationary test (KPSS)*

	ADF				*PP*				*DF-GLS*				*KPSS*			
Series	**lag**	**Test**	**CV 5%**	**CV 10%**	**lag**	**Test**	**CV 5%**	**CV 10%**	**lag**	**Test**	**CV 5%**	**CV 10%**	**lag**	**Test**	**CV 5%**	**CV 10%**
CI_{CK}	1	-2.2656	-2.8932	-2.5837	1	-1.8482	-2.8929	-2.5836	1	-2.3847	-3.0556	-2.7640	7	0.1874	0.1460	0.1190
$D(CI_{CK})$	0	-7.0581	-1.9444	-1.6144	6	-6.9426	-1.9444	-1.6144	0	-7.0340	-3.0556	-2.7640	0	0.1027	0.4630	0.3470
CI_M	0	-1.9354	-2.8929	-2.5836	1	-2.1219	-2.8929	-2.5836	0	-1.9818	-3.0524	-2.7610	7	0.1926	0.1460	0.1190
$D(CI_M)$	0	-8.0374	-1.9444	-1.6144	2	-8.0556	-1.9444	-1.6144	0	-7.9187	-3.0556	-2.7640	0	0.0750	0.4630	0.3470
CI_A	3	-1.9444	-2.8940	-2.5841	3	-2.1690	-2.8929	-2.5836	3	-2.6549	-3.0620	-2.7700	7	0.1324	0.1460	0.1190
$D(CI_A)$	1	-6.8857	-1.9444	-1.6144	5	-6.1784	-1.9444	-1.6144	1	-6.8948	-3.0588	-2.7670	2	0.0669	0.4630	0.3470
CI_{AR}	2	-1.8457	-2.8916	-2.5828	6	-1.5414	-2.8909	-2.5825	1	-1.9913	-3.0364	-2.7460	8	0.2303	0.1460	0.1190
$D(CI_{AR})$	1	-3.1472	-1.9442	-1.6146	3	-2.9875	-1.9441	-1.6146	1	-3.2725	-3.0396	-2.7490	6	0.1015	0.1460	0.1190
CI_{WR}	1	-2.2473	-2.8912	-2.5827	6	-1.5593	-2.8909	-2.5825	1	-2.0738	-3.0364	-2.7460	8	0.2336	0.1460	0.1190
$D(CI_{WR})$	1	-3.2731	-1.9442	-1.6146	3	-3.1119	-1.9441	-1.6146	1	-3.3635	-3.0396	-2.7490	6	0.0857	0.1460	0.1190
CI_{MAR}	8	-2.2057	-2.8936	-2.5839	6	-0.4680	-1.9441	-1.6146	8	-2.1015	-3.0588	-2.7670	8	0.1607	0.4630	0.3470
$D(CI_{MAR})$	7	-3.4280	-1.9444	-1.6144	5	-3.3509	-1.9441	-1.6146	7	-3.4506	-3.0588	-2.7670	6	0.0608	0.4630	0.3470
IR_T	2	-3.3607	-3.4568	-3.1543	6	-1.9316	-3.4558	-3.1537	2	-3.4321	-3.0396	-2.7490	8	0.1660	0.1460	0.1190
$D(IR_T)$	2	-3.6850	-1.9442	-1.6145	3	-5.4085	-1.9441	-1.6146	2	-2.8713	-3.0428	-2.7520	6	0.0545	0.1460	0.1190
IR_M	1	-3.2703	-3.4563	-3.1540	6	-1.9118	-3.4558	-3.1537	1	-3.3814	-3.0364	-2.7460	8	0.1640	0.1460	0.1190
$D(IR_M)$	0	-3.5081	-1.9441	-1.6146	4	-3.8337	-1.9441	-1.6146	0	-2.0778	-1.9441	-1.6146	6	0.0536	0.1460	0.1190
$E(\pi)-\pi_t$	1	-2.0355	-1.9444	-1.6144	3	-1.7291	-1.9443	-1.6145	1	-2.5622	-3.0556	-2.7640	7	0.2022	0.1460	0.1190
$D[E(\pi)-\pi_t]$	1	-7.5747	-1.9444	-1.6144	10	-7.3154	-1.9444	-1.6144	1	-7.5573	-3.0588	-2.7670	5	0.0465	0.1460	0.1190

Notes: ADF – the final choice of lag was made based on Schwarz criterion. For all indices in level, a constant was applied. Constant and linear trend For IR_M and IR_T was used. For other series, no-constant specification or time trend was used.

PP – the final choice of lag was made based on Newey-West. For all indices in level, a constant was applied. Constant and linear trend for IR_M and IR_T was used. For other series no-constant specification or time trend was used.

DF-GLS – the final choice of lag was made based on Schwarz criterion. Constant and linear trend for other series were applied.

KPSS – the final choice of lag was made based on Newey-West. For the series: $D(CI_{CK})$, $D(CI_M)$, $D(CI_A)$, CI_{MAR}, and $D(CI_{MAR})$ constant was applied. Constant and linear trend for other series were applied.

Table A.1.2 - *Granger causality test*

	Null hypothesis	Obs.	F-statistics	P-value
	$D(IR_M)$ does not Granger Cause $D(IR_T)$	87	2.0282	0.0363
	$D(IR_T)$ does not Granger Cause $D(IR_M)$		6.9207	0.0000
	$D[E(\pi)-\pi_t]$ does not Granger Cause $D(IR_T)$	81	2.3141	0.0176
	$D(IR_T)$ does not Granger Cause $D[E(\pi)-\pi_t]$		2.0058	0.0408
Basic interest rate – defined by CBB *($D(IR_T)$)*	*$D(CI_{CK})$ does not Granger Cause $D(IR_T)$*	81	2.02315	0.03888
	$D(IR_T)$ does not Granger Cause $D(CI_{CK})$		1.82029	0.06683
	$D(CI_M)$ does not Granger Cause $D(IR_T)$	81	0.6355	0.8030
	$D(IR_T)$ does not Granger Cause $D(CI_M)$		1.8967	0.0546
	$D(CI_A)$ does not Granger Cause $D(IR_T)$	81	4.0520	0.0002
	$D(IR_T)$ does not Granger Cause $D(CI_A)$		1.4883	0.1562
	$D(CI_{AR})$ does not Granger Cause $D(IR_T)$	87	1.2339	0.2813
	$D(IR_T)$ does not Granger Cause $D(CI_{AR})$		7.2417	0.0000
	$D(CI_{WR})$ does not Granger Cause $D(IR_T)$	87	1.2242	0.2875
	$D(IR_T$ does not Granger Cause DCI_{WR}		7.3391	0.0000
	$D(CI_{MAR})$ does not Granger Cause $D(IR_T)$	87	7.2527	0.0000
	$D(IR_T$ does not Granger Cause $D(CI_{MAR})$		1.3160	0.2328
Basic interest rate – defined by market *($D(IR_M)$)*	*$D(CI_{CK})$ does not Granger Cause $D(IR_M)$*	81	2.0390	0.0373
	$D(IR_M)$ does not Granger Cause $D(CI_{CK})$		1.0157	0.4476
	$D(CI_M)$ does not Granger Cause $D(IR_M)$	81	0.7020	0.7428
	$D(IR_M)$ does not Granger Cause $D(CI_M)$		2.2649	0.0201
	$D(CI_A)$ does not Granger Cause $D(IR_M)$	81	4.0633	0.0002
	$D(IR_M)$ does not Granger Cause $D(CI_A)$		1.3891	0.1986
	$D(CI_{AR})$ does not Granger Cause $D(IR_M)$	87	2.1403	0.0265
	$D(IR_M)$ does not Granger Cause $D(CI_{AR})$		4.9758	0.0000
	$D(CI_{WR})$ does not Granger Cause $D(IR_M)$	87	2.1207	0.0280
	$D(IR_M)$ does not Granger Cause $D(CI_{WR})$		4.9922	0.0000
	$D(CI_{MAR})$ does not Granger Cause $D(IR_M)$	87	4.0548	0.0001
	$D(IR_M)$ does not Granger Cause $D(CI_{MAR})$		2.1435	0.0263

Note: 12 lags were applied.

Table A.1.3 - *Model selection*

Dependent variable: $D(IR_T)$				
Sample (adjusted): 2000:03 2007:10				
Included observations: 92 after adjustments				
Newey-West HAC Standard Errors & Covariance (lag truncation=3)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
$D[E(\pi)-\pi_t](-1)$	0.3859	0.2350	1.6424	0,1002
C	-0.0008	0.0011	-0.7153	0,4763
R-squared	0.1201	Mean dependent var		-0.0008
Adjusted R-squared	0.1103	S.D. dependent var		0.0074
S.E. of regression	0.0070	Akaike info criterion		-7.0685
Sum squared resid	0.0044	Schwarz criterion		-7.0137
Durbin-Watson stat	1.0825	F-statistic***		12.2867
Tests	**DF**	**Test Statistic**		**Value**
White Heteroskedasticity:		F-statistic**		4.3219
		Obs. R-squared**		8.1442
Breusch-Godfrey LM:		F-statistic***		20.5178
		Obs. R-squared***		29.2576
ARCH:		F-statistic		1.,5601
		Obs. R-squared		1.5677
Jarque-Bera:		J-B statistic***		80.4093
Ramsey RESET:		F-statistic***		11.3771
		Log likelihood ratio***		11.0674
Chow Breakpoint: 2003:01		F-statistic***		7.4248
		Log likelihood ratio***		14.3457

Dependent variable: $D(IR_T)$				
Sample (adjusted): 2000:06 2007:10				
Included observations: 89 after adjustments				
Newey-West HAC Standard Errors & Covariance (lag truncation=3)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
$D[E(\pi)-\pi_t](-1)$	0.2567	0.0631	4.0663	0.0001
DCI_{CK}	-0.0791	0.0248	-3.1951	0.0020
$DCI_{CK}(-2)$	-0.0673	0.0166	-4.0537	0.0001
$DCI_{CK}(-3)$	-0.0375	0.0117	-3.2156	0.0019
$DCI_{CK}(-4)$	-0.0404	0.0142	-2.8418	0.0056
C	-0.0007	0.0007	-0.9274	0.3564
R-squared	0.4751	Mean dependent var		-0.0008
Adjusted R-squared	0.4434	S.D. dependent var		0.0075
S.E. of regression	0.0056	Akaike info criterion		-7.4643
Sum squared resid	0.0026	Schwarz criterion		-7.2965
Durbin-Watson stat	1.5544	F-statistic***		15.0225
Tests	**DF**	**Test Statistic**		**Value**
Wald:	(1. 83) / 1	F-stat. / Chi-square ***		30.4613
White Heteroskedasticity:		F-statistic		0.7032
		Obs. R-squared		7.3599
Breusch-Godfrey LM:		F-statistic**		4.7810
		Obs. R-squared*		9.3971
ARCH:		F-statistic		0.0792
		Obs. R-squared		0.0810
Jarque-Bera:		J-B statistic***		35.9052
Ramsey RESET:		F-statistic		0.0460
		Log likelihood ratio		0.0500
Chow Breakpoint: 2003:01		F-statistic		0.7644
		Log likelihood ratio		5.1495

(Continuation)

Dependent variable: D(IR_T)				
Sample (adjusted): 2000:04 2007:10				
Included observations: 91 after adjustments				
Newey-West HAC Standard Errors & Covariance (lag truncation=3)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D[$E(\pi)$-π_t](-1)	0.3821	0.2356	1.6218	0.1008
DCI_M(-2)	-0.0036	0.0013	-1.8440	0.0928
C	-0.0008	0.0011	-0.7132	0.4776
R-squared	0.1251	Mean dependent var		-0.0009
Adjusted R-squared	0.1053	S.D. dependent var		0.0074
S.E. of regression	0.0070	Akaike info criterion		-7.0410
Sum squared resid	0.0044	Schwarz criterion		-6.9582
Durbin-Watson stat	1.0750	F-statistic***		6.2934
Tests	**DF**	**Test Statistic**		**Value**
White Heteroskedasticity:		F-statistic*		2.2568
		Obs. R-squared*		8.6445
Breusch-Godfrey LM:		F-statistic***		20.2657
		Obs. R-squared***		29.1498
ARCH:		F-statistic		1,5315
		Obs. R-squared		1.5395
Jarque-Bera:		J-B statistic***		85.4098
Ramsey RESET:		F-statistic***		11.0145
		Log likelihood ratio***		10.8479
Chow Breakpoint: 2003:01		F-statistic***		4.6595
		Log likelihood ratio***		13.8549

Dependent variable: D(IR_T)				
Sample (adjusted): 2000:06 2007:10				
Included observations: 89 after adjustments				
Newey-West HAC Standard Errors & Covariance (lag truncation=3)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D[$E(\pi)$-π_t](-1)	0.1469	0.0792	1.8555	0.0670
DCI_A	-0.1120	0.0175	-6.4070	0.0000
DCI_A(-2)	-0.1025	0.0136	-7.5391	0.0000
DCI_A(-4)	-0.0541	0.0121	-4.4571	0.0000
C	-0.0008	0.0007	-1.1746	0.2435
R-squared	0.5533	Mean dependent var		-0.0008
Adjusted R-squared	0.5320	S.D. dependent var		0.0075
S.E. of regression	0.0051	Akaike info criterion		-7.6481
Sum squared resid	0.0022	Schwarz criterion		-7.5083
Durbin-Watson stat	1.5603	F-statistic***		26.0091
Tests	**DF**	**Test Statistic**		**Value**
Wald:	(1. 84) / 1	F-stat. / Chi-square ***		82.8126
White Heteroskedasticity:		F-statistic		0.3531
		Obs. R-squared		3.0357
Breusch-Godfrey LM:		F-statistic**		3.6205
		Obs. R-squared**		7.2215
ARCH:		F-statistic		2.4405
		Obs. R-squared		2.4283
Jarque-Bera:		J-B statistic***		31.2069
Ramsey RESET:		F-statistic		0.4556
		Log likelihood ratio		0.4872
Chow Breakpoint: 2003:01		F-statistic		1.5146
		Log likelihood ratio		8.1472

(Continuation)

Dependent variable: D(IR_T)
Sample (adjusted): 2000:03 2007:10
Included observations: 92 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D[$E(\pi)$-π_t](-1)	0.3868	0.1913	2.0220	0.0462
DCI_{AR}	-0.3341	0.1452	-2.3015	0.0237
C	-0.0011	0.0010	-1.1118	0.2692

R-squared	0.1761	Mean dependent var	-0.0008
Adjusted R-squared	0.1576	S.D. dependent var	0.0074
S.E. of regression	0.0068	Akaike info criterion	-7.1125
Sum squared resid	0.0041	Schwarz criterion	-7.0303
Durbin-Watson stat	1.2198	F-statistic***	9.5108

Tests	DF	Test Statistic	Value
White Heteroskedasticity:		F-statistic**	2.6930
		Obs. R-squared**	10.1361
Breusch-Godfrey LM:		F-statistic***	18.2399
		Obs. R-squared***	27.1797
ARCH:		F-statistic	1.8788
		Obs. R-squared	1.8813
Jarque-Bera:		J-B statistic***	59.4904
Ramsey RESET:		F-statistic	0.0619
		Log likelihood ratio	0.0647
Chow Breakpoint: 2003:01		F-statistic**	3.7896
		Log likelihood ratio***	11.4226

Dependent variable: D(IR_T)
Sample (adjusted): 2000:03 2007:10
Included observations: 92 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D[$E(\pi)$-π_t](-1)	0.3785	0.1810	2.0905	0.0394
DCI_{WR}	-0.2046	0.0752	-2.7194	0.0079
C	-0.0010	0.0010	-0.9588	0.3403

R-squared	0.1948	Mean dependent var	-0.0008
Adjusted R-squared	0.1767	S.D. dependent var	0.0074
S.E. of regression	0.0067	Akaike info criterion	-7.1354
Sum squared resid	0.0040	Schwarz criterion	-7.0532
Durbin-Watson stat	1.2537	F-statistic***	10.7629

Tests	DF	Test Statistic	Value
White Heteroskedasticity:		F-statistic	1.7171
		Obs. R-squared	6.7316
Breusch-Godfrey LM:		F-statistic***	16.9601
		Obs. R-squared***	25.8076
ARCH:		F-statistic	1,8788
		Obs. R-squared	1.8813
Jarque-Bera:		J-B statistic***	58.0239
Ramsey RESET:		F-statistic	0.0619
		Log likelihood ratio	0.0647
Chow Breakpoint: 2003:01		F-statistic**	3.7896
		Log likelihood ratio***	11.4226

(Continuation)

Dependent variable: D(IR_T)				
Sample (adjusted): 2000:03 2007:10				
Included observations: 92 after adjustments				
Newey-West HAC Standard Errors & Covariance (lag truncation=3)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D[$E(\pi)$-π_t](-1)	0.3119	0.1014	3.0767	0.0028
DCI_{MAR}	-0.0860	0.0146	-5.8789	0.0000
C	-0.0008	0.0008	-1.0429	0.2998
R-squared	0.4008	Mean dependent var		-0.0008
Adjusted R-squared	0.3873	S.D. dependent var		0.0074
S.E. of regression	0.0058	Akaike info criterion		-7.4310
Sum squared resid	0.0030	Schwarz criterion		-7.3488
Durbin-Watson stat	1.6352	F-statistic***		29.7669
Tests	**DF**	**Test Statistic**		**Value**
White Heteroskedasticity:		F-statistic**		3.0890
		Obs. R-squared**		11.4412
Breusch-Godfrey LM:		F-statistic***		6.2681
		Obs. R-squared***		11.5871
ARCH:		F-statistic		0.1258
		Obs. R-squared		0.1284
Jarque-Bera:		J-B statistic***		189.5571
Ramsey RESET:		F-statistic		4.8042
		Log likelihood ratio		4.8902
Chow Breakpoint: 2003:01		F-statistic		4.0434
		Log likelihood ratio		12.1391

Dependent variable: D(IR_M)				
Sample (adjusted): 1999:09 2007:10				
Included observations: 98 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DIR_M(-1)	0.7922	0.0597	13.2787	0.0000
C	-0.0001	0.0004	-0.2033	0.8393
R-squared	0.6475	Mean dependent var		-0.0009
Adjusted R-squared	0.6438	S.D. dependent var		0.0065
S.E. of regression	0.0039	Akaike info criterion		-8.2489
Sum squared resid	0.0014	Schwarz criterion		-8.1961
		F-statistic***		176.3236
Tests	**DF**	**Test Statistic**		**Value**
White Heteroskedasticity:		F-statistic**		4.0056
		Obs. R-squared**		7.6215
Breusch-Godfrey LM:		F-statistic		1.3671
		Obs. R-squared		2.7699
ARCH:		F-statistic*		3.8731
		Obs. R-squared*		3.7997
Jarque-Bera:		J-B statistic***		80.4093
Ramsey RESET:		F-statistic		0.1098
		Log likelihood ratio		0.1132
Chow Breakpoint: 2003:01		F-statistic		1.8417
		Log likelihood ratio		3.7668

(Continuation)

Dependent variable: D(IR_M)				
Sample (adjusted): 2000:04 2007:10				
Included observations: 91 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DIR_M(-1)	0.7099	0.0608	11.6721	0.0000
DCI_{CK}	-0.0496	0.0098	-5.0826	0.0000
DCI_{CK}(-2)	-0.0299	0.0109	-2.7488	0.0073
C	-0.0002	0.0004	-0.5609	0.5763
R-squared	0.7551	Mean dependent var		-0.0008
Adjusted R-squared	0.7466	S.D. dependent var		0.0067
S.E. of regression	0.0034	Akaike info criterion		-8.4964
Sum squared resid	0.0010	Schwarz criterion		-8.3860
		F-statistic***		89.4026
Tests	**DF**	**Test Statistic**		**Value**
Wald:	(1. 87) / 1	F-stat. / Chi-square ***		25.1571
White Heteroskedasticity:		F-statistic		0.9025
		Obs. R-squared		5.5110
Breusch-Godfrey LM:		F-statistic		2.2824
		Obs. R-squared		4.6379
ARCH:		F-statistic		0.5646
		Obs. R-squared		0.5737
Jarque-Bera:		J-B statistic***		24.6637
Ramsey RESET:		F-statistic		0,2456
		Log likelihood ratio		0.2595
Chow Breakpoint: 2003:01		F-statistic		1.2019
		Log likelihood ratio		5.1240

Dependent variable: D(IR_M)				
Sample (adjusted): 2000:02 2007:10				
Included observations: 93 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DIR_M(-1)	0.8247	0.0610	13.5102	0.0000
DCI_M	0.0014	0.0028	0.4835	0.6299
C	-0.0001	0.0004	-0.3683	0.7135
R-squared	0.6732	Mean dependent var		-0.0008
Adjusted R-squared	0.6660	S.D. dependent var		0.0067
S.E. of regression	0.0038	Akaike info criterion		-8.2531
Sum squared resid	0.0013	Schwarz criterion		-8.1714
		F-statistic***		92.7067
Tests	**DF**	**Test Statistic**		**Value**
White Heteroskedasticity:		F-statistic		1.8023
		Obs. R-squared		7.0417
Breusch-Godfrey LM:		F-statistic		1.4643
		Obs. R-squared		2.9953
ARCH:		F-statistic		2.8641
		Obs. R-squared		2.8375
Jarque-Bera:		J-B statistic***		74.2854
Ramsey RESET:		F-statistic		0.0000
		Log likelihood ratio		0.0000
Chow Breakpoint: 2003:01		F-statistic		1.5599
		Log likelihood ratio		4.8725

(Continuation)

Dependent variable: D(IR_M)				
Sample (adjusted): 2000:03 2007:10				
Included observations: 92 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DIR_M(-1)	0.7047	0.0568	12.4034	0.0000
DCI_A	-0.0342	0.0116	-2.9452	0.0041
DCI_A(-1)	-0.0432	0.0123	-3.5008	0.0007
C	-0.0002	0.0004	-0.6969	0.4877
R-squared	0.7595	Mean dependent var		-0.0008
Adjusted R-squared	0.7513	S.D. dependent var		0.0067
S.E. of regression	0.0033	Akaike info criterion		-8.5266
Sum squared resid	0.0010	Schwarz criterion		-8.4170
		F-statistic***		92.6570
Tests	**DF**	**Test Statistic**		**Value**
Wald:	(1. 88) / 1	F-stat. / Chi-square ***		31.8943
White Heteroskedasticity:		F-statistic		1.1586
		Obs. R-squared		6.9552
Breusch-Godfrey LM:		F-statistic		1.6631
		Obs. R-squared		4.3654
ARCH:		F-statistic		0.5277
		Obs. R-squared		0.5363
Jarque-Bera:		J-B statistic***		30.5185
Ramsey RESET:		F-statistic		2.6871
		Log likelihood ratio		2.7986
Chow Breakpoint: 2003:01		F-statistic		1.7325
		Log likelihood ratio		7.2931

Dependent variable: D(IR_M)				
Sample (adjusted): 1999:09 2007:10				
Included observations: 98 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DIR_M(-1)	0.7834	0.0660	11.8684	0.0000
DCI_{AR}	-0.3973	0.1491	-2.6646	0.0091
DCI_{AR}(-1)	0.4973	0.1391	3.5761	0.0006
C	0.0000	0.0004	0.0261	0.9793
R-squared	0.6904	Mean dependent var		-0.0009
Adjusted R-squared	0.6805	S.D. dependent var		0.0065
S.E. of regression	0.0037	Akaike info criterion		-8.3377
Sum squared resid	0.0013	Schwarz criterion		-8.2322
		F-statistic***		69.8568
Tests	**DF**	**Test Statistic**		**Value**
Wald:	(1. 94) / 1	F-stat. / Chi-square		1.3302
White Heteroskedasticity:		F-statistic**		2.2957
		Obs. R-squared**		12.8837
Breusch-Godfrey LM:		F-statistic		1.0106
		Obs. R-squared		2.1067
ARCH:		F-statistic		2.1070
		Obs. R-squared		2.1047
Jarque-Bera:		J-B statistic***		80.0103
Ramsey RESET:		F-statistic		0,4780
		Log likelihood ratio		0.5024
Chow Breakpoint: 2003:01		F-statistic		1.1609
		Log likelihood ratio		4.9300

(Continuation)

Dependent variable: D(IR_M)
Sample (adjusted): 1999:09 2007:10
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DIR_M(-1)	0.7798	0.0677	11.5115	0.0000
DCI_{WR}	-0.2209	0.0779	-2.8361	0.0056
DCI_{WR}(-1)	0.2618	0.0721	3.6294	0.0005
C	-0.0001	0.0004	-0.1456	0.8846
R-squared	0.6909	Mean dependent var		-0.0009
Adjusted R-squared	0.6810	S.D. dependent var		0.0065
S.E. of regression	0.0037	Akaike info criterion		-8.3394
Sum squared resid	0.0013	Schwarz criterion		-8.2338
	-	F-statistic***		70.0205

Tests	DF	Test Statistic	Value
Wald:	(1. 94) / 1	F-stat. / Chi-square	0.7430
White Heteroskedasticity:		F-statistic	1.8247
		Obs. R-squared	10.5244
Breusch-Godfrey LM:		F-statistic	1.0612
		Obs. R-squared	2.2099
ARCH:		F-statistic	2.2635
		Obs. R-squared	2.2574
Jarque-Bera:		J-B statistic***	82.4173
Ramsey RESET:		F-statistic	0.2927
		Log likelihood ratio	0.3080
Chow Breakpoint: 2003:01		F-statistic	1.1586
		Log likelihood ratio	4.9207

Dependent variable: D(IR_M)
Sample (adjusted): 1999:09 2007:10
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DIR_M(-1)	0.6366	0.0827	7.7024	0.0000
DCI_{MAR}	-0.0323	0.0122	-2.6369	0.0098
C	-0.0002	0.0004	-0.5966	0.5522
R-squared	0.6715	Mean dependent var		-0.0009
Adjusted R-squared	0.6646	S.D. dependent var		0.0065
S.E. of regression	0.0038	Akaike info criterion		-8.2991
Sum squared resid	0.0013	Schwarz criterion		-8.2200
		F-statistic***		97.1053

Tests	DF	Test Statistic	Value
White Heteroskedasticity:		F-statistic	2.1898
		Obs. R-squared	8.8231
Breusch-Godfrey LM:		F-statistic	3.7560
		Obs. R-squared	7.3242
ARCH:		F-statistic	0.9082
		Obs. R-squared	0.9186
Jarque-Bera:		J-B statistic***	189.5571
Ramsey RESET:		F-statistic	0.1851
		Log likelihood ratio	0.1928
Chow Breakpoint: 2003:01		F-statistic	1.5394
		Log likelihood ratio	4.7999

Chapter

2. Inflation and its Volatility in a World with Inflation Targeters

2.1. Introduction

Since the early 1990s, Inflation Targeting framework (IT) has been adopted by several central banks as a strategy for the implementation of monetary policy. IT has as its main feature the official announcement of ranges for inflation fluctuations and the explicit recognition that the main objective of monetary policy is to assure a low and stable inflation rate. This monetary regime works as a guide for inflation expectations and it is associated with an increase in central bank transparency, which, in turn, increases accountability in the implementation of monetary policy and thus improves the central banks' credibility.[10]

An important step in controlling inflation is to guide inflationary expectations, thus one main task of a central bank is to build credibility through the commitment to price stability. Credibility is important because it influences public expectations affecting interest and exchange rates and thereby improves the implementation of monetary policy and a lower and stable inflation rate.

Nowadays, there is a growing literature (both theoretical and empirical) that seeks to demonstrate the advantages and weaknesses of the IT regime. Nonetheless, the effectiveness of this framework for inflation control fuels a controversial debate between policymakers and academics. Two key questions remain unanswered in a conclusive way: (i) How successful is IT in reducing and stabilizing the inflation rate? (ii) Are effects caused by IT sufficiently homogeneous when both developing and industrialized countries are taken into consideration? The answer to these questions depends on the observation of the countries that have adopted IT; as such, the analysis is fundamentally empirical.

Although the empirical results are not always convergent, it is possible to identify a common element in the studies – the self-selection problem, which in turn may create a bias in the outcomes (Lin and Ye, 2007).[11] To mitigate the bias problem, this chapter adopts a method used by the medical literature and that is typically used to solve microeconomic problems: Propensity Score Matching, or PSM

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[10] See, Svensson (1997), Mishkin (1999), Bernanke *et al.* (1999), Landarretche, Corbo e Schmidt-Hebbel (2002), de Mendonça and Simão Filho (2007), and Blinder *et al.* (2008).

[11] This problem is because the adoption of IT is voluntary. For a wide discussion about the problem and its origins, see Wooldridge (2002).

(Rosenbaum and Rubin, 1983). PSM emerged from the theory of counterfactuals, which calculates possible outcomes for patients who do receive or do not receive a given medical treatment. Due to the logical impossibility of observing this situation, the solution is to estimate the event. Hence, the matching framework is adequate for these cases. Moreover, the propensity score also serves as a strategy for overcoming selection bias problems in the estimations.

In comparing inflation to medicine, inflation can be seen as an analogy for a typical illness in capitalist economies. In a general way, inflation is an illness without a cure; that said the illness could still be treated in order to control the symptoms. Under this view, IT can be understood as a remedy for stabilizing and controlling inflation. Hence, just as in medicine, this study involves a quasi-natural experiment in which it is analyzed whether the remedy (IT) leads to the desired effects, or whether observed outcomes derive from other factors. To shed light on this question, this chapter looks at countries that adopted inflation targeting (inflation targeters - ITers) to see whether the changes with respect to inflation / inflation volatility observed over time are really due to the adoption of IT.

With the above-mentioned objective in mind and with recourse to panel data methodology, a set of 180 countries is considered in the analysis of the period 1990 to 2007. Note that among these countries, 29 adopted IT during the period under consideration. Due to the difficulty in determining the date when each country adopted IT, this analysis conducts extensive research of the literature as well as consultation with all the respective central banks. Therefore, two sets of data are used: one with the start date of partial adoption of inflation targeting (soft inflation targeting); another with the date of full adoption of inflation targeting (full-fledged inflation targeting).

The analysis in this chapter employs the best-fitted methodology available in the literature, i.e., PSM. The sample is split into two sets of countries (advanced and developing countries), which provides, using the same database, distinct and comparable results.[12] Based on the same methodology, it is therefore possible to evaluate whether the outcomes for countries under IT still remain when advanced

[12] The division is made taking into consideration the classification made by the International Monetary Fund (IMF).

and developing countries are analyzed separately. Additionally, cases of high inflation in the study are controlled with the objective of rendering a more robust analysis. In brief, it is expected that with the assessment of the conditions described above, this study can improve the analysis of effects on inflation and volatility exclusively caused by implementation of IT. The chapter is organized as follows: Section 2 summarizes the research in literature regarding IT and in central banks vis-à-vis the inflation targeting adoption date according to conceptual criteria. Section 3 describes the matching method known as propensity score and the database. Section 4 presents the estimation of PSM models and reports the results regarding the evaluation of IT worldwide. Section 5 concludes the chapter.

2.2. IT adoption date

Despite the extensive literature on IT, there is no consensus as to the exact date that IT was implemented for the first time. Indeed, varying criteria are used by academics and policymakers. Because the main contribution of this study is empirical, the correct identification of the period under treatment (period under IT) is crucial; thus this study considers the information available in the inflation targeting literature and information from central banks regarding adoption date.

With the intention of avoiding the date-of-adoption problem and of strengthening this analysis, this study adopts two possible start dates for each country, as proposed by Vega and Winkelried (2005). The first set of dates refers to the period when the country announces a numerical target for inflation and the transition to IT is confirmed (soft IT). In this case, the monetary authority releases an inflation target to the public, although a set of policies that characterize a complete IT is not assumed (initial classification). The second set of dates refers to complete adoption of IT (full-fledged IT). In this case, the country assumes explicit adoption of IT and the absence of other nominal anchors (conservative classification).

Table A.2.1 (see appendix) consolidates the data regarding the different dates of IT adoption for the countries considered in this study. The dates in the table were obtained through several studies concerning IT in the period 1997 to 2008. In cases where the literature and consultation with central banks present two distinct dates as to the date of adoption for a given country, the earlier date is considered as "initial" and the later is classified as "conservative."[13]

As can be seen in Table A.2.1, the date of IT adoption is not homogenous among the sources. Even when the presence of one or two authors is observed in different articles, there are different dates for several countries.[14] The reason for this concerns the option of some countries using a transition period leading up to full-fledged IT. In a general way, the dates in advanced countries are less controversial because a transition period is not adopted. This behavior is evidenced by the difference in years between the two classifications used. For the set of countries that adopted IT, the average difference is 1.7 years; for the 17 developing countries, the difference is 2 years; and for the 12 advanced countries, the difference is 1.3 years.

2.3. Methodology

Over time, the experience of countries that have adopted IT, as well as the number of ITers, increases. This burgeoning database is a fertile ground for new possibilities for measuring the IT effects on inflation; consequently, the empirical literature includes myriad ways to exhibit results. For example, Landarretche, Corbo and Schmidt-Hebbel (2002) conduct an empirical study through the use of Vector Autoregression Analysis (VAR) regarding the advantages of IT adoption for the period 1980 to 1999 for three sets of countries (ITers, potential ITers, and non-ITers) in a total sample of 25 countries. They found that ITers have been successful in meeting targets and have consistently reduced inflation-forecast errors. Johnson (2002) compares five ITers with six non-ITers from 1984 to 2000, based on dummy coefficients; it was found that inflation targets correlated with disinflation and smaller forecast errors. In the same way, Neumann and von Hagen (2002) take into consideration six industrial ITers and three non-ITers, quantifying the response of

[13] Due to their entrances into the European Union, the abandon date of IT by Finland and Spain is also shown.
[14] For example, South Africa, Australia, Spain, Israel, and Sweden (see Bernanke and Mishkin, 1997; Bernanke *et al.*, 1999; Mishkin and Schmidt-Hebbel, 2001; Landarretche, Corbo and Schmidt-Hebbel, 2002; and Mishkin and Schmidt-Hebbel, 2007b).

inflation on supply shocks; they found evidence that ITers reduced inflation to low levels and curbed inflation and interest rate volatility.

Taking into account a sample of 21 ITers, Pétursson (2004b) uses a dummy variable for the period after the adoption of IT with the objective of evaluating the performance of macroeconomic indicators. Under this view, IT is successful and increases the probability that monetary policy can engender good decision-making, thereby improving the credibility of monetary policy. Levin, Natalucci and Piger (2004) considered 11 industrialized countries (including five ITers) in analyzing the effect caused by IT on the persistence of inflation through a univariate autoregressive process. They found that IT has played a role in anchoring inflation expectations and in reducing inflation persistence. Based on a sample of 14 full-fledged ITers, de Mendonça (2007a) analyzed macroeconomic performance before and after adoption of IT and concluded that IT is a good framework for disinflation, and contributes to reducing interest rates without curtailing economic growth.

The main problem with the abovementioned studies is due to the arbitrary selection of countries that have not adopted IT for purposes of comparison with countries that have adopted IT, or because the study analyzes a country before and after IT adoption.[15] Moreover, the studies mentioned do not address the problem of self-selection and selectivity bias; thus, suffer from potential bias in the results.

Few studies take into consideration the choice of counterfactuals. Ball and Sheridan (2003) use the difference-in-differences method for 20 OCDE countries (where seven are ITers). Gonçalves and Salles (2008) extend the same analysis to 36 developing countries (where 13 are ITers). Vega and Winkelried (2005) use the PSM method for a sample of 109 countries (23 ITers) for the period 1990 to 2004. However, because the authors use an average of just five years for model variables, the result is based on a mere 100 observations, which in turn, entails few counterfactuals (33 on average for each model). Lin and Ye (2007) employ PSM analysis for seven industrial countries that have adopted IT out of a total sample of 22 countries for the period 1985 to 1999 (total of 321 observations).

[15] It is important to note that when the inflation of a country is compared before and after IT adoption, the observed change can be a result of factors other than the adoption of the monetary regime.

The above review of the literature reveals that the majority of studies concerning IT fails to consider problems caused by selection bias. The few studies that do take the problem into consideration are compromised by (a) too-short a window of analysis; (b) too-few countries implementing IT; (c) insufficient quantity / quality of counterfactuals; and (d) outcomes that enable a comparison to be made between advanced and developing countries. In this study, the PSM framework (the most suitable for analyzing inflation and its volatility under IT),[16] a greater number of treatment and control countries, and a more extensive period including recent experiences with IT are considered. Moreover, temporal control variables, which constitute the context of IT implementation worldwide, are embedded in the model. The full panel data framework shows information of 180 countries for the period 1990 to 2007, i.e., 3,240 observations. In relation to the 30 advanced countries in the sample, 12 have already adopted IT. Among the 150 developing countries in the analysis, 17 have adopted IT. Therefore, this study considers the experience of 29 countries under IT treatment (at the time of writing, the largest sample of ITers studied thus far – see Table A.2.1 – appendix).

The matching method consists of the selection of an ideal control group based on a treatment group. The idea is that for each country that has adopted IT, there is a counterfactual for comparison. However, the statistical literature recognizes that the estimation of a casual effect through the comparison of a treatment group with a control group (non-experimental) can be biased, either due to the selectivity problem or due to some systematic bias by researchers when selecting for matching.

The abovementioned bias can appear a consequence of the difference between ITers and non-ITers, which in turn, can affect the choice for adopting IT as well as its subsequent performance, and causing problems with sample selection. Therefore, the matching method considers distinct sets that are alike, based on their observable characteristics, and that allows finding non-biased estimation. In this sense, due to the high-dimensional covariate vectors needed for the objective of this study, the PSM method is the preferred option (Dehejia and Wahba, 2002).

[16] Appendix A.1 shows the explanation of the PSM methodology used in this study.

It is important to note that the estimation of the propensity score does not attempt to find the best model that can provide the probability of adopting IT. According to Persson (2001, p. 441) "the objective [...] is not to build a statistical (let alone an economic or political) model explaining [...] in the best possible way [...] in fact, a close to perfect fit [...] would be destructive for the matching approach."[17] Therefore, the variables that determine only the probability of IT being adopted by a central bank are not used. The set of characteristics may influence the probability of adopting IT and also the average and volatility of inflation. In addition, variables that characterize and summarize the state of the economy are also considered.

The key question when using this methodology is, had the country not adopted IT, would it have achieved the same results with respect to inflation and inflation volatility? Based on a methodology that simulates a quasi-natural experiment, it should be possible to answer this question.

2.3.1. Data

The panel data present in this study includes information from 180 countries from 1990 to 2007 (see appendix – Table A.2.1 to ITers and A.2.2 to non-ITers). Due to the methodology adopted, it makes little sense to extend the sample to the years before the 1990s. This is because before the 1990s, the likelihood of adopting IT was low due to a lack of theoretical development and practical application. The data was gathered from the following sources: World Development Indicators (WDI); International Financial Statistics (IFS); Reinhart and Rogoff (2004); Ilzetzki, Reinhart and Rogoff (2008); and Chinn and Ito (2008).[18]

Based on an analysis of the probability of adoption of IT and the effects of IT on inflation, the following variables were defined for the PSM:[19]

(i) GDPP – real GDP per capita[20] of the country; GDPP can be understood as a

[17] See also, Vega and Winkelried (2005), and Lin and Ye (2007).
[18] Other sources also considered in the analysis were Penn World Table (PWT 6.3), and Ghosh, Gulde and Wolf (2003); however, for reasons of parsimony, this information was not considered in the final specifications of the models.
[19] The studies considered are Vega and Winkelried (2005), Hu (2006), Lin and Ye (2007), and Leyva (2008).
[20] Gross Domestic Product is the most commonly used single measure of a country's overall economic activity.

universal measure of economic development. Leyva (2008) emphasizes that this variable can work as a general indicator of institutional development for substituting the indices of autonomy or central bank credibility;[21]

(ii) GFB – government fiscal balance (percent of GDP); it is assumed that GFB avoids the monetization process and thus is one precondition to the success of IT.[22] Under this view, the control of money is not a sufficient condition to determine the path of inflation. According to Woodford (2001, p. 724), "a central bank charged with maintaining price stability cannot be indifferent as to how fiscal policy is determined;"

(iii) MONEY – ratio of M2/GDP; based on a monetarist view, it is expected that an increase in this ratio implies pressure on inflation;

(iv) KAOPEN – a measure of financial openness; the degree of integration of a country to international capital markets may affect the way countries react to international shocks, the effectiveness of its monetary (or exchange rate) policy and, ultimately, the rate of inflation. The argument holds that due to financial globalization, competition among currencies helps induce central banks to adopt best practices and keeps inflation low (Tytell and Wei, 2004);

(v) TRADE – a measure of commercial openness; TRADE corresponds to the exportation plus importation of goods and services (percent of GDP). As suggested, for example, by Romer (1993) and Rogoff (2003), more open economies reduces the inflation bias of central banks;

(vi) FER – fixed exchange rate; FER is a dummy variable equal to one when the country has some control over the exchange rate (e.g., currency board, de facto peg, crawling peg, etc.) and zero otherwise (e.g., managed floating, freely floating, etc.);

(vii) CPI_{-1} – the previous inflation rate, as measured by Consumer Price Index; lagged inflation is relevant in the model due to the fact that the magnitude of this variable has the power to influence the adoption of IT; used as a control for initial conditions.

In addition, with the intention of differentiating between the temporal

[21] For an analysis regarding these indices, see Cukierman *et al*. (1992), Svensson and Faust (2001), Cecchetti and Krause (2002), de Mendonça (2007b), and Chapter 1.
[22] See Mishkin (2004) for a survey.

characteristics and the international environment, which influence the decision to adopt IT and also affect the country's inflation and volatility, the following variables are also considered: TIME – a time dummy; WCPI – the world inflation rate; and WGDP – world GDP.

In brief, the covariates matrix chosen (a) characterizes the country's economy and maps the historical moment; (b) assures the random process concerning the choice of adopting IT; and (c) is systematically correlated with the outcomes of inflation and volatility. Given the foregoing, the conditions for estimation of PSM are assured.[23]

As a measure of inflation, the annual variation of Consumer Price Index figures released by the International Monetary Fund are used. Note that regarding inflation volatility, by reducing inflation, countries with a greater level of inflation can decrease the standard deviation, but not relative volatility (coefficient of variation); thus, the use of standard deviation is unsuitable in this case. Nonetheless, the coefficient of variation is not a perfect substitute, since it tends to balloon as inflation becomes very low. Hence, with the objective of mitigating an improper measurement and thus a false outcome concerning inflation volatility, both standard deviation and coefficient of variation are employed in the estimations.[24]

2.4. Evaluation of IT in the world through a PSM model

Since the 1990s, a growing number of countries have adopted IT. The literature concerning IT suggests that the use of this strategy contributes to decreased inflation and inflation volatility. Table 2.1 shows the average inflation and inflation volatility for the set of countries that adopted IT and for countries that adopted other strategies for the implementation of monetary policy in the period 1990 to 2007. The total sample concerns 180 countries, and the IT adoption date is

[23] The variables chosen also take into account characteristics that the literature indicates as prerequisite conditions for the adoption of IT. See, Svensson (2002); Mishkin (2004); Truman (2003); and Lin and Ye (2007).

[24] Standard deviation and the coefficient of variation for inflation rate are calculated for the period of one year.

based on initial classification. In addition, Table 2.1 shows the same information for the case where the countries with high inflation are removed from the sample. The table takes into account two sets of countries: advanced and developing.

Table 2.1 - *Inflation and its Volatility (1990-2007)*

Average	All Sample					
	All Countries		Advanced Countries		Developing Countries	
	Non-ITers	Iters	Non-ITers	Iters	Non-ITers	ITers
CPI	78.25	5.03	3.26	2.76	92.95	6.82
CPI S.E.	49.10	1.12	0.60	0.75	58.54	1.41
Average	**Without High Inflation**					
	All		Advanced Countries		Developing Countries	
	Non-ITers	Iters	Non-ITers	Iters	Non-ITers	ITers
CPI	7.26	4.83	3.26	2.76	8.13	6.48
CPI S.E.	3.04	1.06	0.60	0.75	3.57	1.31

Note: S.E. is the standard error. "Without High Inflation" corresponds to the case of countries with inflation lower than 40% p.a.

It is evident that average inflation, as well as average inflation volatility, is greater for the set of countries that did not adopt IT. The main reason for this outcome is due to the presence of developing countries in the sample.[25] Furthermore, it can be seen that although the difference between ITers and non-ITers diminishes, it is not eliminated.

Taking into account the above considerations, a set of six models (compared one with the other, which allows an ample analysis from the results found) are estimated. The baseline model considers the dates of adoption of IT based on initial classification (similar to dates obtained from central banks) and original data (without any treatment). The second model uses dates of adoption of IT based on conservative classification. Hence, besides the comparison with the baseline model, the second model is also employed to make a specific analysis for the cases where there exists an explicit IT. The third model represents the baseline model without TRADE. The elimination of TRADE from the estimation is motivated by the fact that certain authors, e.g., Wynne and Kersting (2007), argue that the discipline on central banks is a consequence of financial globalization rather than real (goods and

[25] The number of developing countries represents 83.33% of the total countries.

services) globalization. Therefore, the estimation without this variable provides assurance as to its relevance in the analysis. In an attempt to remove the presence of outliers from estimation, the fourth model eliminates the cases of high inflation (annual inflation rate greater than 40%).[26] Because the presence of outliers (very high inflation for a few countries) will be very influential in determining the results, and aiming to maintain the number of observations in the models, the fifth model takes into account the inflation "D" instead of percentage change in price level, as suggested by Cukierman *et al.* (1992).[27] The sixth model, instead of using time dummies (TIME) in order to control the Probit specification, includes worldwide variables (WCPI and WGDP).

Periods of high world inflation imply greater domestic inflation rates and thus the traditional mechanism for controlling the increase in domestic prices loses efficiency. Under such an environment, the monetary authority has a lower credibility and consequently demands a greater sacrifice rate for controlling the increase in prices. One possible outcome is that the adoption of a tight monetary policy, such as IT, may be inhibited, resulting in negative WCPI. On the other hand, it is expected that the sign of WGDP is positive, given that in global boom periods, better structural and institutional conditions for the adoption of IT prevail.

In relation to the other covariates that define the economy of the country, it is expected that GDPP, MONEY, KAOPEN, and TIME have positive signs in the estimations. As pointed out by Truman (2003), and Lin and Ye (2007), greater GDPP implies better conditions for the adoption of IT. The variable MONEY represents the degree to which the economy is monetized. Moreover, when this ratio is higher, greater competence by the government is implied in its programming of monetary policy in an effective way (Hu, 2006).[28] In regard to KAOPEN, an increase in a country's integration with international capital markets can work as an instrument in the control of inflation through an improvement in credibility (see Gruben and

[26] The classical definition of hyperinflation is due to Cagan (1956). The modern classification of hyperinflation and high inflation used in this article is based on Bruno and Easterly (1998), Fischer, Sahay, and Vegh (2002), and Reinhart and Savastano (2003).

[27] "D" is the transformed inflation rate and it takes a value from "0" to "1" ($D=\pi/(1+\pi)$), where π is the inflation rate.

[28] This ratio is useful to determine the efficiency of the financial system to mobilize funds for economic growth (Williamson and Mahar, 1998).

McLeod, 2002), thereby creating a favorable environment for the adoption of IT. At a minimum, a positive relation for TIME is expected because it captures the increase in the probability of adopting IT over time.

Contrary to the variables listed above, it is expected that the signs for GFB, TRADE, FER, and CPI_{-1} are negative. Fiscal control is a necessary condition for achieving price stability. Therefore, contrary to the monetarist view, the determination of price level is a fiscal phenomenon. Underpinning this theory is the hypothesis that the growth rate of public bonds explains the price level. Therefore, a fiscal imbalance suggests a lower chance for the adoption of IT. Based on Vega and Winkelried (2005), and Lin and Ye (2007), the use of exchange rate targeting is more attractive to countries that are more open to trade; thus a negative coefficient of the variable TRADE is expected. As the use of a fixed exchange rate regime is incompatible with IT, a negative sign for FER is expected. Concerning earlier inflation levels, high current inflation inhibits the adoption of IT because the use of a disinflationary strategy can have a high social cost; therefore, a negative sign is expected.

Figure 2.1 - *Characteristics of the variables – full data*

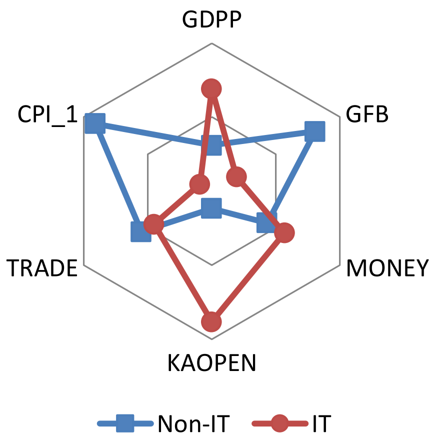

Figure 2.1 depicts the main characteristics of the variables present in the analysis, taking into account full data (developing and advanced countries). As indicated, GDPP and KAOPEN are greatest for the set of ITers. The opposite occurs when GFB and CPI_{-1} are considered. No reasonably clear interpretation of MONEY

and TRADE is apparent. Nonetheless, in a general way, the variables used in the models behave differently when ITers and non-ITers are considered. Therefore, the distinction between the two sets regarding the effects of these variables in the estimation of the propensity score is confirmed.

Table 2.2 shows the estimations for the six models of propensity score. In a general way, independently of the specifications, the observed signs of the coefficients on the variables are in agreement with the theoretical view. The PSM models estimated using Probit present a good degree of fit and were approved in the diagnostic tests.[29]

It is observed that the tripod pertaining to the external side of the economy (KAOPEN-TRADE-FER) is relevant in the estimations. In particular, the worst specification takes place when TRADE is taken out of the model (lowest pseudo R^2, highest AIC and BIC). Furthermore, the following factors did not considerably change the outcomes achieved in the baseline model: (a) the use of models taking into account the conservative date in regard to the adoption of IT; (b) the elimination of countries with high inflation; (c) the use of inflation "D" to mitigate the possible influence of outliers.

The results from the last model suggest that the use of time dummies as a control is preferable to the inclusion of variables such as WCPI and WGDP. Nonetheless, as expected, in the sixth specification, the coefficient on WCPI is negative, albeit with no statistical significance. In short, it is not safe to say that high WCPI is a disincentive to the adoption of IT. The coefficient on the other temporal control variable (WGDP) is positive, however, and does have statistical significance. Thus, moments of greater world economic activity correlate with a greater probability to adopt IT.

[29] The value of 0.7 for an adjusted R^2 of a model calculated through OLS can be compared to a value of 0.2 of a pseudo R^2 (Louviere, Hensher, and Swait, 2000).

Table 2.2 - *Propensity Score Estimations – Probit model*

Variables	Baseline		Conservative Dates		Without TRADE		High Inflation		With D		International Controls	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
GDPP	0,0358 ***	0,0083	0,0398 ***	0,0093	0,0299 ***	0,0073	0,0394 ***	0,0088	0,0354 ***	0,0083	0,0368 ***	0,0083
GFB	-0,0466 ***	0,0171	-0,0713 **	0,0203	-0,0524 ***	0,0132	-0,0477 ***	0,0177	-0,0467 ***	0,0171	-0,0498 ***	0,0174
MONEY	0,0019 *	0,0011	0,0029 *	0,0017	-0,0019	0,0015	0,0014 **	0,0008	0,0017 *	0,0010	0,0017	0,0018
KAOPEN	0,0928 **	0,0424	0,0211	0,0459	0,0928 **	0,0409	0,0765 *	0,0425	0,0930 **	0,0424	0,0929 **	0,0429
TRADE	-0,0049 ***	0,0013	-0,0038 ***	0,0014			-0,0048 ***	0,0013	-0,0049 ***	0,0013	-0,0049 ***	0,0013
FER	-1,1434 ***	0,1330	-1,3686 ***	0,1500	-1,1458 ***	0,1265	-1,1308 ***	0,1329	-1,1440 ***	0,1337	-1,1574 ***	0,1324
CPI_1	-0,0213 **	0,0085	-0,0718 ***	0,0133	-0,0218 ***	0,0081	-0,0180 **	0,0093	-3,0423 ***	1,0167	-0,0222 ***	0,0085
TIME	0,0707 ***	0,0158	0,1446 ***	0,0246	0,0591 ***	0,0145	0,0707 ***	0,0159	0,0712 ***	0,0159		
WCPI											-0,0027	0,0151
WGDP											0,0275 ***	0,0080
Observations	828		828		863		779		828		828	
Common Support	[0.0069, 0.9064]		[0.0211, 0.9548]		[0.0056, 0.8107]		[0.0093, 0.9084]		[0.0073, 0.9059]		[0.0067, 0.9097]	
Log pseudolikelihood	-264,02		-196,86		-285,36		-258,04		-264,21		-263,32	
Wald chi^2	134.16***		136.78***		140.35***		129.63***		133.87***		134.59***	
Pseudo R^2	0,3042		0,4194		0,2667		0,2967		0,3037		0,3060	
AIC	546,05		411,71		586,73		534,07		546,41		546,63	
BIC	588,52		454,18		624,81		576,00		588,88		593,82	
Correctly Classified	0,8816		0,9082		0,8691		0,8793		0,8804		0,8804	

Notes: Pseudo R^2 is the McFadden's R^2, AIC is the Akaike information Criterion and BIC is the Bayesian information Criterion. ***, ** and * indicate the significance level of 1%, 5% and 10%, respectively. The constants terms are included but not reported. The balancing property is satisfied for every models. D_1 was used instead of CPI_1 in the model With D .

2.4.1. Average effect of treatment on the treated (ATT)

The ATT may be calculated after propensity score estimations. For each of the six PSM models, the average effects of adoption of IT for the ITers with respect to inflation and inflation volatility are reported. The ATT for each model is calculated based on by Stratification Matching, Nearest Neighbor-Matching, Radius Matching, and Kernel Matching estimators.[30] With the objective of increasing the sensitivity in the analysis, an ample radius (r=0.10) and a lower radius (r=0.05) in Radius estimator are used, whereas in the Kernel estimator, the functions Gaussian and Epanechnikov are used.

Table 2.3 summarizes the six models, taking into consideration the effects on inflation. Each model shows the outcomes of ATT for the average inflation with regard to the total sample, developing countries, and advanced countries. For a more detailed analysis of the effects of treatment (IT), the set of "matching" estimators was used. Despite the use of the common support condition (which improves the quality of matching, but reduces the number of observations), a great number of individuals for all models are available, which in turn improves the properties of PSM model.

[30] The two manners for calculating the Nearest Neighbor estimator (equal weight and random draw) are identical, thus only one is reported.

Table 2.3 – *Estimations of the treatment effect by IT on inflation for ITers*

Countries	Matching: Stratification	Nearest Neighbor	Radius *0,1*	Radius *0,05*	Kernel *Gausssian*	Kernel *Epanechnikov*		Stratification	Nearest Neighbor	Radius *0,1*	Radius *0,05*	Kernel *Gausssian*	Kernel *Epanechnikov*	Stratification	Nearest Neighbor	Radius *0,1*	Radius *0,05*	Kernel *Gausssian*	Kernel *Epanechnikov*
Model	**Baseline**							**Conservatives Dates**						**Without TRADE**					
All sample	-3,422	-3,181	-6,996	-3,436	-3,378	-3,529		-3,770	-4,230	-2,637	-2,983	-3,655	-3,976	-3,870	-1,948	-5,689	-3,918	-3,591	-3,543
	(1,197) ***	(1,890) *	(2,219) ***	(1,124) ***	-	-		(2,071) *	(1,340) ***	(1,569) *	(1,353) **	-	-	(1,168) ***	(1,107) *	(2,751) **	(2,187) *	-	-
	[1,245] ***	[1,679] *	[1,118] ***	[1,211] ***	[1,465] **	[1,409] **		[2,450]	[2,435] *	[1,627]	[1,451] **	[1,761] **	[1,814] **	[1,468] ***	[1,433]	[3,418] *	[3,221]	[1,078] ***	[1,282] ***
IT	142	142	105	96	142	142		118	118	83	69	118	118	144	144	122	112	144	144
Non-IT	616	74	612	612	616	616		380	66	380	380	380	380	671	89	670	670	671	671
All	*758*	*216*	*717*	*708*	*758*	*758*	*0*	*498*	*184*	*463*	*449*	*498*	*498*	*815*	*233*	*792*	*782*	*815*	*815*
Developing Countries	-5,017	-4,766	-6,718	-6,780	-4,964	-5,560		-6,366	-6,564	-4,292	-4,469	-6,324	-6,372	-6,554	-3,406	-6,099	-8,164	-5,656	-6,016
	(1,440) ***	(2,565) *	(3,611) *	(4,067) *	-	-		(2,263) ***	(1,445) ***	(1,863) **	(2,589) *	-	-	(1,851) ***	(1,896) *	(3,293) *	(4,666) *	-	-
	[1,242] ***	[3,399]	[5,140]	[5,185]	[1,328] ***	[1,587] ***		[1,839] ***	[2,359] ***	[1,635] ***	[1,672] ***	[1,687] ***	[2,120] ***	[2,311] ***	[3,454]	[4,809]	[6,196]	[1,573] ***	[1,951] ***
IT	90	90	84	72	90	90		70	72	56	46	72	72	90	90	79	69	90	90
Non-IT	565	60	565	565	565	565		336	48	334	334	334	334	600	68	539	539	600	600
All	*655*	*150*	*649*	*637*	*655*	*655*	*0*	*406*	*120*	*390*	*380*	*406*	*406*	*690*	*158*	*618*	*608*	*690*	*690*
Advanced Countries	0,265	-0,058	0,142	-0,900	0,365	0,186		0,123	0,343	-1,355	-1,499	0,262	0,214	0,656	1,005	-0,682	-0,934	0,685	0,807
	(0,403)	(0,782)	(0,394)	(1,284)	-	-		(0,487)	(0,680)	(0,826)	(1,378)	-	-	(0,549)	(0,785)	(0,574)	(1,180)	-	-
	[0,427]	[0,408]	[0,382]	[1,280]	[0,380]	[0,433]		[0,549]	[0,411]	[0,866]	[1,132]	[0,314]	[0,438]	[0,495]	[0,633]	[0,748]	[1,034]	[0,495]	[0,583]
IT	52	52	52	13	52	52		46	46	18	13	46	46	53	54	25	17	54	54
Non-IT	35	14	35	35	35	35		42	12	42	42	42	42	57	21	56	56	56	56
All	*87*	*66*	*87*	*48*	*87*	*87*	*0*	*88*	*58*	*60*	*55*	*88*	*88*	*110*	*75*	*81*	*73*	*110*	*110*
Model	**High Inflation**							**With D**						**International Controls**					
All sample	-2,439	-2,644	-2,362	-1,966	-2,532	-2,613		-0,022	-0,026	-0,029	-0,031	-0,022	-0,021	-3,697	-2,217	-7,142	-3,624	-3,378	-3,587
	(0,876) ***	(2,661)	(0,638) ***	(0,894) **	-	-		(0,007) ***	(0,018)	(0,008) ***	(0,010) ***	-	-	(1,317) ***	(2,241)	(2,812) **	(2,078) *	-	-
	[1,138] **	[1,955]	[0,802] ***	[0,921] **	[0,865] ***	[1,373] *		[0,010] **	[0,017]	[0,008] ***	[0,010] ***	[0,011] **	[0,008] ***	[1,500] **	[1,266] *	[2,820] **	[3,270]	[1,507] **	[1,390] **
IT	141	141	102	94	141	141		142	142	109	96	142	142	141	142	110	98	142	142
Non-IT	606	78	606	606	606	606		615	79	615	615	615	615	625	78	623	623	624	624
All	*747*	*219*	*708*	*700*	*747*	*747*	*0*	*757*	*221*	*724*	*711*	*757*	*757*	*766*	*220*	*733*	*721*	*766*	*766*
Developing Countries	-4,726	-7,311	-1,941	-1,960	-4,123	-4,860		-0,032	-0,034	-0,024	-0,028	-0,033	-0,035	-5,528	-3,476	-7,743	-7,146	-4,967	-5,531
	(1,151) ***	(2,896) **	(0,854) **	(1,025) *	-	-		(0,010) ***	(0,017) **	(0,010) **	(0,011) **	-	-	(1,935) ***	(1,822) *	(4,338) *	(3,882) *	-	-
	[1,486] ***	[2,667] ***	[0,979] **	[0,967] **	[1,153] ***	[2,034] **		[0,009] ***	[0,016] **	[0,010] **	[0,012] **	[0,010] ***	[0,012] ***	[1,769] ***	[1,952] *	[4,540] *	[4,767]	[1,580] ***	[1,678] ***
IT	90	90	79	74	90	90		90	90	78	76	90	90	88	90	81	69	90	90
Non-IT	555	59	555	555	555	555		564	65	564	564	564	564	575	63	573	573	573	573
All	*645*	*149*	*634*	*629*	*645*	*645*	*0*	*654*	*155*	*642*	*640*	*654*	*654*	*663*	*153*	*654*	*642*	*663*	*663*
Advanced Countries	0,282	0,050	-0,689	-0,900	0,369	0,286		0,002	0,000	-0,010	-0,012	0,003	0,002	0,437	0,491	-0,709	-1,187	0,404	0,398
	(0,357)	(0,811)	(0,961)	(1,309)	-	-		(0,004)	(0,007)	(0,009)	(0,011)	-	-	(0,380)	(0,668)	(1,006)	(1,031)	-	-
	[0,451]	[0,380]	[0,966]	[1,352]	[0,364]	[0,415]		[0,004]	[0,003]	[0,009]	[0,014]	[0,004]	[0,004]	[0,384]	[0,365]	[0,921]	[1,349]	[0,325]	[0,343]
IT	51	51	23	13	51	51		52	52	23	12	52	52	49	52	19	14	52	52
Non-IT	35	15	35	35	35	35		35	14	35	35	35	35	34	16	31	31	31	31
All	*86*	*66*	*58*	*48*	*86*	*86*	*0*	*87*	*66*	*58*	*47*	*87*	*87*	*83*	*68*	*50*	*45*	*83*	*83*

Notes: 0.06 fixed bandwith is used for Epanechnikov kernel. The analytical standard errors are reported in parentheses and the bootstrapped standard errors are reported in box brackets (they are based on 1000 replications of the data). ***, ** and * indicate the significance level of 1%, 5% and 10%, respectively.

Taking into account the total sample, the effect of the treatment on inflation is negative and has statistical significance independent of the estimator used for the six models. The most relevant reduction in the inflation average is observed by baseline model, which corresponds to 4 percentage points (hereinafter p.p.); the smallest reduction in the inflation average is presented by the model without the presence of high inflation (2.4 p.p.).[31] The same behavior is seen when the sample of developing countries is considered in the analysis. In fact, the results are stronger than in the previous case: the highest fall in inflation is 6 p.p. (model "without trade") and the lowest is 4.2 p.p. (model "high inflation"). It is important to stress that, when the outcomes found for advanced countries are analyzed separately, there is no empirical evidence that the presence of IT causes inflation to drop. This observation suggests that the result found in the total sample is influenced by developing countries.

In sum, the results considering "all sample" and "developing countries," are strong and robust for the distinct PSM models and for different methods of matching. The evidence suggests that the adoption of full-fledged IT, in opposition to soft IT, is advantageous for the case of developing countries. Furthermore, it is important to note that the use of controls for the cases of "conservative dates," "without trade," "high inflation," "with D," and "international controls" did not considerably change the results found by the baseline model.

It is expected that IT is capable not only of reducing inflation, but also of maintaining price stability. In this sense, Tables 2.4 and 2.5 show the outcomes concerning inflation volatility (standard deviations and coefficient of variation, respectively). The stability contributes to improving the public's expectation of inflation and becomes an important mechanism for central banks to implement monetary policy under IT. "As the most important step in controlling inflation is to control inflationary expectations, one main task of the [central bank] has been to build credibility as a monetary authority committed to price stability. Such credibility is important because it influences expectations affecting interest and

[31] The analysis of comparison among the models excludes the model "with D" because its coefficients do not allow a direct comparison with the others.

exchange rates and thereby affects the cost of reducing inflation in terms of lost output and employment." (de Mendonça, 2007b, p. 2604)

The analysis regarding absolute volatility (standard deviations – Table 2.4) suggests that there is a significant decrease in volatility when the total sample and the case of developing countries are considered. Taking into account the total sample, the results indicate that the decrease in volatility is greater for the "baseline model," while the decrease in volatility is lower for the "high inflation" model. In other words, when the countries with high inflation are removed from the sample (a typical case of developing economies) the consequence is a smaller impact on inflation volatility. Therefore, the results observed in the "all sample" model are explained in great measure by the performance of developing countries. About developing economies, the model that captures the greater decrease in volatility is "international controls," although the "without trade" model is very close. The smallest decrease in volatility is observed through the "baseline model."

Table 2.4 - *Estimations of the treatment effect by IT on inflation volatility for ITers (standard deviations)*

	Matching																			
Countries	Stratification	Nearest Neighbor	Radius		Kernel			Stratification	Nearest Neighbor	Radius		Kernel		Stratification	Nearest Neighbor	Radius		Kernel	
			0,1	*0,05*	*Gausssian*	*Epanechnikov*				*0,1*	*0,05*	*Gausssian*	*Epanechnikov*			*0,1*	*0,05*	*Gausssian*	*Epanechnikov*
Model	**Baseline**							**Conservatives Dates**						**Without TRADE**					
	-1,183	-1,432	-4,980	-1,218	-1,113	-1,204		-1,439	-1,573	-1,059	-0,672	-1,406	-1,543	-1,182	-0,819	-5,522	-1,613	-1,160	-1,187
All sample	(0,460) **	(0,829) *	(5,753)	(0,729) *	-	-		(0,860) *	(0,451) ***	(0,576) *	(0,459)	-	-	(0,405) ***	(0,532)	(3,293) *	(4,884)	-	-
	[0,515] **	[0,765] *	[2,865] *	[0,877]	[0,536] **	[0,451] ***		[0,739] *	[1,125]	[0,788]	[0,601]	[0,582] **	[0,816] *	[0,402] ***	[0,515]	[4,104]	[4,672]	[0,329] ***	[0,334] ***
IT	142	142	105	96	142	142		118	118	83	69	118	118	144	144	122	112	144	144
Non-IT	616	74	612	612	616	616		380	66	380	380	380	380	671	89	670	670	671	671
All	*758*	*216*	*717*	*708*	*758*	*758*	*0*	*498*	*184*	*463*	*449*	*498*	*498*	*815*	*233*	*792*	*782*	*815*	*815*
	-1,799	-2,071	-5,073	-5,968	-1,725	-1,941		-2,607	-2,763	-0,878	-0,921	-2,552	-2,613	-2,077	-1,480	-5,582	-7,534	-1,911	-2,040
Developing Countries	(0,490) ***	(0,769) ***	(5,586)	(4,811)	-	-		(0,727) ***	(0,493) ***	(0,459) *	(0,927)	-	-	(0,689) ***	(0,591) **	(3,070) *	(11,697)	-	-
	[0,445] ***	[0,966] **	[6,020]	[7,917]	[0,513] ***	[0,566] ***		[0,749] ***	[0,871] ***	[0,755]	[0,927]	[0,687] ***	[0,988] ***	[0,685] ***	[0,863] *	[3,096] *	[6,625]	[0,452] ***	[0,564] ***
IT	90	90	84	72	90	90		70	72	56	46	72	72	90	90	79	69	90	90
Non-IT	565	60	565	565	565	565		336	48	334	334	334	334	600	68	539	539	600	600
All	*655*	*150*	*649*	*637*	*655*	*655*	*0*	*406*	*120*	*390*	*380*	*406*	*406*	*690*	*158*	*618*	*608*	*690*	*690*
	0,248	0,270	0,255	0,051	0,294	0,234		0,313	0,303	0,262	0,061	0,297	0,303	0,293	0,321	0,076	-0,024	0,290	0,288
Advanced Countries	(0,133) *	(0,186)	(0,215)	(0,235)	-	-		(0,157) **	(0,202)	(0,231)	(0,444)	-	-	(0,102) ***	(0,101) ***	(0,171)	(0,245)	-	-
	[0,142] *	[0,131] **	[0,294]	[0,338]	[0,101] ***	[0,147]		[0,139] **	[0,126] **	[0,327]	[0,291]	[0,107] ***	[0,130] **	[0,108] ***	[0,106] ***	[0,193]	[0,224]	[0,096] ***	[0,104] ***
IT	52	52	52	13	52	52		46	46	18	13	46	46	53	54	25	17	54	54
Non-IT	35	14	35	35	35	35		42	12	42	42	42	42	57	21	56	56	56	56
All	*87*	*66*	*87*	*48*	*87*	*87*	*0*	*88*	*58*	*60*	*55*	*88*	*88*	*110*	*75*	*81*	*73*	*110*	*110*
Model	**High Inflation**							**With D**						**International Controls**					
	-0,884	-0,795	-0,951	-0,738	-0,887	-0,927		-0,008	-0,008	-0,007	-0,006	-0,007	-0,007	-1,175	-0,789	-5,173	-1,422	-1,067	-1,142
All sample	(0,377) **	(0,702)	(0,253) ***	(0,326) **	-	-		(0,003) ***	(0,004) **	(0,003) **	(0,003) *	-	-	(0,443) ***	[0,464] *	(3,140) *	(3,240)	-	-
	[0,450] **	[0,433] *	[0,216] ***	[0,276] ***	[0,434] **	[0,457] **		[0,003] ***	[0,005]	[0,003] **	[0,003] *	[0,004] *	[0,003] **	[0,545] **	[0,460] *	[4,228]	[4,484]	[0,345] ***	[0,508] **
IT	141	141	102	94	141	141		142	142	109	96	142	142	141	142	110	98	142	142
Non-IT	606	78	606	606	606	606		615	79	615	615	615	615	625	78	623	623	624	624
All	*747*	*219*	*708*	*700*	*747*	*747*	*0*	*757*	*221*	*724*	*711*	*757*	*757*	*766*	*220*	*733*	*721*	*766*	*766*
	-1,781	-2,619	-1,002	-1,065	-1,574	-1,814		-0,012	-0,012	-0,010	-0,009	-0,012	-0,012	-1,844	-1,036	-5,210	-6,782	-1,682	-1,839
Developing Countries	(0,438) ***	(0,834) ***	(0,334) ***	(0,323) ***	-	-		(0,003) ***	(0,004) ***	(0,003) ***	(0,004) **	-	-	(0,584) ***	(0,462) **	4,528	(4,194)	-	-
	[0,464] ***	[1,003] ***	[0,278] ***	[0,366] ***	[0,424] ***	[0,648] ***		[0,003] ***	[0,004] ***	[0,004] **	[0,004] **	[0,003] ***	[0,004] ***	[0,608] ***	[0,585] *	[6,414]	[4,020] *	[0,430] ***	[0,618] ***
IT	90	90	79	74	90	90		90	90	78	76	90	90	88	90	81	69	90	90
Non-IT	555	59	555	555	555	555		564	65	564	564	564	564	575	63	573	573	573	573
All	*645*	*149*	*634*	*629*	*645*	*645*	*0*	*654*	*155*	*642*	*640*	*654*	*654*	*663*	*153*	*654*	*642*	*663*	*663*
	0,253	0,050	0,137	0,045	0,292	0,291		0,002	0,003	0,002	0,001	0,003	0,002	0,301	0,305	0,378	0,365	0,298	0,291
Advanced Countries	(0,105) **	(0,811)	(0,254)	(0,309)	-	-		(0,001) **	(0,002)	(0,002)	(0,002)	-	-	(0,096) ***	(0,178) *	(0,214) *	(0,279)	-	-
	[0,132] *	[0,380]	[0,288]	[0,312]	[0,097] ***	[0,171] *		[0,001] **	[0,001] ***	[0,003]	[0,003]	[0,001] ***	[0,001] **	[0,117] **	[0,102] ***	[0,292]	[0,387]	[0,080] ***	[0,130] **
IT	51	51	23	13	51	51		52	52	23	12	52	52	49	52	19	14	52	52
Non-IT	35	15	35	35	35	35		35	14	35	35	35	35	34	16	31	31	31	31
All	*86*	*66*	*58*	*48*	*86*	*86*	*0*	*87*	*66*	*58*	*47*	*87*	*87*	*83*	*68*	*50*	*45*	*83*	*83*

Notes: 0.06 fixed bandwith is used for Epanechnikov kernel. The analytical standard errors are reported in parentheses and the bootstrapped standard errors are reported in box brackets (they are based on 1000 replications of the data). ***, ** and * indicate the significance level of 1%, 5% and 10%, respectively.

Table 2.5 - *Estimations of the treatment effect by IT on inflation volatility for ITers (coefficient of variation)*

	Matching																		
Countries	**Stratification**	**Nearest Neighbor**	**Radius**		**Kernel**			**Stratification**	**Nearest Neighbor**	**Radius**		**Kernel**		**Stratification**	**Nearest Neighbor**	**Radius**		**Kernel**	
			0,1	*0,05*	*Gausssian*	*Epanechnikov*				*0,1*	*0,05*	*Gausssian*	*Epanechnikov*			*0,1*	*0,05*	*Gausssian*	*Epanechnikov*
Model	**Baseline**							**Conservatives Dates**						**Without TRADE**					
All sample	-0,118	-0,176	-0,163	-0,092	-0,121	-0,121		-0,046	-0,091	-0,203	-0,259	-0,064	-0,059	-0,298	-0,363	-0,360	-0,378	-0,347	-0,337
	(0,116)	(0,242)	(0,150)	(0,158)	-	-		(0,107)	(0,363)	(0,164)	(0,207)	-	-	(0,211)	(0,241)	(0,270)	(0,288)	-	-
	[0,099]	[0,116]	[0,141]	[0,158]	[0,093]	[0,101]		[0,116]	[0,173]	[0,164]	[0,228]	[0,087]	[0,124]	[0,341]	[0,416]	[0,339]	[0,372]	[0,214]	[0,170] **
IT	142	142	105	96	142	142		118	118	83	69	118	118	144	144	122	112	144	144
Non-IT	616	74	612	612	616	616		380	66	380	380	380	380	671	89	670	670	671	671
All	*758*	*216*	*717*	*708*	*758*	*758*	*0*	*498*	*184*	*463*	*449*	*498*	*498*	*815*	*233*	*792*	*782*	*815*	*815*
Developing Countries	-0,309	-0,265	-0,221	-0,207	-0,279	-0,267		-0,245	-0,317	-0,456	-0,399	-0,250	-0,249	-0,346	-0,463	-0,307	-0,214	-0,356	-0,364
	(0,134) **	(0,123) **	(0,208)	(0,219)	-	-		(0,138) *	(0,410)	(0,242) *	(0,316)	-	-	(0,129) ***	(0,194) **	(0,180) *	(0,213)	-	-
	[0,150] **	[0,153] *	[0,185]	[0,239]	[0,145] *	[0,126] **		[0,145] *	[0,250]	[0,253] *	[0,295]	[0,125] **	[0,134] *	[0,144] **	[0,310]	[0,175] *	[0,263]	[0,115] ***	[0,151] **
IT	90	90	84	72	90	90		70	72	56	46	72	72	90	90	79	69	90	90
Non-IT	565	60	565	565	565	565		336	48	334	334	334	334	600	68	539	539	600	600
All	*655*	*150*	*649*	*637*	*655*	*655*	*0*	*406*	*120*	*390*	*380*	*406*	*406*	*690*	*158*	*618*	*608*	*690*	*690*
Advanced Countries	0,233	0,222	0,128	0,118	0,165	0,145		0,270	0,246	0,315	0,195	0,230	0,249	-0,141	-1,142	0,008	0,099	-0,275	-0,518
	(0,185)	(0,131) *	(0,245)	(0,270)	-	-		(0,172)	(0,177)	(0,493)	(0,725)	-	-	(0,210)	(1,675)	(0,784)	(1,257)	-	-
	[0,189]	[0,190]	[0,289]	[0,339]	[0,136]	[0,194]		[0,159] *	[0,161]	[0,305]	[0,348]	[0,185]	[0,174]	[0,299]	[1,846]	[1,121]	[1,286]	[0,374]	[0,517]
IT	52	52	52	13	52	52		46	46	18	13	46	46	53	54	25	17	54	54
Non-IT	35	14	35	35	35	35		42	12	42	42	42	42	57	21	56	56	56	56
All	*87*	*66*	*87*	*48*	*87*	*87*	*0*	*88*	*58*	*60*	*55*	*88*	*88*	*110*	*75*	*81*	*73*	*110*	*110*
Model	**High Inflation**							**With D**						**International Controls**					
All sample	-0,108	-0,104	-0,160	-0,106	-0,122	-0,113		-0,180	-0,001	-0,239	-0,255	-0,214	-0,200	-0,108	-0,132	-0,208	-0,348	-0,110	-0,109
	(0,113)	(0,373)	(0,155)	(0,150)	-	-		(0,130)	(0,207)	(0,231)	(0,227)	-	-	(0,107)	(0,272)	(0,157)	(0,215)	-	-
	[0,111]	[0,166]	[0,160]	[0,183]	[0,102]	[0,115]		[0,190]	[0,148]	[0,236]	[0,280]	[0,170]	[0,188]	[0,125]	[0,134]	[0,137]	[0,211] *	[0,100]	[0,103]
IT	141	141	102	94	141	141		142	142	109	96	142	142	141	142	110	98	142	142
Non-IT	606	78	606	606	606	606		615	79	615	615	615	615	625	78	623	623	624	624
All	*747*	*219*	*708*	*700*	*747*	*747*	*0*	*757*	*221*	*724*	*711*	*757*	*757*	*766*	*220*	*733*	*721*	*766*	*766*
Developing Countries	-0,320	-0,269	-0,260	-0,336	-0,287	-0,269		-0,418	-0,125	-0,271	-0,355	-0,427	-0,402	-0,275	-0,205	-0,308	-0,189	-0,273	-0,266
	(0,142) **	(0,372)	(0,148) *	(0,203) *	-	-		(0,199) **	(0,147)	(0,297)	(0,364)	-	-	(0,150) *	(0,233)	(0,227)	(0,229)	-	-
	[0,166] *	[0,188]	[0,196]	[0,213]	[0,123] **	[0,111] **		0,287	[0,189]	[0,275]	[0,444]	[0,290]	[0,239] *	[0,139] **	[0,316]	[0,179] *	[0,197]	[0,154] *	[0,111] **
IT	90	90	79	74	90	90		90	90	78	76	90	90	88	90	81	69	90	90
Non-IT	555	59	555	555	555	555		564	65	564	564	564	564	575	63	573	573	573	573
All	*645*	*149*	*634*	*629*	*645*	*645*	*0*	*654*	*155*	*642*	*640*	*654*	*654*	*663*	*153*	*654*	*642*	*663*	*663*
Advanced Countries	0,254	0,203	0,121	0,121	0,169	0,138		0,240	0,217	0,219	0,323	0,174	0,160	0,196	0,002	0,436	0,448	0,173	0,170
	(0,168)	(0,157)	(0,346)	(0,498)	-	-		(0,165)	(0,226)	(0,245)	(0,269)	-	-	(0,185)	(0,428)	(0,280)	(0,536)	-	-
	[0,147] *	[0,121] *	[0,299]	[0,349]	[0,155]	[0,156]		[0,128] *	[0,184]	[0,260]	[0,438]	[0,164]	[0,203]	[0,102] *	[0,232]	[0,418]	[0,307]	[0,160]	[0,168]
IT	51	51	23	13	51	51		52	52	23	12	52	52	49	52	19	14	52	52
Non-IT	35	15	35	35	35	35		35	14	35	35	35	35	34	16	31	31	31	31
All	*86*	*66*	*58*	*48*	*86*	*86*	*0*	*87*	*66*	*58*	*47*	*87*	*87*	*83*	*68*	*50*	*45*	*83*	*83*

Notes: 0.06 fixed bandwith is used for Epanechnikov kernel. The analytical standard errors are reported in parentheses and the bootstrapped standard errors are reported in box brackets (they are based on 1000 replications of the data). ***, ** and * indicate the significance level of 1%, 5% and 10%, respectively.

Contrary to the evidence above, the case of advanced countries suggests an increase in volatility due to the introduction of IT. Although the significance is not as robust as in the previous cases, the use of counterfactuals indicates a very small increase in volatility in more than half of the models.[32]

With respect to relative volatility, measured by the coefficient of variation, the results are less conclusive than in the previous analysis. It can be seen that in the models "all sample" and "advanced countries," the influence caused by adoption of IT on inflation volatility can be disregarded. Nonetheless, as in the analysis concerning absolute volatility, the models for developing economies reveal significant influence of IT on inflation volatility. Thus, this observation strengthens the relevance of the analysis for developing economies.

With the intention of analyzing the main results from the ATTs reported in tables 2.3, 2.4, and 2.5, Table 2.6 presents a summary of the aggregate results of all matching models.[33] There is no doubt that the effect of the treatment on inflation has statistical significance and causes a decrease in the inflation rate when the total sample (average of -3.3 p.p.) and developing countries (average of -5 p.p.) are considered. In contrast, there is no evidence that the adoption of IT implies any effect on inflation in the case of advanced countries.[34]

Similar to the analysis concerning the effect of the treatment on inflation, the results from standard deviations suggest there is a significant decrease in inflation volatility for cases where the total sample (average of -1.5 p.p.) and developing countries (average of -2 p.p.) are considered. The evidence from the coefficient of variations is not as strong as that shown by the standard deviations. However, where significant results were observed, the models also provided evidence of a decrease in inflation volatility (especially for developing countries). The results for the advanced economies indicate a different behavior. In the case of the outcomes from standard deviations, the increase in inflation volatility, although small, cannot be ignored (average of 0.3 p.p.). The models with statistical significance for

[32]Note that the analysis on developed countries is based on a small sample size, which, in turn, implies that the results cannot be considered definitive.
[33]Differently from the previous analysis, the model "with D" considers the inflation ($\pi=D/(1-D)$) to permit a direct comparison of the averages.
[34]The average of the models do not present large differences, which in turn, strengthens the idea that the PSM specifications are correct.

coefficient variation also suggest an increase in inflation volatility. A possible reason for this result is that in the case of advanced economies, credibility is already high, thus the central bank has more flexibility in the management of monetary policy.

In short, as in medical cases, the effects are not homogenous when different types of individuals are considered (here developing and advanced countries). The results suggest that for developing countries, IT contributes effectively to the reduction of average inflation and inflation volatility. However, for advanced countries, the results suggest that the non-adoption of this monetary regime would engender similar results.

Table 2.6 – *Aggregate results*

Countries	**Models**	**Average treatment effect by IT on inflation for ITers**					
		Inflation	Obs.	Inflation Volatility			
				Stand. Error	Obs.	Coef. of Var.	Obs.
All Sample	Baseline	-3.990	10	-1.855	8	-	0
	Conservative Dates	-3.542	8	-1.404	6	-	0
	Without TRADE	-3.760	8	-2.263	5	-0.337	1
	High Inflation	-2.382	8	-0.864	9	-	0
	With D	-2.438	8	-0.711	9	-	0
	International Controls	-3.941	8	-1.869	7	-0.348	1
	Average	***-3.342***	***8.3***	***-1.494***	***7.3***	***-0.343***	***0.3***
Developing Countries	Baseline	-5.634	7	-1.884	6	-0.280	6
	Conservative Dates	-5.731	10	-2.283	7	-0.300	6
	Without TRADE	-5.983	7	-2.618	8	-0.367	7
	High Inflation	-4.153	10	-1.642	10	-0.294	6
	With D	-2.997	10	-1.101	10	-0.410	2
	International Controls	-5.732	9	-2.637	7	-0.281	5
	Average	***-5.038***	***8.8***	***-2.027***	***8.0***	***-0.322***	***5.3***
Advanced Countries	Baseline	-	0	0.271	4	0.222	1
	Conservative Dates	-	0	0.304	5	0.270	1
	Without TRADE	-	0	0.298	6	-	0
	High Inflation	-	0	0.279	4	0.229	2
	With D	-	0	0.251	5	0.240	1
	International Controls	-	0	0.315	7	0.196	1
	Average	***-***	***0***	***0.286***	***5.2***	***0.231***	***1.0***

Note: Only statistically significant results. Obs.: number of significant results (10%).

2.5. Concluding remarks

Despite the increase in the number of countries that have adopted IT, the advantages from the adoption of this monetary regime are controversial. However, the increases in the number of countries that use this strategy, combined with the growing experience over time, provide better conditions to achieve robust empirical analysis. Through simulation techniques of a quasi-natural experiment, the real contribution of IT in reducing inflation and inflation volatility around the world in recent years was analyzed. Although the drop in the inflation is a global phenomenon, the reduction in price levels is different between developing and advanced countries; thus, a distinct analysis for each case was made.

For developing economies, the treatment effects are strong on inflation and inflation volatility. Therefore, IT is an ideal strategy for driving inflation to internationally acceptable levels. Moreover, IT contributes to decreasing inflation volatility. This conclusion is in consonance with Faust and Henderson (2004, p.1): "Common wisdom and conventional models suggest that best-practice policy can be summarized in terms of two goals: first, get mean inflation right; second, get the variance of inflation right." In summary, the empirical findings outlined in this chapter confirm the findings in the theoretical literature concerning IT. However, the adoption of IT is advantageous only for countries that need increased credibility for conducting monetary policy. In contrast, in the case of advanced economies, the adoption of IT is innocuous.

2.6. Appendix

A.1. Matching analysis – the PSM methods

According to Ravallion (2001, p.126), "propensity score matching is a better method of dealing with the differences in observables." PSM is fundamentally a weighting procedure, which in turn, determines the weights for control individuals in the estimation of the treatment effect. In the same way, this procedure to match the units based on propensity score, which is a measure of conditional probability regarding the participation of treatment given by vector X, is given by *p(X)*,[35]

$$p(X) \equiv \Pr(D = 1 \mid X) = E(D \mid X), \tag{2.1}$$

where X is a multidimensional vector of variables that measure the characteristics, and *D={0,1}* is the indicator (*dummy*) of exposition to the treatment. Therefore, if the exposition to the treatment is random within the elements defined by values of a one-dimensional covariates vector *X*, it is also random within the elements defined by values of a one-dimensional variable *p(X)*. As a result, since a population of individuals is denoted by *I*, and if the propensity score *p(X)* is known, then the average effect of treatment on the treated (ATT) may be estimated as:

$$\tau \equiv E\{Y_{1i} - Y_{0i} \mid D_i = 1\} \tag{2.2}$$

$$= E[E\{Y_{1i} - Y_{0i} \mid D_i = 1, p(X_i)\}]$$

$$= E[E\{Y_{1i} \mid D_i = 1, p(X_i)\} - E\{Y_{0i} \mid D_i = 0, p(X_i)\} \mid D_i = 1],$$

where Y_1 and Y_0 are the possible results in both counterfactuals cases, i.e., with treatment and without treatment, respectively. Formally, the next two hypotheses are needed to derive (2.2), given (2.1). If *p(X)* is the propensity score, then

[35] This presentation takes into account Rosenbaum and Rubin (1983), Imbens (2000), and Becker and Ichino (2002).

$$D \perp X \mid p(X),$$

where $\perp$ means statistical independence. This assumption is known as the Balancing Hypothesis. The second hypothesis assumes that although the choice by treatment is non-random, it is unconfoundable (Unconfoundedness Hypothesis), or

$$Y_1, Y_0 \perp D \mid X.$$

Hence, the choice of treatment is (conditionally) unconfoundable if the treatment is independent from the outcomes *Y* conditionals to *X*. If this proposition is maintained, it is implied that

$$Y_1, Y_0 \perp D \mid p(X),$$

i.e., the independence of Y_1, Y_0, and *D* for a given *p(X)*.

With the first hypothesis satisfied, the observations with the same propensity score may have the same distribution of observable (and unobservable) characteristics independent of the treatment status (0 or 1). Hence, for a given propensity score, the exposition to the treatment is artificially random, and the average outcomes in *Y* for the treated and control individuals may be identical. It is important to note that any probability model can be used to estimate the propensity scores.[36]

According to Dehejia and Wahba (2002) and Becker and Ichno (2002) for testing the Balancing Hypothesis the following steps are needed:

(i) estimation of probability model $\Pr(D_i = 1 \mid X_i) = \Phi\{h(X_i)\}$, where Φ refers to accumulated probability function of a normal distribution and $h(X_i)$ is an initial specification that includes all covariates;

(ii) the sample is divided into *k* equidistant intervals as a function of propensity scores;

(iii) within each interval, the equality of average of the propensity scores between the treatment and the control is tested. If the test fails for any one interval, the

[36] In this case, the Probit model was chosen.

interval is divided into a smaller interval and the test is redone. The process iterates until the average propensity score between treated and control individuals is statistically equal for all intervals.

(iv) each interval is tested to see if the average of each characteristic (covariate) does not differ between the treated and the control individuals ; and

(v) in the case in which one or more characteristics differ, a more parsimonious specification of *h(X_i)* is necessary for satisfying the Balancing Hypothesis.[37]

For a best quality to the matches to be obtained, the common support condition is imposed. This constraint implies that only the propensity scores that are in the intersection region between treated and control individuals will be tested taking into account the balancing condition.

For calculating the ATT, the literature suggests several methods. In this chapter, four methods widely used in the literature - Stratification Matching, Nearest Neighbor-Matching, Radius Matching, and Kernel Matching - are used with the intention of strengthening the analysis.

The Stratification Matching makes use of the intervals achieved from estimation of the propensity scores. Inside of each interval, where treated and control individuals are present, the difference between the averages of results of both groups is computed. Hence, the ATT is a result of the average of ATT of each interval, weighted by the distribution of treated individuals between the intervals. Formally, with *T* the treated group and *C* the controls group, and Y_i^T and Y_i^C, the observed outcomes for the treated and control groups are, then, respectively

$$\tau_q^S = \frac{\sum_{i \in I(q)} Y_i^T}{N_q^T} - \frac{\sum_{j \in I(q)} Y_j^C}{N_q^C}, \qquad (2.3)$$

where q is the index of intervals; *I(q)* is the group of individuals in the interval q; N_q^T and N_q^C are the number of treated and control individuals in the interval q.

[37] It is important to highlight that the second hypothesis cannot be tested.

The estimation of (2.2) may be given by:

$$\tau^S = \sum_{q=1}^{Q} \tau_q^S \frac{\sum_{i \in I(q)} D_i}{\sum_{\forall i} D_i}, \qquad (2.4)$$

where, Q is the number of intervals and the weight of each interval is given by the share of corresponding treated individuals.

Assuming the independence of results between individuals, the variance of τ^T is estimated by:

$$Var(\tau^S) = \frac{1}{N^T}\left\{Var(Y_i^T) + \sum_{q=1}^{Q} \frac{N_q^T}{N^T}\frac{N_q^T}{N_q^C} Var(Y_j^C)\right\}. \qquad (2.5)$$

The standard errors are achieved analytically through formula or through a bootstrapping procedure. One problem with the Stratification Matching method is with regard to the selection of intervals where treated or control individuals are missing: some individuals may not find matches. However, there exist methods that assure at least one control individual for all treated individuals. One such method is Nearest Neighbor-Matching, which entails the choice of a control individual with the nearest propensity score for each treated individual. The method is applied with reposition, that is, a control individual can be the best match for more than one treated individual. With the control individual denoted by *C(i)* the match for each treated individual *i* with a value of propensity score *p(i)* is formally: $C(i) = \min_j \|p_i - p_j\|$.

In the case of the existence of two matches, one lower and the other greater than that observed for the treated individual, there are two possibilities: to take into consideration both using equal weight, or to choose one of them through a random draw process. Hence, the ATT by Nearest Neighbor is measured by the average of differences,

$$\tau^M = \frac{1}{N^T}\sum_{i\in T} Y_i^T - \frac{1}{N^T}\sum_{j\in C} w_j Y_j^C , \tag{2.6}$$

where the weights w_j are defined by $w_j = \sum_i w_{ij}$.

Assuming the independence of results between the individuals and the fixed weights, the variance of the estimator corresponds to:

$$Var(\tau^M) = \frac{1}{N^T} Var(Y_i^T) + \frac{1}{(N^T)^2}\sum_{j\in C}(w_j)^2 Var(Y_j^C) . \tag{2.7}$$

The standard errors can be achieved by (2.7) or through a bootstrapping procedure. However, due to the fact that under this methodology all treated individuals find a match, the probability of occurrence of matches of low quality is high, given that the nearest neighbor can have a very different propensity score. The Radius and the Kernel Matching are options to solve this problem. With Radius Matching, each treated unity is matched only with control individuals whose propensity score belongs to a predefined radius of distance measured by score (a pre-declared neighborhood). The extension of the radius defines the dimension of the trade-off between quality and quantity of matches. The estimation (2.2) by Radius Matching is also by (2.6) and its variance (2.7). However, *C(i)* is achieved by $C(i) = \{ p_j \mid \|p_i - p_j\| < r \}$, that is, all control individuals with propensity scores lower than radius *r* for *p(i)* are paired with the treated individual *i*.

Kernel Matching is a method that weighs quality and quantity of matches. Each treated individual is matched with whole control individuals, where the attributed weight is inversely proportional to the distance between the propensity scores of treated and controls. The estimator is given by

$$\tau^K = \frac{1}{N^T}\sum_{i\in T}\left\{ Y_i^T - \frac{\sum_{j\in C} Y_j^C G\left(\frac{p_j - p_i}{h_n}\right)}{\sum_{k\in C} G\left(\frac{p_k - p_i}{h_n}\right)} \right\}, \tag{2.8}$$

where $G(.)$ is a kernel function (Gaussian or Epanechnikov) and h_n is the smoothing parameter that specifies the bandwidth. Hence, the consistent estimator for the counterfactual outcome Y_{0i} is

$$\frac{\sum_{j\in C} Y_j^C G\left(\frac{p_j - p_i}{h_n}\right)}{\sum_{k\in C} G\left(\frac{p_k - p_i}{h_n}\right)}. \tag{2.9}$$

The standard errors for the Kernel Matching are estimated exclusively by bootstrapping.

In brief, the PSM analysis made a selection of each one of the *i* countries that adopted IT with another country (or set of countries) *j* from the set of countries that did not adopt IT but that is similar to it. PSM estimation entails two stages: first, a Probit model is estimated, taking into consideration characteristic variables of the countries to ascertain the probability of their adopting IT; and second, subsamples composed of pairs of countries (treatment and control) subjected to comparison are identified.

Table A.2.1 - *Dates of IT adoption*

Country	Bernanke and Mishkin (1997)	Bernanke, Laubach, Mishkin and Posen (1999)	Schaechter and Zelmer (2000)	Mishkin and Schmidt-Hebbel (2001)	Landarretche, Corbo and Schmidt-Hebbel (2001)	Sabbán, Rozada and Powell (2003)	Ball and Sheridan (2003)	Fracasso, Genberg and Wyplosz (2003)	Truman (2003)	Fraga, Goldfajn and Minella (2003)	Pétursson (2004)	Wu (2004)	Levin, Natalucci and Piger (2004)	Roger and Stone (2005)	Vega and Winkelried (2005)
Australia *	1993	Sep-94	Jun-93	Sep-94	1994	1993	Q4:94	Sep-94	Jun-93	Apr-93	Apr-93	Sep-94		Apr-93	1994
Brazil			Jun-99	Jun-99	1999	1999		Jun-99	Jun-99	Jun-99	Jun-99		Jun-99	Jun-99	1999
Canada *	Feb-91	Feb-91	Feb-91	Feb-91	1991	1991	Q1:92 - 94	Feb-91	Feb-91	Feb-91	Feb-91	Feb-91		Feb-01	1991 -94
Chile			Sep-99	Jan-91	1991	1991		Jan-91	Sep-91 - 99	Jan-91	Sep-90		Jan-91	Sep-99	1991 - 99
Colombia				Sep-99	1999			Sep-99	Oct-99	Sep-99	Sep-99		Sep-99	Sep-99	1995 - 99
Czech Republic **			Dec-97	Jan-98	1998			Jan-98	Dec-97	Jan-98	Jan-98		Jan-98	Jan-98	1998
Finland *	Feb-93			Feb-93	1993		Q1:94		Feb-93			Feb-93		Feb-93	1993
Finland (Out)				Jun-98	Jan-99		99		Dec-98			Dec-98		Dec-98	1999
Ghana															
Guatemala															
Hungary **								Jul-01	Jun-01	Jun-01	Jun-01		Aug-01	Jun-01	2001
Iceland *					2001			Mar-01	Mar-01	Mar-01	Mar-01			Mar-01	2001
Indonesia															
Israel *	Dec-91	Jan-92	Jun-97	Jan-92	1992	1991		Jan-92	Dec-91 - Jun-97	Jan-92	Jan-92		Jan-92	Jun-97	1992 - 97
Mexico				Jan-99	1999	1999		Jan-99	Jan-95 - 01	Jan-99	Jan-99		Jan-99	Jan-01	1995 - 99
New Zealand *	Mar-90	Mar-90	Jul-89	Mar-90	1990	1990	Q3:90 - Q1:93	Apr-88	Dec-89	Mar-90	Mar-90	Mar-90		Mar-90	1990 - 91
Norway *					2001			Mar-01	Mar-01	Mar-01	Mar-01		2001	Mar-01	2001
Peru				Jan-94	1994			Jan-02	Jan-02	Jan-94	Jan-02		Jan-02	Jan-02	1994 - 02
Philippines								Jan-02	Jan-02		Jan-02		Jan-02	Jan-02	1995 - 02
Poland **			Mar-99	Oct-98	1998			Oct-98	Sep-98	Oct-98	Oct-98		Jun-98	Oct-98	1998
Romania															
Slovak Republic **															
South Africa			Feb-00	Feb-00	2000			Feb-00	Feb-02	Feb-00	Feb-00		Feb-00	Feb-00	2000
South Korea *				Jan-98	1998			Apr-98	Apr-98	Jan-98	Apr-98		Apr-98	Jan-01	1998
Spain *	Jan-95			Nov-04	1995		Q2:95 - Q1:94		Jan-95			Nov-94		Jan-95	1994 - 95
Spain (Out)				Jun-98	Jan-99		99		Dec-98			Dec-98		Dec-98	1999
Sweden *	Jan-93	Jan-93	Jan-93	Jan-93	1993	1995	Q1:95	Jan-93	Jan-93	Jan-93	Jan-93	Jan-93		Jan-93	1993 - 95
Switzerland *				Jan-00	2000			Jan-00		Jan-00	Jan-00	Jan-00	2000		2000
Thailand				Apr-00	2000			May-00	May-00	Apr-00	May-00		May-00	May-00	2000
Turkey															
United Kingdom *	Oct-92	Oct-92	Oct-92	Oct-92	1992	1993	Q1:93	Oct-92	Oct-92	Oct-92	Oct-92	Oct-92		Oct-92	1992
Total Countries	**8**	**6**	**11**	**19**	**21**	**9**	**7**	**21**	**22**	**20**	**21**	**8**	**15**	**22**	**23**

Table A.2.1- *Dates of IT adoption (continuation)*

Country	Allen, Baumgartner and Rajan (2006)	Dotsey (2006)	Mishkin and Schmidt-Hebbel (2007)	Gosselin (2007)	Lin and Ye (2007)	Monetary Bulletin (2007)	Rose (2007)	Gonçalves and Salles (2008)	Leyva (2008)	Central Banks	Initial Classification	Conservative Classification	Difference of Classifications (in years)
Australia *	Q2:93	Jun-93	Q3:94	Q3:94	1994	1993	Mar-93 - Sep-94		1993	Mar-93	**1993**	**1994**	1
Brazil	Q2:99		Q1:99	Q1:99		1999	Jun-99	1999	1999	Jun-99	**1999**	**1999**	0
Canada *	Q1:91	Feb-91	Q1:91 - 95	Q1:91	1992-94	1991	Feb-91 - Jan-92		1991	Feb-91	**1991**	**1994**	3
Chile	Q3:99		Q1:91 -01	Q1:91		1990	Jan-91 - Aug-99	1991	1991 - 00	Sep-90	**1991**	**2000**	9
Colombia	Q3:99		Q1:99	Q1:99		1999	Sep-99 - Oct-99	2000	2000	Sep-99	**2000**	**2000**	0
Czech Republic **	Q1:98		Q1:98	Q1:98		1998	Jan-98	1998	1998	Jan-98	**1998**	**1998**	0
Finland *					1994		Feb-93 - Jan-94			Feb-93 - Jan-95	**1993**	**1995**	2
Finland (Out)					1999	Jan-99	Jan-99			Jan-99	**1999**	**1999**	0
Ghana						May-07				Apr-03 - May-07	**2003**	**2007**	4
Guatemala									2005	Mar-05 - Jan-06	**2005**	**2006**	1
Hungary **	Q2:01		Q1:01	Q1:01		2001	Jun-01 - Aug-01	2001	2001	Jun-01	**2001**	**2001**	0
Iceland *	Q1:01		Q1:01 - 03	Q1:01		2001	Mar-01		2001	Mar-01	**2001**	**2001**	0
Indonesia	Q3:05					Jul-05	Jul-05		2005	Jan-05	**2005**	**2006**	1
Israel *	Q2:97		Q1:92 - 03	Q1:92		1992	Jan-92 - Jun-97	1992	1992 - 97	Jan-92	**1992**	**1997**	5
Mexico	Q1:01		Q1:99 03	Q1:99		1999	jan-99 - 01	1999	1995 -01	Jan-01	**1995**	**2001**	6
New Zealand *	Q1:90	Dec-89	Q1:90 - 93	Q1:90	1990-93	1990	Mar-90		1990	Dec-89	**1990**	**1990**	0
Norway *	Q1:01		Q1:01	Q1:01		2001	Mar-01		2001	Mar-01	**2001**	**2001**	0
Peru	Q1:02		Q1:94 - 02	Q1:94		2002	Jan-02	1994	1994 - 02	Jan-02	**1994**	**2002**	8
Philippines	Q1:02		Q1:01	Q1:01		2002	Jan-02	2002	2002	Jan-02	**2002**	**2002**	0
Poland **	Q4:98		Q1:98 - 04	Q1:98		1998	Sep-98	1999	1999	Sep-98	**1999**	**1999**	0
Romania	Q3:05					Aug-05	Aug-05		2005	Aug-05	**2005**	**2006**	1
Slovak Republic **	Q1:05					2005	Jan-05		2005	Jan-05	**2005**	**2005**	0
South Africa	Q1:00		Q1:01	Q1:01		2000	Feb-00	2000	2000	Feb-00	**2000**	**2000**	0
South Korea *	Q1:01		Q1:98 - 99	Q1:98		1998	Apr-98	1998	1998	Apr-98	**1998**	**2001**	3
Spain *					1994-95		Jan-95			Jan-95	**1995**	**1995**	0
Spain (Out)					1999	Jan-99	Jan-99			Jan-99	**1999**	**1999**	0
Sweden *	Q1:93	Jan-93	Q1:95	Q1:95		1993	Jan-93 - 95		1993	Jan-93	**1993**	**1995**	2
Switzerland *			Q1:00	Q1:00		2000	Jan-00		2000	Jan-00	**2000**	**2000**	0
Thailand	Q2:00		Q1:00	Q1:00		2000	May-00	2000	2000	May-00	**2000**	**2000**	0
Turkey						2006	Jan-06			Jan-02 - Jan-06	**2002**	**2006**	4
United Kingdom *	Q4:92	Oct-92	Q1:92	Q1:92		1992	Oct-92		1993	Oct-92	**1993**	**1993**	0
Total Countries	**23**	**5**	**21**	**21**	**5**	**26**	**27**	**13**	**25**	**29**	**29**	**29**	

Notes: Blank cells mean non-availability of information by the authors. If the IT adoption date is July or later of any year t, the annual date reported is year t+1. The Inicial Classification differs from central banks' classification only for two countries: Mexico and Peru. * Advanced economies - IMF's methodology. ** Countries that will leave the ITR to adopt the Euro.

Table A.2.2 - *Non-Iters*

Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, China, Comoros, Democratic Republic of the Congo, Congo, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Fiji, France, Gabon, The Gambia, Georgia, Germany, Greece, Grenada, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, India, Iran, Ireland, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Portugal, Qatar, Russian Federation, Rwanda, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, São Tomé and Príncipe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovenia, Solomon Islands, Sri Lanka, Sudan, Suriname, Swaziland, Syrian Arab Republic, Tajikistan, Tanzania, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United States, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.

Chapter

3. The Relationship between Inflation Targeting and Output around the World

3.1. Introduction

Over the past few decades, Inflation Targeting (IT) has been adopted by several countries with the main objective of maintaining a low and stable inflation. However, the recent subprime crisis challenges the capacity of this monetary regime to create a macroeconomic environment that permits a recovery in economic activity. This point is crucial because the empirical literature on IT and economic growth is still in evolution and the results are not convergent.[38]

Most of the empirical literature on IT and economic growth neglects the effect of common shocks across countries. This study presents a contribution through a combination of econometric models seeking flexibility to capture the collateral effects of IT on economic growth and incorporating the relationship among the countries in the models with panel data. With this focus in mind, a set of 128 countries (of which 31 adopted IT during the period under consideration) is considered in the analysis for the period 1970 to 2007.

The chapter is organized as follows: Section 2 presents the underpinnings for the econometric model. Section 3 describes the database, presents the estimation of the models, and reports the results. Section 4 concludes the chapter.

3.2. Theoretical underpinning

In a general way, most studies which measure IT as a treatment, independently of the methods (difference-in-difference, propensity score, panel data models), incorporate a dummy variable which assumes value "1" for the period after the adoption of IT and "0" for the previous period (step dummy). In this sense, a general specification of the effect of IT on output (Y), in a dynamic perspective (output growth), for a panel data model is:

[38] Empirical evidence favorable to the IT on economic growth can be found in: Truman (2003), Pétursson (2004a), Ball and Sheridan (2005), Apergis *et al.* (2005), Mollick, Cabral, and Carneiro (2011). Unfavorable effects or no evidence whatsoever that IT improves the behavior of output is observed in: Fraga, Goldfajnm, and Minella (2004), and Fang, Lee, and Miller (2009), Brito and Bystedt (2010), Ball (2011).

$$Y_{i,t} = \alpha_i + \phi Y_{i,t-1} + \beta' X_{i,t} + \delta IT_{i,t} + \varepsilon_{i,t} \tag{3.1}$$

where i=1…N is the cross-section unit; t=1…T is the time index; α_i specific vector of time-fixed characteristics of the country i; $X_{i,t}$ is the set of time-varying variables; $IT_{i,t}$ is the binary variable regarding *IT*.

In other words, the standard specification assumes that the effect of the adoption of IT on the economy is immediate, without delay in response or anticipation, and that this effect is constant and permanent. Due to the fact that these assumptions may not be plausible, we change the traditional model making the substitution of the step dummy by a pulse dummy[39]. Then,

$$Y_{i,t} = \alpha_i + \phi Y_{i,t-1} + \beta' X_{i,t} + \delta_{-j} PIT_{i,-j} + \ldots + \delta_{-1} PIT_{i,-1} + \delta_0 PIT_{i,0} + \delta_1 PIT_{i,1} + \ldots + \delta_j PIT_{i,j} + \varepsilon_{i,t}$$

$$Y_{i,t} = \alpha_i + \phi Y_{i,t-1} + \beta' X_{i,t} + \sum_{j=-l}^{r} \delta_j PIT_{i,j} + \varepsilon_{i,t} \tag{3.2}$$

where j=0 is the date of adoption of IT, and PIT_j is the effect of the treatment in each period of time: at the moment of the adoption of IT, before (possible anticipation of effects due to the expectation of changes) and after. Hence, the dummy variable assumes value "1" at the moment of adoption (and for j periods before and after), and "0" for the other.

Equation (3.2) allows one to measure the effect on output with the control of explanatory variables considering the individual characteristics of the countries and the time effect. Therefore, the effect of the treatment in each period related with the adoption of IT is obtained in comparison with the average behavior. It is important to observe that this framework allows one to observe several characteristics that are not observed in models that use the traditional step dummy. Firstly, for the period before the adoption of IT, the statistical significance of δ_{-j} can suggest that the public anticipated the effects or a possible endogenous effect where the output affects the decision for adoption of IT.[40] Secondly, the observation of the coefficients

[39] A variation of this methodology is suggested by Laporte and Windmeijer (2005).
[40] The inclusion of the output lagged one period considers a possible bias due to the correlation between the dummy and the past output. In other words, countries with greater economic growth are more likely to adopt IT (see, Lin and Ye (2007), and Chapter 2).

(δ_0 and $\delta_{0\pm j}$) permits seeing if the effects are not immediate or if there is some delay in the process. Thirdly, the magnitude and the significance of the coefficients regarding the treatment in each point of time allows one to see if the effect is decreasing, increasing, constant, or random.

In line with models like Mankiw, Romer, and Weil (1992) and Islam (1995), we estimate the dynamic of economic growth in the following way:[41]

$$\ln y_{i,t} = \alpha_i + \phi \ln y_{i,t-1} + \beta \ln kinv_{i,t} + \sum_{j=-l}^{r} \delta_j PIT_{i,j} + \varepsilon_{i,t} \tag{3.3}$$

where $\ln y_{i,t}$ is real GDP (in logs), $\ln kinv_{i,t}$ as well as the investment/GDP ratio (in logs), and $PIT_{i,j}$ assumes value "1" at the year of the adoption of IT (and for *j* periods before and after) and "0" for the other years, and

$$\ln y_{i,t} = \alpha_i + \phi \ln y_{i,t-1} + \beta \ln kinv_{i,t} + \varphi popg_{i,t} + \sum_{j=-l}^{r} \delta_j PIT_{i,j} + \varepsilon_{i,t} \tag{3.4}$$

where $popg_{i,t}$ is the population growth rate.

With the intention of incorporating the equilibrium relation and the short-term dynamic, a basic version of a panel error correction model is considered.[42] As a consequence, equations (3.3) and (3.4) are rewritten, respectively, as:

$$\Delta \ln y_{i,t} = \alpha_i + \lambda(\ln y_{i,t-1} - \tau \ln kinv_{i,t-1}) + \sum_{j=-l}^{r} \delta_j PIT_{i,j} + \varpi \Delta \ln y_{i,t-1} + \beta \Delta \ln kinv_{i,t} + \varepsilon_{i,t} \tag{3.5}$$

and

$$\begin{aligned} \Delta \ln y_{i,t} = \alpha_i + \lambda(\ln y_{i,t-1} - \tau \ln kinv_{i,t-1} - \iota popg_{i,t-1}) + \sum_{j=-l}^{r} \delta_j PIT_{i,j} + \\ \varpi \Delta \ln y_{i,t-1} + \beta \Delta \ln kinv_{i,t} + \varsigma \Delta popg_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{3.6}$$

[41] According to Hauk and Wacziarg (2009, 104) "since the mid-1990s, the use of dynamic panel data estimators in growth empirics has become prevalent".
[42] Based on error correction in panel data (Westerlund, 2007).

In brief, with these specifications, we give robustness to the results through the test of the effect of IT over time taking into account the short-term and long-term effects on the control variables.

3.3. Data and empirical evidence

This study considers information from 128 countries, which represent 99% of the world GDP and 97% of the world population measured by Penn World Table (PWT), in an unbalanced panel data.[43] As observed in Corbo, Landerretche, and Schmidt-Hebbel (2002), Roger and Stone (2005), Mollick, Cabral, and Carneiro (2011), and in the previous chapter, we consider two different dates of IT adoption for the monitored countries. The first set of dates (soft IT) refers to the period when the country announces a numerical target. The second set of dates (full-fledged IT) refers to complete adoption of IT (Table A.3.1).

The period under analysis spans from 1970 to 2007 (38 years)[44] and thus there is a T sufficiently large which, in turn, permits the estimation of dynamic models based on fixed effects (*Dynamic Fixed-Effects* - DFE).[45]

With the objective of observing the effect of IT on output, we consider two different j (5 and 10). These two different time horizons are relevant because they allow one to detect whether the results are robust in different periods. Besides considering all countries in the analysis, we make the estimations dividing the sample between advanced and developing countries (based on IMF classification). The main idea is to observe if the impact, due to the adoption of IT, is different for countries with different levels of development.

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[43] Data gathered from PWT 7.0 is real GDP per capita, investment/GDP ratio, and population growth rate.

[44] The international crisis period (2008-2009) was omitted in order to not bias the results.

[45] Corrections for bias due to endogeneity between the error term and lagged dependent variable as proposed in Kiviet (1995) and Bun and Carree (2005) are unnecessary because of the dimension of T. Then, DFE is the best choice overall, for long and unbalanced panels, while dynamic GMM estimators and their well-known problem of too many instruments is just a second-best solution (Judson and Owen, 1999; Roodman, 2009). Even Difference and System GMM estimators were developed for large N and short T. Some problems: they require stationary variables or at least stationarity in the initial condition ($t=0$ in system GMM), overfitting with long T panels; and assume parameter homogeneity for instrumentation (see Pesaran and Smith, 1995).

It is important to highlight that although the sample size is adequate for estimating fixed effect models, a period larger than 20-30 years amplifies the cross-sectional dependence among the countries. Concerning the cross-dependence among the countries, the Cross-Dependence (CD) test suggested by Pesaran (2004) is applied (Table A.3.2)[46]. In a general way, independent of the series being in level or in difference and also the sample which is considered (all countries, advanced countries, and developing countries), the CD test rejects the assumption that there is cross-section independence among the countries. As a manner of treating this problem, the variance and covariance matrix is adjusted as proposed by Driscoll and Kraay (1998). This adjustment (no restrictions on the number of countries due to the use of a non-parametric estimation) implies standard errors that are robust in the presence of heterogeneity, residual autocorrelation, and cross-dependence among the countries[47].

The Table 3.1 summarizes the results for the full sample and the case of soft IT. In all specifications, the control variables are statistically significant and the coefficients have the signs predicted by the literature. In the dynamic models the coefficient of $\ln y_{i,t-1}$ is positive and significant which, in turn, indicates a gradual economic growth. In addition, the coefficient of the error correction is negative and significant indicating an adjustment to short-term variations. As expected, in both models (*j*=5 and *j*=10) we find positive values for the relationship between investment and output, and negative for the relationship between population growth rate and output.

About the parameters of interest, the individual coefficients are positive and significant after the adoption of IT (*j*>0). Another highlight is the homogeneity among the estimated coefficients in the period after adoption of IT. Even when we amplify the measurement of the effect by the inclusion of additional dummies, the coefficients are around the average of 0.02. This observation matters because it suggests the presence of constant effects due to IT on output. Furthermore, we test the joint significance of the coefficients of $PIT_{i,j}$ for the two possibilities: before

[46] For a survey about cross-sectional dependence in panels, see Moscone and Tosetti (2009).
[47] The lag length is the integer part of $4(T/100)^{2/9}$.

adoption of IT ("pre-adoption") and after the adoption of IT including the year of adoption ("post-adoption"). The results strengthen the presence of the effect only after the adoption of IT. It is important to observe that the non-significance in the period before the adoption of IT minimizes the possible problem of endogeneity (adoption of IT due to economic growth) [48].

Table 3.1 - *Estimations – full sample and soft IT*

Variable	*Soft IT*							
	j = 5				*j = 10*			
	Dynamic Model		*Error Correction Model*		*Dynamic Model*		*Error Correction Model*	
	Invest	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*
$\ln y_{i,t-1}$	0,9733 ***	0,9727 ***	-0,0290 **	-0,0305 ***	0,9720 ***	0,9716 ***	-0,0303 **	-0,0316 ***
$\ln kinv_{i,t}$	0,0256 ***	0,0259 ***			0,0253 ***	0,0256 ***		
$popg_{i,t}$		-0,0026 **				-0,0025 **		
$\ln kinv_{i,t-1}$			0,0175 ***	0,0191 ***			0,0173 ***	0,0188 ***
$\ln popg_{i,t-1}$				-0,0057 ***				-0,0056 ***
$soft\ PIT_{i,-10}$					0,0012	0,0006	0,0014	0,0001
$soft\ PIT_{i,-9}$					-0,0145	-0,0150	-0,0141	-0,0153 *
$soft\ PIT_{i,-8}$					-0,0033	-0,0039	-0,0023	-0,0034
$soft\ PIT_{i,-7}$					-0,0069	-0,0075	-0,0019	-0,0031
$soft\ PIT_{i,-6}$					-0,0039	-0,0046	-0,0039	-0,0052
$soft\ PIT_{i,-5}$	0,0094	0,0088	0,0088	0,0077	0,0103	0,0094	0,0100	0,0084
$soft\ PIT_{i,-4}$	0,0042	0,0036	0,0023	0,0010	0,0051	0,0043	0,0036	0,0017
$soft\ PIT_{i,-3}$	0,0099	0,0093	0,0096	0,0082	0,0109	0,0100	0,0109	0,0090
$soft\ PIT_{i,-2}$	0,0026	0,0021	0,0022	0,0009	0,0036	0,0028	0,0035	0,0017
$soft\ PIT_{i,-1}$	-0,0041	-0,0045	-0,0038	-0,0048	-0,0030	-0,0037	-0,0024	-0,0040
$soft\ PIT_{i,0}$	0,0007	0,0001	0,0017	0,0005	0,0018	0,0009	0,0031	0,0013
$soft\ PIT_{i,1}$	0,0175 ***	0,0170 ***	0,0173 ***	0,0160 ***	0,0186 ***	0,0178 ***	0,0186 ***	0,0169 ***
$soft\ PIT_{i,2}$	0,0203 ***	0,0197 ***	0,0185 ***	0,0173 ***	0,0215 ***	0,0206 ***	0,0200 ***	0,0182 ***
$soft\ PIT_{i,3}$	0,0197 ***	0,0190 ***	0,0181 ***	0,0167 ***	0,0212 ***	0,0202 ***	0,0198 ***	0,0179 ***
$soft\ PIT_{i,4}$	0,0235 ***	0,0227 ***	0,0215 ***	0,0200 ***	0,0251 ***	0,0240 ***	0,0234 ***	0,0213 ***
$soft\ PIT_{i,5}$	0,0230 ***	0,0222 ***	0,0214 ***	0,0197 ***	0,0247 ***	0,0236 ***	0,0234 ***	0,0211 ***
$soft\ PIT_{i,6}$					0,0196 ***	0,0183 **	0,0195 ***	0,0168 **
$soft\ PIT_{i,7}$					0,0194 **	0,0180 **	0,0192 ***	0,0160 **
$soft\ PIT_{i,8}$					0,0214 ***	0,0201 **	0,0218 ***	0,0190 ***
$soft\ PIT_{i,9}$					0,0195 **	0,0181 **	0,0188 **	0,0160 **
$soft\ PIT_{i,10}$					0,0200 *	0,0185 *	0,0209 **	0,0178 *
$\Delta\ln y_{i,t-1}$			0,0950 **	0,0981 **			0,0950 **	0,0980 **
$\Delta\ln kinv_{i,t}$			0,0434 ***	0,0427 ***			0,0432 ***	0,0425 ***
$\Delta\ popg_{i,t}$				-0,0029 ***				-0,0029 ***
Pre-Adoption	0,0219	0,0191	0,0192	0,0130	-0,0006	-0,0076	0,0048	-0,0102
Post-Adoption	0,1041 ***	0,1006 ***	0,0969 ***	0,0898 ***	0,2109 ***	0,1992 ***	0,2056 ***	0,1809 ***
Wald Het.	62273,58 ***	62077,5 ***	73662,9 ***	72899,2 ***	60467,7 ***	60341,18 ***	77052,8 ***	76017,3 ***
Woold.Autocorr.	44,41 ***	44,13 ***	65,90 ***	65,66 ***	44,55 ***	44,26 ***	65,91 ***	65,67 ***
F test	3694,39 ***	3769,57 ***	25,56 ***	29,19 ***	10675,5 ***	10765,43 ***	58,52 ***	92,58 ***
Within R^2	0,95	0,95	0,04	0,05	0,95	0,95	0,04	0,05
N	4338	4338	4296	4296	4338	4338	4296	4296
Countries	128	128	128	128	128	128	128	128

Notes: * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%. To the coefficients of the equation, the significance level are based on the Driscoll and Kraay's standard errors - Driscoll and Kraay (1998).

[48] Traditional diagnostic measures of each model are also presented. The tests indicate the presence of heterogeneity and residual autocorrelation; however, they are treated together with cross-dependence effect by Driscoll and Kraay's (1998) correction.

Table 3.2 - *Estimations – full sample and full-fledged IT*

Variable	*Full IT*							
	j = 5				*j = 10*			
	Dynamic Model		*Error Correction Model*		*Dynamic Model*		*Error Correction Model*	
	Invest	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*
$\ln y_{i,t-1}$	0,9727 ***	0,9723 ***	-0,0296 **	-0,0309 ***	0,9709 ***	0,9705 ***	-0,0315 ***	-0,0325 ***
$\ln kinv_{i,t}$	0,0256 ***	0,0260 ***			0,0256 ***	0,0259 ***		
$popg_{i,t}$		-0,0025 **				-0,0025 **		
$\ln kinv_{i,t-1}$			0,0175 ***	0,0191 ***			0,0176 ***	0,0191 ***
$\ln popg_{i,t-1}$				-0,0057 ***				-0,0056 ***
$full\ PIT_{i,-10}$					0,0008	0,0001	-0,0004	-0,0020
$full\ PIT_{i,-9}$					-0,0023	-0,0030	-0,0022	-0,0037
$full\ PIT_{i,-8}$					-0,0038	-0,0044	-0,0035	-0,0050
$full\ PIT_{i,-7}$					0,0064	0,0059	0,0127 **	0,0115 *
$full\ PIT_{i,-6}$					0,0096	0,0090	0,0083	0,0071
$full\ PIT_{i,-5}$	0,0094	0,0090	0,0085	0,0076	0,0123	0,0116	0,0114	0,0100
$full\ PIT_{i,-4}$	0,0012	0,0006	0,0005	-0,0006	0,0041	0,0033	0,0036	0,0019
$full\ PIT_{i,-3}$	0,0069	0,0062	0,0074	0,0061	0,0098	0,0089	0,0105	0,0086
$full\ PIT_{i,-2}$	0,0077	0,0069	0,0080	0,0063	0,0107	0,0097	0,0111	0,0089
$full\ PIT_{i,-1}$	0,0058	0,0050	0,0056	0,0039	0,0088	0,0078	0,0087	0,0065
$full\ PIT_{i,0}$	0,0125 ***	0,0115 **	0,0125 ***	0,0107 **	0,0156 ***	0,0144 **	0,0157 ***	0,0133 **
$full\ PIT_{i,1}$	0,0099 **	0,0090 *	0,0099 **	0,0077 *	0,0131 **	0,0119 **	0,0132 ***	0,0105 **
$full\ PIT_{i,2}$	0,0136 **	0,0126 **	0,0133 **	0,0113 **	0,0171 ***	0,0159 **	0,0169 ***	0,0143 **
$full\ PIT_{i,3}$	0,0229 ***	0,0219 ***	0,0220 ***	0,0199 ***	0,0265 ***	0,0252 ***	0,0257 ***	0,0230 ***
$full\ PIT_{i,4}$	0,0279 ***	0,0268 ***	0,0261 ***	0,0238 ***	0,0318 ***	0,0304 ***	0,0300 ***	0,0272 ***
$full\ PIT_{i,5}$	0,0287 ***	0,0275 ***	0,0265 ***	0,0241 ***	0,0326 ***	0,0312 ***	0,0306 ***	0,0275 ***
$full\ PIT_{i,6}$					0,0224 ***	0,0210 ***	0,0223 ***	0,0193 ***
$full\ PIT_{i,7}$					0,0314 ***	0,0300 ***	0,0306 ***	0,0276 ***
$full\ PIT_{i,8}$					0,0315 ***	0,0303 ***	0,0291 ***	0,0266 ***
$full\ PIT_{i,9}$					0,0306 ***	0,0294 ***	0,0282 ***	0,0258 ***
$full\ PIT_{i,10}$					0,0231 ***	0,0219 ***	0,0227 ***	0,0200 ***
$\Delta\ln y_{i,t-1}$			0,0953 **	0,0984 **			0,0955 **	0,0985 **
$\Delta\ln kinv_{i,t}$			0,0435 ***	0,0428 ***			0,0433 ***	0,0426 ***
$\Delta\ popg_{i,t}$				-0,0029 ***				-0,0028 ***
Pre-Adoption	0,0309	0,0278	0,0300	0,0233	0,0564	0,0489	0,0602	0,0439
Post-Adoption	0,1030 ***	0,0978 ***	0,0978 ***	0,0868 ***	0,2601 ***	0,2472 ***	0,2492 ***	0,2219 ***
Wald Het.	60096,61 ***	60026,8 ***	71138,2 ***	70674,5 ***	62382,81 ***	62362,77 ***	77085,7 ***	76572,1 ***
Woold.Autocorr.	44,42 ***	44,14 ***	65,88 ***	65,64 ***	44,68 ***	44,40 ***	66,10 ***	65,86 ***
F test	3917,49 ***	3980,64 ***	64,96 ***	94,88 ***	9711,44 ***	14045,62 ***	165,57 ***	626,33 ***
Within R^2	0,95	0,95	0,04	0,05	0,95	0,95	0,04	0,05
N	4338	4338	4296	4296	4338	4338	4296	4296
Countries	128	128	128	128	128	128	128	128

Notes: * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%. To the coefficients of the equation, the significance level are based on the Driscoll and Kraay's standard errors - Driscoll and Kraay (1998).

The estimations in Table 3.2 consider the case of full sample and full-fledged IT. In a general way, the results are close to those observed for the case of soft IT. In brief, the result that the adoption of IT is advantageous for economic growth is observed (the effects of IT are constant and the coefficients are near the average of 0.02). The only difference in relation to the previous case is that with a conservative date for the adoption of IT, the period "$PIT_{i,0}$" becomes significant. This result suggests that a more formal and explicit adoption of IT implies more credibility and the effects on the output are immediate.

Table 3.3 - *Estimations – Developing countries and soft IT*

Variable	*Soft IT*							
	j = 5				*j = 10*			
	Dynamic Model		*Error Correction Model*		*Dynamic Model*		*Error Correction Model*	
	Invest	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*
$\ln y_{i,t-1}$	0,9701 ***	0,9695 ***	-0,0328 **	-0,0346 ***	0,969 ***	0,9685 ***	-0,0341 **	-0,0355 ***
$\ln kinv_{i,t}$	0,0239 ***	0,0242 ***			0,0236 ***	0,0239 ***		
$popg_{i,t}$		-0,0025 **				-0,0025 **		
$\ln kinv_{i,t-1}$			0,0173 ***	0,0188 ***			0,017 ***	0,0185 ***
$\ln popg_{i,t-1}$				-0,0057 ***				-0,0057 ***
$soft\ PIT_{i,-10}$					0,0026	0,002	0,0032	0,0016
$soft\ PIT_{i,-9}$					-0,0181	-0,0188	-0,0173	-0,0189
$soft\ PIT_{i,-8}$					-0,0047	-0,0055	-0,0029	-0,0045
$soft\ PIT_{i,-7}$					-0,0146	-0,0155	-0,0069	-0,0088
$soft\ PIT_{i,-6}$					-0,0107	-0,0118	-0,0094	-0,0116
$soft\ PIT_{i,-5}$	0,0108	0,01	0,0111	0,0095	0,0113	0,0101	0,0121	0,0097
$soft\ PIT_{i,-4}$	0,0028	0,002	0,0009	-0,0011	0,0033	0,0021	0,0019	-0,0008
$soft\ PIT_{i,-3}$	0,0193 **	0,0185 **	0,019 **	0,017 **	0,0198 **	0,0186 **	0,0202 **	0,0173 **
$soft\ PIT_{i,-2}$	0,0154	0,0146	0,0136	0,0117	0,0159	0,0148	0,0148	0,012
$soft\ PIT_{i,-1}$	0,0024	0,0017	0,0016	-0,0001	0,0029	0,0019	0,0028	0,0003
$soft\ PIT_{i,0}$	0,0082	0,0072	0,0084	0,0066	0,0088	0,0074	0,0097	0,007
$soft\ PIT_{i,1}$	0,0291 ***	0,0283 ***	0,0284 ***	0,0264 ***	0,0298 ***	0,0286 ***	0,0297 ***	0,0269 ***
$soft\ PIT_{i,2}$	0,0295 ***	0,0286 ***	0,0272 ***	0,0252 ***	0,0304 ***	0,0291 ***	0,0287 ***	0,0258 ***
$soft\ PIT_{i,3}$	0,024 ***	0,023 ***	0,0224 ***	0,0201 ***	0,0254 ***	0,024 ***	0,0243 ***	0,0211 ***
$soft\ PIT_{i,4}$	0,0272 ***	0,026 ***	0,0257 ***	0,0231 ***	0,0286 ***	0,027 ***	0,0277 ***	0,0242 ***
$soft\ PIT_{i,5}$	0,0304 ***	0,0291 ***	0,0293 ***	0,0265 ***	0,032 ***	0,0303 ***	0,0315 ***	0,0277 ***
$soft\ PIT_{i,6}$					0,0232 **	0,0212 **	0,023 ***	0,0187 **
$soft\ PIT_{i,7}$					0,0231 **	0,0211 **	0,023 **	0,0183 **
$soft\ PIT_{i,8}$					0,0308 ***	0,029 ***	0,0316 ***	0,0275 ***
$soft\ PIT_{i,9}$					0,0222 *	0,0202 *	0,0213 **	0,0171 *
$soft\ PIT_{i,10}$					0,0329	0,0306	0,0346 *	0,0297
$\Delta \ln y_{i,t-1}$			0,093 **	0,0968 **			0,093 **	0,0965 **
$\Delta \ln kinv_{i,t}$			0,0373 ***	0,0365 ***			0,0371 ***	0,0363 ***
$\Delta\ popg_{i,t}$				-0,003 ***				-0,0029 ***
Pre-Adoption	0,0508	0,0468	0,0463	0,0130	0,007802	-0,0021	0,0185	-0,0037
Post-Adoption	0,1403 ***	0,1351 ***	0,1330 ***	0,0898 ***	0,2783 ***	0,2611 ***	0,2754 ***	0,2371 ***
Wald Het.	9598,85 ***	9837,3 ***	10974,6 ***	11581,1 ***	9542,05 ***	9792,21 ***	15068,8 ***	14784,5 ***
Woold.Autocorr.	45,62 ***	45,33 ***	65,56 ***	65,25 ***	45,91 ***	45,63 ***	65,61 ***	65,30 ***
F test	2522,54 ***	2935,67 ***	21,23 ***	0,0448 ***	3890,48 ***	4124,81 ***	66,25 ***	149,48 ***
Within R^2	0,94	0,94	0,04	0,05	0,94	0,94	0,04	0,05
N	3465	3465	3424	3424	3465	3465	3424	3424
Countries	105	105	105	105	105	105	105	105

Notes: * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%. To the coefficients of the equation, the significance level are based on the Driscoll and Kraay's standard errors - Driscoll and Kraay (1998).

After the analysis considering all countries in the sample, next estimations take into account specific effects of the adoption of IT on developing and advanced countries. Tables 3.3 and 3.4 present the estimations for developing economies (analysis for the soft IT and full-fledged IT cases, respectively). The results in both cases (soft and full-fledged IT) are in agreement with those observed for the full sample estimations. Therefore, we can state that the adoption of IT is also relevant in the case of developing countries for sustaining economic growth. However, an important change in the previously observed results is that there is a possible anticipation of the positive effects from the adoption of IT (some coefficients of the periods before adoption are significant). As it is the case of developing countries, a possible increase in the credibility due to the announcement of a numerical target or the expectation regarding the change in the conduct of the monetary policy can be a possible explanation.[49]

Table 3.4 - *Estimations – Developing countries and full-fledged IT*

Variable	*Full IT*							
	j = 5				*j = 10*			
	Dynamic Model		*Error Correction Model*		*Dynamic Model*		*Error Correction Model*	
	Invest	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*
$\ln y_{i,t-1}$	0,9694 ***	0,9689 ***	-0,0336 **	-0,0352 ***	0,9674 ***	0,9671 ***	-0,0356 ***	-0,0368 ***
$\ln kinv_{i,t}$	0,0239 ***	0,0242 ***			0,0239 ***	0,0242 ***		
$popg_{i,t}$		-0,0025 **				-0,0024 **		
$\ln kinv_{i,t-1}$			0,0172 ***	0,0187 ***			0,0174 ***	0,0188 ***
$\ln popg_{i,t-1}$				-0,0057 ***				-0,0055 ***
$full\ PIT_{i,-10}$					-0,0009	-0,0018	-0,0018	-0,0037
$full\ PIT_{i,-9}$					-0,0022	-0,0031	-0,0013	-0,0034
$full\ PIT_{i,-8}$					-0,0055	-0,0064	-0,0047	-0,0068
$full\ PIT_{i,-7}$					0,0042	0,0033	0,0139 *	0,0118
$full\ PIT_{i,-6}$					0,0101	0,0092	0,0098	0,0077
$full\ PIT_{i,-5}$	0,0155	0,0148	0,0146	0,0131	0,0188 *	0,0178	0,0183 *	0,016
$full\ PIT_{i,-4}$	0,0097	0,0089	0,0082	0,0065	0,0131	0,012	0,012	0,0095
$full\ PIT_{i,-3}$	0,0192 **	0,0183 *	0,0191 **	0,0171 **	0,0227 **	0,0215 **	0,0229 **	0,0202 **
$full\ PIT_{i,-2}$	0,0207 **	0,0196 *	0,0198 **	0,0174 *	0,0242 **	0,0228 **	0,0236 **	0,0206 **
$full\ PIT_{i,-1}$	0,0097	0,0087	0,0091	0,0066	0,0133	0,012	0,0131 *	0,0098
$full\ PIT_{i,0}$	0,0161 **	0,0147 **	0,0163 ***	0,0135 **	0,0198 **	0,0181 **	0,0202 ***	0,0168 **
$full\ PIT_{i,1}$	0,0189 ***	0,0176 **	0,0189 **	0,0157 **	0,0228 ***	0,0211 ***	0,0231 ***	0,0191 ***
$full\ PIT_{i,2}$	0,0205 **	0,0191 **	0,0201 **	0,0169 **	0,0251 **	0,0233 **	0,025 ***	0,0209 **
$full\ PIT_{i,3}$	0,0253 ***	0,0238 ***	0,0252 ***	0,0218 ***	0,0301 ***	0,0282 ***	0,0302 ***	0,026 ***
$full\ PIT_{i,4}$	0,0329 ***	0,0313 ***	0,0315 ***	0,028 ***	0,0378 ***	0,0358 ***	0,0367 ***	0,0323 ***
$full\ PIT_{i,5}$	0,0384 ***	0,0367 ***	0,0365 ***	0,0327 ***	0,0433 ***	0,0412 ***	0,0417 ***	0,0371 ***
$full\ PIT_{i,6}$					0,0317 ***	0,0296 ***	0,0312 ***	0,0265 ***
$full\ PIT_{i,7}$					0,0466 ***	0,0444 ***	0,0451 ***	0,0402 ***
$full\ PIT_{i,8}$					0,0622 ***	0,0603 ***	0,057 ***	0,0528 ***
$full\ PIT_{i,9}$					0,0579 ***	0,056 ***	0,049 ***	0,0448 ***
$full\ PIT_{i,10}$					0,0395 ***	0,0373 ***	0,0377 ***	0,033 ***
$\Delta\ln y_{i,t-1}$			0,0934 **	0,0971 **			0,0933 **	0,0969 **
$\Delta\ln kinv_{i,t}$			0,0374 ***	0,0366 ***			0,0372 ***	0,0365 ***
$\Delta\ popg_{i,t}$				-0,0029 ***				-0,0029 ***
Pre-Adoption	0,0748 *	0,0703 *	0,0709 **	0,0607 *	0,0979	0,0872	0,1056	0,0816
Post-Adoption	0,1360 ***	0,1283 ***	0,1322 ***	0,1150 ***	0,3968 ***	0,3773 ***	0,3767 ***	0,3327 ***
Wald Het.	9088,31 ***	9338,33 ***	10327,1 ***	10953,4 ***	9251,76 ***	9459,96 ***	20452,5 ***	19903,3 ***
Woold.Autocorr.	45,66 ***	45,38 ***	65,55 ***	65,26 ***	47,17 ***	46,90 ***	66,41 ***	66,13 ***
F test	3264,6 ***	3646,76 ***	28,3 ***	32,68 ***	40778,05 ***	38396,02 ***	121,22 ***	205,82 ***
Within R^2	0,94	0,94	0,04	0,04	0,94	0,94	0,04	0,05
N	3465	3465	3424	3424	3465	3465	3424	3424
Countries	105	105	105	105	105	105	105	105

Notes: * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%. To the coefficients of the equation, the significance level are based on the Driscoll and Kraay's standard errors - Driscoll and Kraay (1998).

The analysis regarding the case of advanced countries (tables 3.5 and 3.6) denotes that the adoption of IT is not harmful to the output. Once again, we observe for the control variables a significant adjustment of the short-term dynamics and the expected signs. Although a lower number of significant coefficients in comparison

[49] Regarding the effect of credibility on a developing country, see de Mendonça (2007b) and Chapter 1.

with the previous samples, independently of the classification soft or full-fledged IT, the negative effects of the adoption of IT on output and economic growth are not observed[50]. One point that cannot be neglected is that in the case of advanced countries the gain of credibility due to the adoption of IT is lower than in the other countries (as in the preceding chapter).

Table 3.5 - *Estimations – Advanced countries and soft IT*

Variable	*Soft IT*							
	j = 5				*j = 10*			
	Dynamic Model		*Error Correction Model*		*Dynamic Model*		*Error Correction Model*	
	Invest	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*
ln $y_{i,t-1}$	0,9892 ***	0,9898 ***	-0,0112 **	-0,0109 *	0,9877 ***	0,9887 ***	-0,0125 **	-0,0121 **
ln $kinv_{i,t}$	0,0703 ***	0,0787 ***			0,0726 ***	0,0813 ***		
$popg_{i,t}$		-0,0112 ***				-0,0112 ***		
ln $kinv_{i,t-1}$			0,0171 **	0,0216 **			0,0165 **	0,021 **
ln $popg_{i,t-1}$				-0,0047 ***				-0,0045 ***
soft $PIT_{i,-10}$					0,0052	0,0047	-0,0019	-0,002
soft $PIT_{i,-9}$					-0,0009	-0,0008	-0,0069	-0,0068
soft $PIT_{i,-8}$					0,0054	0,0057	-0,0022	-0,0019
soft $PIT_{i,-7}$					0,0151 ***	0,0168 ***	0,0092 ***	0,01 ***
soft $PIT_{i,-6}$					0,0139 ***	0,0137 ***	-0,0011	-0,0008
soft $PIT_{i,-5}$	0,0073	0,0066	-0,0037	-0,0038	0,0098	0,0089	-0,0029	-0,003
soft $PIT_{i,-4}$	0,0063	0,0054	-0,0002	-0,0004	0,0088 *	0,0077	0,0008	0,0005
soft $PIT_{i,-3}$	-0,0097	-0,0103	-0,0094 **	-0,0097 ***	-0,0071	-0,008	-0,0084 **	-0,0088 **
soft $PIT_{i,-2}$	-0,0204 **	-0,0198 **	-0,0071 *	-0,0072 *	-0,0176 *	-0,0173 *	-0,0061	-0,0062
soft $PIT_{i,-1}$	-0,0137 **	-0,0133 **	-0,0108 **	-0,0107 **	-0,0109 *	-0,0108 *	-0,0099 *	-0,0099 *
soft $PIT_{i,0}$	-0,0082	-0,0075	0,0001	0,0003	-0,0054	-0,0049	0,001	0,0011
soft $PIT_{i,1}$	0,0009	0,0021	-0,0009	-0,0003	0,0038	0,0048	-0.0000	0,0004
soft $PIT_{i,2}$	0,0078	0,0081	-0,0005	-0,0002	0,0107	0,0107 *	0,0004	0,0006
soft $PIT_{i,3}$	0,0148 ***	0,0145 ***	0,0022	0,0024	0,0176 ***	0,017 ***	0,0032	0,0032
soft $PIT_{i,4}$	0,0166 ***	0,0163 ***	0,0018	0,002	0,0194 ***	0,0188 ***	0,0029	0,003
soft $PIT_{i,5}$	0,0075	0,0065	-0,0043	-0,0044	0,0102 *	0,0089	-0,0031	-0,0033
soft $PIT_{i,6}$					0,0096 **	0,0077 **	0,0104 ***	0,0097 **
soft $PIT_{i,7}$					0,0128 ***	0,0111 ***	0,0155 ***	0,0148 ***
soft $PIT_{i,8}$					0,0047	0,0022	0,0038 *	0,0029
soft $PIT_{i,9}$					0,0117 *	0,0084	0,0073	0,0061
soft $PIT_{i,10}$					0,0027	-0,0008	0,0027	0,0012
$\Delta ln\ y_{i,t-1}$			0,2059 **	0,2027 **			0,2026 **	0,1995 **
$\Delta ln\ kinv_{i,t}$			0,2109 ***	0,2112 ***			0,2115 ***	0,2118 ***
$\Delta\ popg_{i,t}$				-0,0043				-0,004
Pre-Adoption	-0,0302	-0,0314	-0,0312 **	-0,0317 ***	0,0217	0,0206	-0,0294	-0,0289
Post-Adoption	0,0476 ***	0,0475 ***	-0,0016	-0,0006	0,1032 ***	0,0888 ***	0,0431 *	0,0386 *
Wald Het.	374,44 ***	390,65 ***	793,3 ***	797,56 ***	390,45 ***	408,95 ***	795,6 ***	792,03 ***
Woold.Autocorr.	207,74 ***	200,034 ***	118,01 ***	132,67 ***	212,12 ***	203,60 ***	117,83 ***	130,49 ***
F test	3490,57 ***	4035,53 ***	76,82 ***	109,85 ***	7557,31 ***	10660,74 ***	158,3 ***	818,62 ***
Within R^2	0,99	0,99	0,52	0,52	0,99	0,99	0,52	0,53
N	873	873	872	872	873	873	872	872
Countries	23	23	23	23	23	23	23	23

Notes: * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%. To the coefficients of the equation, the significance level are based on the Driscoll and Kraay's standard errors - Driscoll and Kraay (1998).

[50] In general, the outcomes are higher to estimates after IT adoption (positive values) than before that (negative values), as shown in the Figure A.3.1.

Table 3.6 - *Estimations – Advanced countries and full-fledged IT*

Variable	*Full IT*							
	j = 5				*j = 10*			
	Dynamic Model		*Error Correction Model*		*Dynamic Model*		*Error Correction Model*	
	Invest	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*	*Invest*	*Invest/Popg*
$ln\ y_{i,t-1}$	0,9885 ***	0,9893 ***	-0,0117 **	-0,0114 **	0,987 ***	0,9883 ***	-0,0128 **	-0,0122 **
$ln\ kinv_{i,t}$	0,0702 ***	0,0784 ***			0,0725 ***	0,081 ***		
$popg_{i,t}$		-0,0111 ***				-0,0113 ***		
$ln\ kinv_{i,t-1}$			0,0175 **	0,0218 **			0,0165 *	0,0208 **
$ln\ popg_{i,t-1}$				-0,0046 ***				-0,0045 ***
$full\ PIT_{i,-10}$					0,0103 *	0,0089 *	-0,0003	-0,0006
$full\ PIT_{i,-9}$					0,0034	0,0028	-0,005	-0,0051
$full\ PIT_{i,-8}$					0,0052	0,0056	-0,0006	-0,0003
$full\ PIT_{i,-7}$					0,0158 ***	0,0179 ***	0,0056	0,0066 *
$full\ PIT_{i,-6}$					0,0103 ***	0,0103 ***	-0,0061 *	-0,0058 *
$full\ PIT_{i,-5}$	-0,0024	-0,002	-0,0065	-0,0062	0,0001	0,0002	-0,0059	-0,0058
$full\ PIT_{i,-4}$	-0,0133	-0,0132	-0,0045	-0,0046	-0,0107	-0,0109	-0,0038	-0,0041
$full\ PIT_{i,-3}$	-0,0143	-0,0149	-0,0103 ***	-0,0106 ***	-0,0116	-0,0126	-0,0097 **	-0,0101 ***
$full\ PIT_{i,-2}$	-0,0117 *	-0,0117 *	-0,002	-0,0022	-0,0089	-0,0091	-0,0014	-0,0016
$full\ PIT_{i,-1}$	0,003	0,0032	-0,0036	-0,0034	0,0058	0,0056	-0,0031	-0,003
$full\ PIT_{i,0}$	0,0105 *	0,0107 **	0,007 **	0,0071 **	0,0133 **	0,0131 **	0,0075 **	0,0075 **
$full\ PIT_{i,1}$	-0,0004	-0,0004	-0,0003	-0,0003	0,0025	0,0022	0,0003	0,0002
$full\ PIT_{i,2}$	0,0074	0,0066	-0,0001	-0,0003	0,0103 *	0,0091 *	0,0004	0,0001
$full\ PIT_{i,3}$	0,0192 ***	0,0178 ***	0,0036	0,0033	0,022 ***	0,0202 ***	0,0041	0,0037
$full\ PIT_{i,4}$	0,0172 ***	0,0157 ***	0,0053	0,0049	0,0199 ***	0,018 ***	0,006	0,0055
$full\ PIT_{i,5}$	0,0073	0,0057	-0,0026	-0,0031	0,01 *	0,0079	-0,0018	-0,0024
$full\ PIT_{i,6}$					0,0049 **	0,003	0,0108 ***	0,0099 **
$full\ PIT_{i,7}$					0,0098 **	0,0082 *	0,0121 ***	0,0113 **
$full\ PIT_{i,8}$					0,0014	-0,0016	-0,0015	-0,0026
$full\ PIT_{i,9}$					0,0099	0,0058	0,0047	0,0032
$full\ PIT_{i,10}$					0,0061 *	0,0016	0,0028	0,0011
$\Delta ln\ y_{i,t-1}$			0.2046**	0,202 **			0,205 **	0,2032 **
$\Delta ln\ kinv_{i,t}$			0.2108***	0,2111 ***			0,2118 ***	0,212 ***
$\Delta\ popg_{i,t}$				-0,0044				-0,0045
Pre-Adoption	-0,0386	-0,0386	-0,0268 *	-0,0270 *	0,0198	0,0187	-0,0304	-0,0298
Post-Adoption	0,0507 ***	0,0454 ***	0,0058	0,0045	0,0968 ***	0,0743 ***	0,0379	0,0300
Wald Het.	380,13 ***	400,15 ***	813,13 ***	808,52 ***	401,41 ***	421,32 ***	835,39 ***	830,11 ***
Woold.Autocorr.	209,31 ***	201,38 ***	116,49 ***	133,70 ***	210,00 ***	204,00 ***	118,24 ***	134,67 ***
F test	3912,88 ***	4959,21 ***	76,26 ***	148,47 ***	5145,11 ***	5642,08 ***	110,17 ***	482,86 ***
Within R^2	0,99	0,99	0,52	0,52	0,99	0,99	0,52	0,52
N	873	873	872	872	873	873	872	872
Countries	23	23	23	23	23	23	23	23

Notes: * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%. To the coefficients of the equation, the significance level are based on the Driscoll and Kraay's standard errors - Driscoll and Kraay (1998).

3.4. Final comments

An important result of the several estimations in this study is that there is a positive constant effect on the output after the adoption of IT. This observation suggests that there is a possible structural change capable of changing the economic growth. As a general result, we can state that the adoption of IT implies gains for economic growth or that it does not imply a sluggish economic growth. In particular, although the positive effects of IT on output are lower for the case of advanced economies, they are not as negative as pointed out by some critics.

3.5. Appendix

Table A.3.1 - ***Countries by Level of Development Classification and IT Adoption***

	Group of Countries								
	Advanced Economies			*Developing Economies*					
		IT soft	*IT full*		*IT soft*	*IT full*		*IT soft*	*IT full*
ITers	Australia	2006	2007	Armenia	2006	2007	Korea	1998	2001
	Canada	1991	1994	Brazil	1999	1999	Mexico	1995	2001
	Finland[a]	1993	1995	Chile	1991	2000	Peru	1994	2002
	Iceland	2001	2001	Colombia	2000	2000	Philippines	2002	2002
	New Zealand	1990	1990	Czech Republic	1998	1998	Poland	1999	1999
	Norway	2001	2001	Ghana	2003	2007	Romania	2005	2006
	Spain[a]	1995	1995	Guatemala	2005	2006	Serbia	2007	2009
	Sweden	1993	1995	Hungary	2001	2001	Slovak Republic	2005	2005
	Switzerland	2000	2000	Indonesia	2005	2006	South Africa	2000	2000
	United Kingdom	1993	1993	Israel	1992	1997	Thailand	2000	2000
							Turkey	2002	2006
Non-ITers	Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Portugal, United States.			Afghanistan, Albania, Algeria, Angola, Argentina, Azerbaijan, Bahrain, Bangladesh, Belarus, Bolivia, Bosnia and Herzegovina, Botswana, Brunei, Bulgaria, Cambodia, Cameroon, China, Costa Rica, Côte d'Ivoire, Croatia, Cuba, Cyprus, Dem. Rep. Congo, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Gabon, Georgia, Haiti, Honduras, Hong Kong, India, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Lao PDR, Latvia, Lebanon, Libya, Lithuania, Macao, Macedonia, Madagascar, Malaysia, Morocco, Mozambique, Nepal, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Puerto Rico, Qatar, Russia, Saudi Arabia, Senegal, Singapore, Slovenia, Sri Lanka, Sudan, Syrian Arab Republic, Tanzania, Trinidad and Tobago, Tunisia, Turkmenistan, Uganda, Ukraine, United Arab Emirates, Uruguay, Uzbekistan, Venezuela, Vietnam, Yemen, Zambia.					

Notes: a) Finland and Spain have left IT to join the European Monetary Union (EMU) in 1999. The classification of countries are based on their level of development proposed by IMF (initial classification - before 1997).

Table A.3.2 - ***Cross-Dependence Test by Sample***

	All Sample				Advanced Economies				Developing Economies			
Variable	CD-test	p-value	avg ρ	avg $\|\rho\|$	CD-test	p-value	avg ρ	avg $\|\rho\|$	CD-test	p-value	avg ρ	avg $\|\rho\|$
ln $y_{i,t}$	234.42	0.000	0.493	0.651	94.65	0.000	0.965	0.965	162.30	0.000	0.438	0.607
ln $kinv_{i,t}$	32.88	0.000	0.071	0.337	29.40	0.000	0.300	0.377	24.27	0.000	0.066	0.339
$popg_{i,t}$	65.18	0.000	0.124	0.362	14.55	0.000	0.148	0.285	69.99	0.000	0.163	0.396
	Observations (average):			31.34	Observations (average):			39.73	Observations (average):			30.04
Δln $y_{i,t}$	46.32	0.000	0.100	0.200	30.41	0.000	0.311	0.323	35.79	0.000	0.100	0.199
Δln $kinv_{i,t}$	16.93	0.000	0.034	0.168	23.54	0.000	0.240	0.262	11.80	0.000	0.030	0.169
$\Delta popg_{i,t}$	-0.40	0.000	-0.001	0.186	4.49	0.000	0.046	0.166	-0.58	0.563	-0.002	0.195
	Observations (average):			30.79	Observations (average):			39.64	Observations (average):			29.41
	Countries:			128	Countries:			23	Countries:			105

Notes: Under the null hypothesis of cross-section independence CD ~*N(0,1)*.

Figure A.3.1 - *Lags and Lead Estimates by Sample and IT Classification*

Source: Author's calculations. These estimates are calculated by the model's coefficients average and are multiplied by 100 for comparison purposes.

Chapter

4. Does 'IT' Matter for Growth? Only time can tell

4.1. Introduction

Since the 1990s, Inflation Targeting (IT) has become the main monetary regime adopted by both developed and developing economies. In general, IT is defined by a public announcement of medium term for the numerical target and its range. Since there is an explicit recognition that the main objective of the monetary policy is to assure a low and stable inflation rate, IT is characterized by an improvement in transparent and accountable monetary policy. According to Blinder *et al.* (2008), the use of IT has been the preferred way for anchoring expectations.

The debate on the advantages and disadvantages of the IT has received new impetus after the subprime crisis. There is no doubt that high and volatile inflation cause serious damage to the economy and thus an efficient policy framework can create a more stable macroeconomic environment. However, nowadays, the recession observed in several countries demands a more accurate analysis of the inflation control on output. Interest rate is the main instrument available to the monetary authority under IT and the use of a tight monetary policy can reduce the investment in the economy (Bernanke and Mishkin, 1997; Woodford, 2003). Furthermore, as pointed out by Stiglitz (2008), the inflation in developing countries is largely imported and an increase in the interest rate does not affect the tradable prices but decreases the aggregate demand reducing the economic growth.

Notwithstanding, the evidence of the effect of the adoption of IT on economic growth is controversial.[51] There is a huge literature concerning this point. As examples of the evidence favorable to IT we have: Truman (2003); Pétursson (2004a); Ball and Sheridan (2005); Apergis *et al.* (2005). In contrast, examples of negative effect or no evidence of IT on economic growth can be found in Fraga, Goldfajn, and Minella (2003), and Fang, Lee, and Miller (2009). As suggested by Pétursson (2004a) a possible reason for the divergence in literature is a result of the short life span of the IT. Hence, with the advance of time, studies should provide converging results. However, after more than 20 years since the pioneering adoption of IT by New Zealand, recent analyses show that contradictory results are

[51] Furthermore, some studies have highlighted the effects of inflation on economic growth. See Barro (1998) and the references therein.

still observed. For example, Brito and Bystedt (2010) observed that there is a lower economic growth in developing countries during the adoption of IT while Mollick, Cabral, and Carneiro (2011) found evidence that IT implies greater per capita output for both industrialized and developing economies.

One disadvantage of the above-mentioned studies is that most of them make use of cross-section analysis in an attempt to explore the difference between inflation targeters (ITers) and non-inflation targeters (non-ITers) countries and thus the time effect is relegated to the second plan. It is important to note that the differentiation between ITers and non-ITers over time is more complicated because part of the characteristics of inflation targeting has been incorporated in the monetary policy framework by several non-ITers countries. Moreover, according to Ball and Sheridan (2005) and Pétursson (2004a) the effects of IT on the economic growth take time to be perceived. This is the point that is explored in this study. Making use of long time series and the set of ITers, we analyze whether there is a change in the output and economic growth for countries that adopted IT.

As highlighted by North (1990) the institutions define the rules of the game of a society such as regulations, policies, cultures, and norms. Acemoglu, Johnson, and Robison (2005b, p. 386-387) note, "Economic institutions determine the incentives of and the constraints on economic actors, and shape economic outcomes". They "argued that the available evidence is consistent with the view that whether or not a society grows depends on how its economy is organized - on its economic institutions" (p. 463). Hence, in an innovative way, we consider the adoption of IT as an institutional change in the conduct of the monetary policy and thus we evaluate whether adoption of IT has changed the trajectory of economic growth over time. In particular, we measure the average effect on output level and growth for ITers through the fundamental equation of economic growth and a wide range of estimators controlled by long-term equilibrium and by short-term dynamic. We assume also distinct possibilities for the relationship between the variables and the countries over time. In short, this chapter contributes to the literature providing comprehensive empirical evidence (which considers extensive time series with several subsamples, new estimators for macroeconomic data, control for unobserved factors for underlying coefficients, non-constant effect over-time) of the effect of adopting of inflation targeting on output and economic growth. The chapter is organized as follows: Section 2 presents the underpinnings for the econometric model and describes the database. Section 3 presents the estimation of the models and reports the results. Section 4 concludes the chapter.

4.2. The model

Based on a standard neoclassical model of economic growth it is possible to observe the effect of IT on output.[52] In particular, this type of model we allow to consider differences in total factor productivity. With this objective, this section provides a short theoretical model and explains how the econometric analysis is considered in this study. Hence, the model follows the same basic framework available in Mankiw, Romer, and Weil (1992) and Islam (1995), a standard Cobb-Douglas production function is assumed:

$$Y(t) = K(t)^{\alpha}[A(t)L(t)]^{1-\alpha}, \quad 0 < \alpha < 1. \tag{4.1}$$

where: $Y(t)$ is the output, $K(t)$ is the capital, $L(t)$ is the labor, and $A(t)$ is the technological progress. Labor and technological progress grow at constant rates *n* and *g*, respectively, and thus $L(t) = L(0)e^{nt}$ and $A(t) = A(0)e^{gt}$. The effective labor grows at $n+g$.

The model assumes that the dynamics of the capital per unit of effective labor ($k=K/AL$) is

$$\dot{k}(t) = sy(t) - (n+g+\delta)k(t). \tag{4.2}$$

where *s* is a fraction of the output invested, $y=Y/AL$ is the output per unit of effective labor, and δ is the depreciation rate.

Since $y(t) = f\left[k(t)\right] = k(t)^{\alpha}$, thus *k* converges for a steady state k^*, which is

[52] See, Solow (1956), Swan (1956), Cass (1965), and Koopmans (1965).

defined by $sk^{*\alpha} = (n+g+\delta)k^{*}$. Hence:

$$k^{*} = \left[s/\left(n+g+\delta\right)\right]^{1/(1-\alpha)}. \tag{4.3}$$

Substituting (4.3) into (4.1) and applying logs yields

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \frac{\alpha}{1-\alpha}\ln s - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \ln A(0) + gt. \tag{4.4}$$

In general g and δ are assumed as constant among countries and $A(0)$ reflects technology, endowments, climate, institutions and other characteristics that differentiate countries.[53] Since gt is constant, then $\ln A(0) = a + \in$, where a is constant and $\in$ is the specific country shock. Therefore, at t=0, we have

$$\ln\left[\frac{Y}{L}\right] = a + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \in. \tag{4.5}$$

4.2.1. The econometric model

The empirical literature of economic growth presents a very large number of regressors. According to Durlauf (2001), the choice of variables for a particular model is a serious problem in literature. In general, regressors are defined in an *ad hoc* way and they vary according to database and modeling (cross-section, time series, and panel data). As suggested by Durlauf (2005), a manner of minimizing the uncertainty about determinants of economic growth is to use only variables that are robust for different samples and model specifications. Among the papers in the search for the determinants of economic growth, Levine and Renelt (1992) conclude that among the proxies suggested by the Solow model, only investment/GDP ratio and initial income are relevant. These results are confirmed by Sala-i-Martin (1997a, 1997b) and Kalaitzidakis, Mamuneas, and Stengos (2000). Hendry and Krolzig

[53] Note that while the fixed effect captures these features is not time-varying, the trend captures the characteristics that vary and may be different for each country (see, Lee, Pesaran, and Smith, 1998).

(2004) and Hoover and Perez (2004) also confirm investment as a determinant of economic growth. Therefore, we decide to adopt a reduced version of the canonical model.

The steady state of the Solow model implies that permanent changes in the saving rate are associated with permanent changes in the per capita income whose ratio is determined by the parameters of capital of the Cobb-Douglas production function (Pedroni, 2007). Since investment is the best and the most traditional measure of saving, the use of this variable and the control of variation for the short term and long term allows us to explore the impact caused by the institutional change due to the adoption of IT. Despite the simplicity of the initial model, modeling the panel allowing heterogeneity, common factors, and fixed time effects captures the human and social capital without the need to impose variables difficult to measure (Pedroni, 2007; Cavalcanti, Mohaddes, and Raissi, 2011). Therefore, based on the long run equilibrium between real GDP per capita and investment, a basic model specification is

$$\ln y_{i,t} = \partial_i' d_t + \beta_i \ln kinv_{i,t} + \varepsilon_{i,t} , \tag{4.6}$$

where $\ln y_{i,t}$ is real GDP per capita (in logs), $\ln kinv_{i,t}$ is the investment/GDP ratio (in logs), and $d_t = (1,t)'$ are the determinist components where $\partial_i = (\partial_{1i}, \partial_{2i})'$ is the associated parameters vector. Countries and time period are indicated by $i = 1....N$ e $t = 1....T$, respectively.[54]

In fact, it is possible that the long run relationship among the variables changes and thus shifts in the cointegrating vectors can occur. The reason can be a result of: technological changes, financial crisis, and abrupt changes in the agent's behavior, changes in policies and regimes, or even institutional development. This point deserves attention especially when one considers a long period. Hence, for testing the changes due to the adoption of IT, the equation is adjusted in order to capture changes in the average level of real GDP per capita. Therefore, IT represents a

[54] We chose to use the flexible version of the model, but restricted versions that do not allow heterogeneity in the slopes and do not even allow heterogeneity in the intercept are also estimated.

structural change (specifically a shift in the intercept),[55]

$$\ln y_{i,t} = \partial_i' d_t + \beta_i \ln kinv_{i,t} + \theta_i IT_{i,t} + \varepsilon_{i,t} \text{ or}$$

$$\ln y_{i,t} = \mu_i + \beta_i \ln kinv_{i,t} + \theta_i IT_{i,t} + \varepsilon_{i,t}. \quad (4.7)$$

While IT is a scalar dummy variable of value 1 under inflation targeting and 0 in the absence of this monetary regime, θ_i is a structural change captured by the effect on the intercept or fixed country effect.

One extension of the model is to assume $\ln kinv_{i,t} = \ln kinv_{i,t-1} + m_{i,t}$ (it is modeled as a pure random walk process) and to allow the dependence among the countries by the identification of non-observable common factors through the error decomposition $\varepsilon_{i,t} = \omega_i' F_t + v_{i,t}$, $F_{j,t} = \varsigma_j F_{j,t-1} + u_{j,t}$, $o_i(L)\Delta v_{i,t} = o_i v_{i,t-1} + \xi_{i,t}$, where $o_i(L) := 1 - \sum_{j=1}^{pi} o_{i,j} L^j$ is a polynomial scalar in the lag operator *L*, and F_t is a vector of *r* dimensions of non-observable common factors $F_{j,t}$, with $j = 1,\ldots,r$ and ω_i is the parameter of the factor loading vector. If $\varsigma_j < 1$ for all *j*, F_t is stationary and the integration order of the composed error $\varepsilon_{i,t}$, depends on $v_{i,t}$.[56] Then the model is

$$\ln y_{i,t} = \mu_i + \beta_i \ln kinv_{i,t} + \theta_i IT_{i,t} + \omega_i' F_t + v_{i,t}. \quad (4.8)$$

Equation (4.8) allows us to see whether the adoption of IT implied a long run change in the relationship (cointegration) between real GDP per capita and its determinants summarized by the investment and the other common factors. Although the specification is parsimonious, it is general. Traditional estimations

[55] The model with time trend is $\ln y_{i,t} = \mu_i + a_i t + \theta_i IT_{i,t} + \beta_i \ln kinv_{i,t} + \varepsilon_{i,t}$. The deterministic parameters vector can be null, but also allows the addition of the constant and trend, and other types of fixed regressors, such as time dummies. In order to keep the notation simple, we omitted these effects and kept only the constant.

[56] Peasaran (2006) suggests the use of Common Correlated Effects, which are robust in the presence of stationary and non-stationary common factors.

aggregate time data and explore cross-section volatility, impose independence among the countries, and assume homogeneity in the estimated coefficients for different countries. As a result, a large number of variables attempting to incorporate non-observable factors are needed and, in most cases, they are hard to measure and non-reliable (for example, total factor productivity, institutions, human capital, social capital, and others). In the model which is proposed in this study, specific deterministic factors of each country and the use of the common factor allows us to consider these effects and to shed light upon the coefficient of interest.

It is important to note that equations [(4.7)-(4.8)] show a long run relationship among the variables. In the traditional models with static and dynamic panels, the use of averages between 5 and 10 years in order to consider the business cycle is common.[57] According to Durlauf, *et al.* (2005), this construction is arbitrary and the development of tools to ensure that panel findings are robust with respect to the implied assumptions is needed. Furthermore, another problem, as identified by Durlauf and Quah (1999) and Pedroni (2007), is that, in most cases, the relationship of high frequency is considered instead of the long run relationship that is essential for economic growth analysis.

Under the assumption that there is a cointegrating vector, the estimators are super-consistent and robust as far as the omission of variables that do not belong to the equilibrium is concerned. It is therefore important to check for the presence of cointegration in the model. One possibility is the estimation of equations (4.7)-(4.8) and to make a unit root panel data test on the residuals (Engle-Granger two-step cointegration analysis). However, as pointed out by McCoskey and Kao (1998), Kao (1999), Pedroni (1999 and 2004), and Westerlund and Edgerton (2008) this type of test is less reliable than models based on error correction term (Westerlund, 2007; Gengenbach, Urbain, and Westerlund, 2009).[58] Therefore, besides the test on the residuals of equation (4.8), equation (4.6) is rearranged for building a general model

[57] The most traditional view considers cross-section analysis, where the initial conditions are measured by the output at t=0, which corresponds in time series environment to lagged output, or t-1 (see Barro, 1991, and Mankiw, Romer, and Weil, 1992).
[58] As Campos, Ericsson, and Hendry (1996), the superiority of this method occurs even when the data generating process has a common factor and in the presence of structural breaks.

of error correction for panel data,

$$\Delta \ln y_{i,t} = \lambda_i (\ln y_{i,t-1} - \mu_i - \beta_i \ln kinv_{i,t-1} - \theta_i IT_{i,t-1}) + \sum_{j=1}^{p_i} \tau_{1i,j} \Delta \ln y_{i,t-j} + \sum_{j=0}^{q_i} \tau_{2i,j} \Delta \ln kinv_{i,t-j} + e_{i,t}$$

$$\Delta \ln y_{i,t} = c_i + \lambda_i \ln y_{i,t-1} + \gamma_i \ln kinv_{i,t-1} + \phi_i IT_{i,t-1} + \sum_{j=1}^{p_i} \tau_{1i,j} \Delta \ln y_{i,t-j} + \sum_{j=0}^{q_i} \tau_{2i,j} \Delta \ln kinv_{i,t-j} + e_{i,t} \quad . \tag{4.9}$$

Taking into account a common factors model [equation (4.8)], the specification becomes,[59]

$$\Delta \ln y_{i,t} = \lambda_i (\ln y_{i,t-1} - \mu_i - \beta_i \ln kinv_{i,t-1} - \theta_i IT_{i,t-1} - \omega_i' F_{t-1}) + \sum_{j=1}^{p_i} \tau_{1i,j} \Delta \ln y_{i,t-j} + \sum_{j=0}^{q_i} \tau_{2i,j} \Delta \ln kinv_{i,t-j} + \sum_{j=0}^{h_i} \tau_{3i,j}' \Delta F_{t-j} + v_{i,t}$$

$$\Delta \ln y_{i,t} = c_i + \lambda_i \ln y_{i,t-1} + \gamma_i \ln kinv_{i,t-1} + \phi_i IT_{i,t-1} + w_i' F_{t-1} + \sum_{j=1}^{p_i} \tau_{1i,j} \Delta \ln y_{i,t-j} + \sum_{j=0}^{q_i} \tau_{2i,j} \Delta \ln kinv_{i,t-j} + \sum_{j=0}^{h_i} \tau_{3i,j}' \Delta F_{t-j} + v_{i,t} \quad , \tag{4.10}$$

where, $\mu_i = -\frac{c_i}{\lambda_i}, \quad \beta_i = -\frac{\gamma_i}{\lambda_i}, \quad \theta_i = -\frac{\phi_i}{\lambda_i}, \quad \omega_i' = -\frac{w_i'}{\lambda_i}$.

As ϕ_i, γ_i, and w_i' are unrestricted in the estimation of (4.9) and (4.10), the cointegrating vector is implicitly estimated under alternative assumption and hypothesis tests on λ_i indicate whether there is the error correction term and thus the Engle-Granger cointegration (Cavalcanti, Mohaddes, and Raissi, 2011). In addition, as suggested by Bowijk (1994), Wald test on cointegrating vector is made in order to check joint significance.

It is important to highlight that the main objective of our specification is to

[59] Our specification by incorporating the unrestricted lagged error term also provides an efficient lagged effect of IT, since the credibility effect is not immediate.

check both the short- and the long-term effects on real GDP per capita and thus whether the variables under consideration share a relationship of long run equilibrium, where the short term dynamic can be understood as departures from the equilibrium and the error correction term as time adjustment to this equilibrium. Therefore, we can identify whether the adoption of IT implied a positive or negative shift and significant, or not significant.

In order to consider the several characteristics on the analysis concerning time series in panel data, we program specific estimators for each possible data generating process. We start with a very simple model (4.11), which assumes that there is no difference among the countries regarding per capita output growth.

$$\begin{aligned}\Delta \ln y_{i,t} &= c + \lambda \ln y_{i,t-1} + \gamma \ln kinv_{i,t-1} + \phi IT_{i,t-1} \\ &+ \sum_{j=1}^{p} \tau_{1j} \Delta \ln y_{i,t-j} + \sum_{j=0}^{q} \tau_{2j} \Delta \ln kinv_{i,t-j} + e_{i,t}\end{aligned} \quad . \tag{4.11}$$

In this sense, all coefficients are the same for all countries (*Pooled OLS* - POLS). We calculate the standard errors through Driscoll-Kraay (1998) methodology in order to allow heterogeneity and residuals autocorrelation, also considering the dependency among the countries. Based on the asymptotic theory, our samples with $T > N$ are appropriate.

The second model (4.12) allows the heterogeneity among the countries through intercept (*Dynamic Fixed-Effects* - DFE).[60] Then,

$$\begin{aligned}\Delta \ln y_{i,t} &= c_i + \lambda \ln y_{i,t-1} + \gamma \ln kinv_{i,t-1} + \phi IT_{i,t-1} \\ &+ \sum_{j=1}^{p} \tau_{1j} \Delta \ln y_{i,t-j} + \sum_{j=0}^{q} \tau_{2j} \Delta \ln kinv_{i,t-j} + e_{i,t}\end{aligned} \quad . \tag{4.12}$$

[60] Corrections for bias due to endogeneity between the error term and lagged dependent variable as proposed in Kiviet (1995) and Bun and Carree (2005) are unnecessary because of the dimension of T. Dynamic GMM estimators and their well-known problem of too many instruments, for long panels, is not the best solution here (Judson and Owen, 1999, Roodman, 2009). Even Difference and System GMM estimators were developed for large *N* and short *T*. Some problems: they require stationary variables or at least stationarity in the initial condition (*t=0* in system GMM), overfitting with long *T* panels; and assume parameter homogeneity for instrumentation (see Pesaran and Smith, 1995; Pesaran, 2006).

In the same way, heterogeneity and residual autocorrelation was treated as well as dependency across countries. However, if the coefficients of inclination are not identical across countries, DFE produces inconsistent and possibly misleading results. As highlighted by Durlauf (2001, p. 67), "empirical growth needs far greater considerations of the limits to formal statistical work. Given the large number of plausible competing theories and the likelihood of substantial parameter heterogeneity across countries, there are clear limits to what econometric analyses can do." Consequently, we decide to use new methodologies in order to work with heterogeneity. The next step is to allow that intercept, coefficient of parameters, and error variance can be different among the countries. With this intention, the models Random Coefficient Model (RCM – Swamy, 1970) and Mean Group estimator (MG – Pesaran and Smith, 1995) are used. The first enables each panel to have its own random coefficient vector defined from a common distribution for all panel data. The coefficient vector of each panel (γ_i) is related with a common underlying parameter vector (γ), i.e. $\gamma_i = \gamma + \tau_i$. Through a Generalized Least Squares, this weighs the average of the estimated coefficients by the matrix of heterogeneous variance-covariance parameters. On the other hand, MG estimates separately the coefficients of each group by OLS and calculates the simple arithmetic average (or weighted by the inverse outliers) of the found coefficients.

A possible version for the data generating process is that the short-term coefficients can be heterogeneous and represent the dynamic while the long-term coefficients are homogeneous. Then,

$$\begin{aligned}\Delta \ln y_{i,t} &= c_i + \lambda \ln y_{i,t-1} + \gamma \ln kinv_{i,t-1} + \phi IT_{i,t-1} \\ &+ \sum_{j=1}^{p} \tau_{1i,j} \Delta \ln y_{i,t-j} + \sum_{j=0}^{q} \tau_{2i,j} \Delta \ln kinv_{i,t-j} + e_{i,t}\end{aligned} \quad . \qquad (4.13)$$

Therefore, besides the short-term intercept, the coefficients and the error variance, they can make a difference among the countries (as in MG) but they are bound to be the same in the long term (as in pooled estimation). The Pooled Mean Group model (PMG - Pesaran, Shin, and Smith, 1999) permits this mixed approach.

Since parameters in (4.13) are not linear, the estimation by Maximum Likelihood is made.

As it can be observed by equations (4.7) to (4.10) the presence of common factors affects all countries but in a different way. The incorrect consideration of these factors can imply a relation between the error term and the variables in the model, in particular the real GDP per capita in the right hand side of the equation. Furthermore, there is the possibility of non-identification of desired parameters (Kapetanios, Pesaran, and Yamagata, 2011; Eberhardt and Teal, 2012).

Hence, with the objective of avoiding the above mentioned problems, the use of Common Correlated Effects (CCE) as proposed by Pesaran (2006), which assumes a multi-factor approach to errors ($\varepsilon_{i,t} = \omega_i' F_t + v_{i,t}$) as specified in equation (4.8), is used. These estimators allow that the non-observable common shock vector (F_t), independently of being stationary or non-stationary, are serially correlated or correlated with regressors. Regarding the individual errors, $v_{i,t}$ is assumed to be independently distributed from the regressors including non-observable common factors, however, it can be autocorrelated and weakly dependent among the countries. Therefore, as pointed out by Kapetanios, Pesaran, and Yamagata (2011), the use of these estimators can avoid the cross-section dependence caused by non-observable common factors.

Two estimators are used: the Common Correlated Effects Pooled (CCEP) and Common Correlated Effects Mean Group (CCEMG). The first [equation (4.14)] takes advantage of the poolability. In other words, it assumes that the coefficients on individual parameters are the same ($\gamma_i = \gamma$ and $\sigma_i^2 = \sigma^2$), however allowing that the coefficients of the common factors are different. The second, more flexible to the idiosyncrasy, allows heterogeneous parameters for both variables and for the common factors structure [equation (4.10)].

$$\begin{aligned}\Delta \ln y_{i,t} &= c_i + \lambda \ln y_{i,t-1} + \gamma \ln kinv_{i,t-1} + \phi IT_{i,t-1} + w_i' F_{t-1} \\ &+ \sum_{j=1}^{p} \tau_{1,j} \Delta \ln y_{i,t-j} + \sum_{j=0}^{q} \tau_{2,j} \Delta \ln kinv_{i,t-j} + \sum_{j=0}^{h} \tau_{3i,j}' \Delta F_{t-j} + v_{i,t}\end{aligned} \quad (4.14)$$

In brief, according to proposed specifications and models we cover a broad field of data generating process. The first group is a result of the most restricted models, with homogenous parameters and homogeneous factor loadings. Hereafter, we use POLS, DFE (distinct intercepts), and PMG, which allows heterogeneous parameters in the short term. The second group consisting of RCM and MG, it takes into consideration the heterogeneous parameters of short and long term but with the homogeneous factor loadings. The third group allows idiosyncrasy in the common factors but imposes a homogeneous parameter to the model (CCEP). The fourth group has the most general version where the heterogeneity is present in both parameters of model and common factor (CCEMG).

4.3. Data and Empirical analysis

This study makes use of unbalanced panel data based on information regarding 30 countries that adopted IT. As well as for Corbo, Landerretche and Schimidt-Hebbel (2002), Roger and Stone (2005), Mollick, Cabral, and Carneiro (2011), and the Chapter 2-3, two different dates of IT adoption for the countries are considered. Two dummy variables are built: the first is about the initial date of IT (in some cases it corresponds to a partial adoption) and the second corresponds to a conservative date (where the adoption is explicit). We call the first "soft IT" and the second "full-fledged IT". The ITers and their respective date of adoption are reported in Table A.4.1 (see appendix) and are in accordance with Table A.2.1 and Hammond (2012).[61] Data regarding real GDP per capita and investment/GDP ratio were gathered from Penn World Table (PWT 7.0).

The reduced number of variables makes it possible to better explore the temporal perspective through long series, which are important to identify long-term effects, and breaks in the trend. On the other hand, remote past is not necessarily a good predictor of future economic growth (Easterly *et al.*, 1993) and can contain many breaks. Thus, for purposes of robustness, we use three samples, 1970-2007, 1960-2007, and 1950-2007 in an attempt to ensure a large T in the sample (the smallest sample included 38 years) and to capture the relation of equilibrium.[62] Due

[61] Due to the size of the time series, which begins in 2005, Serbia was not included.
[62] Due to the fact that the international crisis (2008-2009) represents a strong structural break in the series, this period is omitted in this analysis.

to the wide range of models and characteristics of some of them, in considering idiosyncrasies of each country it is important that T is large in order to allow separate estimations. Hence, we have a sample of 30 countries over the years regarding the three samples.[63]

It is important to highlight that considering heterogeneity among countries grants the chance to study ITers as a group even with the presence of advanced and developing countries in the same sample. This characteristic permits, in an unprecedented manner, the analysis of different countries that adopted IT in a uniform and comparable manner. Therefore, we can answer whether or not IT was a break in economic growth (long term) and/or business cycles (short term) for countries that adopted this monetary policy regime. In particular, it is possible to give this answer considering the idiosyncrasies and differences among the countries that adopted IT without the need to disaggregate them or to treat them as outliers.

Although the theoretical assumption of the cross dependence in output growth across many countries is strong, we make the empirical cross-section dependence (CD) test as suggested by Pesaran (2004), who considers heterogeneous parameters, structural break, unbalanced panel data, non-stationarity and can be made on variables or residuals. Table A.4.2 shows the outcome of the tests. The results reject the assumption that there is cross-section independence for all series (in level or in difference).

About the integration of series, the presence of variables I(2) is not appropriate because a long-term relationship among the variables is needed for the use of panel data correction. Hence, in order to identify the integration order we apply tests both on individual series and on panel data. Due to the fact that the CIPS test developed by Pesaran (2007) allows heterogeneous parameters and cross-section dependence, we use it. The test statistic is constructed from the results of each specific panel by Cross-Sectionally Augmented Dickey-Fuller (CADF) regressions. In fact, Pesaran (2007) improves the IPS test (Im, Pesaran, and Shin,

[63] Besides the visual analysis and the use of box-plot, we apply the process of identifying outliers proposed by Billor, Hadi, and Velleman (2000). As the number of identified values was not large, we prefer not to delete the values in question. We also estimate all models without the presence of outliers identified, which did not change the results with original samples. For a comparison between the methods for detection of outliers, see Barnett and Lewis (1994).

1997 and 2003) to filter the dependency among cross-section units.[64]

Table A.4.3 (see appendix) reports the results for different lags (for controlling the autocorrelation in the residuals due to the autoregressive framework) and with the presence of constant and trend and only constant. In the case of constant and trend, it is clear that the processes are first order integrated. In the case of only constant, the result is less robust for investment with reduced number of lags, probably due to the presence of serial autocorrelation in the underlying data generating process.[65] For the series in the first difference, the results indicate that they are stationary. Then we can trust that there is not a mix of I(2) and I(1) series in the three non-stationary panel data.[66]

With the objective of checking the long-term relationship equilibrium and thus to estimate the panel data that consider the short term dynamic to this equilibrium, we make the Maddala e Wu (1999) test on the residuals of equation (4.8).[67] As in Cavalcanti, Mohaddes, and Raissi (2011) for avoiding any form of cross-section dependence we employ the CCEMG estimator. For improving robustness we combine the models with constant, and with constant and trend, in both equation (4.8) and ADF models with up to four lags, thus covering a broad set of possibilities of cointegration taking into account the three samples and the two IT classification.[68] The results in Table A.4.4 (see appendix) denotes the rejection of null hypothesis of non-cointegration at level of 1% (based on all models, specifications, and samples).

Therefore, we may estimate a data panel that considers both long- term equilibrium and short-term dynamic. Seven estimators are used: POLS equation

[64] The test considers an unobserved common factor, but with heterogeneous factor loadings, that is, specific to each panel unit. Due to the existence of gaps in the series, we report the test statistic Z, or normal inverse as suggested by Choi (2001). Further details of the procedure can be found in Pesaran (2007).
[65] In general, Investment/GDP ratio is restricted to the limits of 0 and 1, and as noted by Pedroni (2007), can be only locally non-stationary. However, this case is useful for estimating a cointegrated dynamic panel (Cavalcanti, Mohaddes and, Raissi, 2011).
[66] It is important to note that the well-known weakness of the unit root tests Dickey-Fuller with null hypothesis I(1) is the possibility of non-rejection due to a break in series which are possibly stationary (Baum, 2001).
[67] As pointed out by these authors, the Fisher (1932) test is better than the LL test (Levin-Lin, 1992 and 1993) and IPS test (Im, Pesaran, and Shin, 1997 and 2003) for panel data.
[68] Although the both tests are based on ADF, the first neglects the cross-section dependency while the second assumes an unobserved common factor.

(4.11); DFE equation (4.12); PMG equation (4.13); RCM and MG equation (4.9); CCEP equation (4.14); and CCEMG equation (4.10). The models were computed for two IT classification and the three samples. The error correction model specification (general form allowing heterogeneous parameters) is given by,[69]

$$\begin{aligned}\Delta \ln y_{i,t} &= c_i + \lambda_i \ln y_{i,t-1} + \gamma_i \ln kinv_{i,t-1} + \phi_i IT_{i,t-1} \\ &+ \tau_{1i} \Delta \ln y_{i,t-1} + \tau_{2i} \Delta \ln kinv_{i,t} + e_{i,t}\end{aligned} \tag{4.15}$$

with the inclusion of the common factor, then[70]

$$\begin{aligned}\Delta \ln y_{i,t} &= c_i + \lambda_i \ln y_{i,t-1} + \gamma_i \ln kinv_{i,t-1} + \phi_i IT_{i,t-1} + w_i' F_{t-1} \\ &+ \tau_{1i} \Delta \ln y_{i,t-1} + \tau_{2i} \Delta \ln kinv_{i,t} + \sum_{j=0}^{h} \tau_{3i,j}' \Delta F_{t-j} + v_{i,t}\end{aligned} \quad . \tag{4.16}$$

A first step is to observe whether λ_i is statistically different from zero and negative (short-term imbalance).[71] Otherwise, the cointegration relationship is not confirmed. A second step is to observe whether the short and long-term relationship is significant, as well as the coefficient of the variable IT (ϕ_i).[72] Moreover, we estimate the underlying parameters for the long-term for each model and α as proposed in the traditional literature. Concerning the cross-section dependence, the CD test suggested by Pesaran (2004) test modified for residual analysis was applied. To verify the heterogeneity of the parameters, we use the constancy test that assumes homogeneity in null hypothesis. The other traditional diagnostic measures of each model are also presented.

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[69] Because the inclusion of common time effects does not substantially change the estimates of the coefficients, we present the estimates without common time dummies included. Anyway, we present the results of all models (with trend) in the appendix (Table A.2.5).

[70] We make the option for a homogeneous structure of lags, since the use of traditional selection criteria such as AIC and SIC are not efficient in this case.

[71] Besides the heterogeneous coefficient (denoted by subscript "i"), we also considering coefficients for the homogenous models (without subscript).

[72] Besides the individual significance, we checked the significance of the short-term vector as a whole in order to confirm the presence of short-term dynamics. We did the same for long-term relationship defined by the theoretical model.

Table 4.1 - *Estimation for soft IT (sample 1970-2007)*

Variables	1970-2007 Estimators						
	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0029	-0.0335	-0.0534	-0.0497	-0.0515	-0.1341	-0.2430
	(0.0016) *	(0.0052) ***	(0.0135) ***	(0.0149) ***	(0.0078) ***	(0.0245) ***	(0.0388) ***
$\ln kinv_{i,t-1}$	0.0131	0.0213	0.0224	0.0213	0.0224	0.0742	0.1051
	(0.0046) ***	(0.0097) **	(0.0067) ***	(0.0097) **	(0.0099) **	(0.0141) ***	(0.0159) ***
$soft\ IT_{i,t-1}$	0.0074	0.0194	0.0193	0.0204	0.0195	0.0103	0.0109
	(0.0026) ***	(0.0034) ***	(0.0051) ***	(0.0039) ***	(0.0041) ***	(0.0040) ***	(0.0058) *
$\Delta\ln y_{i,t-1}$	0.3262	0.2513	0.1978	0.1762	0.1603	0.0900	0.0813
	(0.0562) ***	(0.0610) ***	(0.0272) ***	(0.0246) ***	(0.0352) ***	(0.0474) *	(0.0424) *
$\Delta\ln kinv_{i,t}$	0.1600	0.1584	0.1816	0.1880	0.1919	0.1741	0.2087
	(0.0154) ***	(0.0154) ***	(0.0224) ***	(0.0216) ***	(0.0193) ***	(0.0180) ***	(0.0210) ***
$\hat{\beta}_i$	4.55 *	0.64 **	0.42 ***	0.74 ***	0.51 **	0.55 ***	0.53 ***
$\hat{\theta}_i$	2.57	0.58 ***	0.36 ***	0.32 ***	0.41 ***	0.08 *	0.15
$\hat{\alpha}$	0.82	0.39	0.30	0.42	0.34	0.36	0.35
$\hat{\tau}_j$	96.16 ***	83.84 ***	132.51 ***	155.9 ***	76.95 ***	30.88 ***	37.57 ***
$Wald_{coint.}$							10.83 ***
CD test	11.42 ***	9.52 ***	50.69 ***	19.78 ***	8.39 ***	-2.28 **	-0.3
avg ρ	0.09	0.08	0.42	0.16	0.06	-0.02	-0.01
avg |ρ|	0.18	0.17	0.49	0.22	0.18	0.18	0.18
RMSE	0.0340	0.0324			0.0264	0.0290	0.0209
F / Wald	69.82 ***	72.52 ***		317.21 ***	191.22 ***		188.91 ***
R^2	0.345	0.347				0.578	
$R^2_{adj.}$	0.342	0.344				0.472	
Log Likelihood			2583.78				
Test of parameter constancy				684.09 ***			
N	1070	1070	1070	1070	1070	1070	1070
Countries	30	30	30	30	30	30	30

Notes: The constants terms are included but not reported. POLS stands for Pooled Ordinary Least Squares, DFE for Dynamic Fixed Effects, PMG for Pooled Mean Group, RCM for Random Coefficients Model, MG for mean group estimates while CCEP and CCEMG denote the Common Correlated Effects Pooled estimates and Mean Group, respectively. $\hat{\tau}_j = (\hat{\tau}_{1,j}, \hat{\tau}_{2,j})$. *Standard errors are given in parentheses. * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%.*

Table 4.1 summarizes the results for the sample 1970-2007 and the classification soft IT. The coefficients on $\ln y_{i,t-1}$, in all their specifications, are negative and significant. This denotes an adjustment of the short-term variations to the equilibrium. The short-term dynamics is also significant in all simulated data generating process both individually and $\hat{\tau}_j$. The parameter of interest presents positive and significant values in most of the suggested estimators, both unrestricted coefficients (ϕ_i) and underlying coefficients (θ_i). Furthermore, it is important to observe that, with the exception of the POLS estimation, $\hat{\alpha}$ is close to that found in the literature (1/3)[73].

The test for parameter constancy suggests preference for heterogeneous models, while the CD test captures cross-section correlation among the countries for almost all models. The models POLS and DFE attempt to consider this effect through standard errors suggested by Driscoll-Kraay (1998), while the CCE models explicit the underlying common factor.[74] Despite the rejection of independence between the units measured by the CD test, its significance changes from 1% to 5% for the CCEP model. Only the estimation through CCEMG explicitly eliminates the cross effect between the countries. Other diagnostic tests support the results and the standard specification of the estimated models.

When we modify the structure to full-fledged IT, the results remain and seem to confirm the good effect due to monetary policy conduct after the adoption of IT (Table 4.2). The coefficients are significant and consistent with the literature. In other words, a positive effect of the adoption of IT is observed.

[73] The statistical significance test for this underlying variable is not performed.

[74] It is important to consider that the first method will naturally present cross-dependence measured by the CD test, because its setting is on the standard error and not directly on the model specification as in CCE estimators.

Table 4.2 - *Estimation for full-fledged IT (sample 1970-2007)*

Variables	1970-2007						
	Estimators						
	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0029	-0.0298	-0.0502	-0.0455	-0.0420	-0.1424	-0.2413
	(0.0016) *	(0.0058) ***	(0.0120) ***	(0.0149) ***	(0.0075) ***	(0.0287) ***	(0.0379) ***
$\ln kinv_{i,t-1}$	0.0133	0.0224	0.0236	0.0186	0.0223	0.0728	0.1055
	(0.0046) ***	(0.0100) **	(0.0068) ***	(0.0107) *	(0.0098) **	(0.0151) ***	(0.0160) ***
$full\ IT_{i,t-1}$	0.0070	0.0173	0.0207	0.0163	0.0150	0.0101	0.0136
	(0.0028) **	(0.0039) ***	(0.0052) ***	(0.0053) ***	(0.0031) ***	(0.0048) **	(0.0039) ***
$\Delta\ln y_{i,t-1}$	0.3275	0.2558	0.1908	0.1790	0.1596	0.0887	0.0755
	(0.0565) ***	(0.0615) ***	(0.0273) ***	(0.0323) ***	(0.0350) ***	(0.0358) **	(0.0435) *
$\Delta\ln kinv_{i,t}$	0.1610	0.1617	0.1872	0.1892	0.1961	0.1729	0.2070
	(0.0156) ***	(0.0160) ***	(0.0213) ***	(0.0177) ***	(0.0187) ***	(0.0146) ***	(0.0241) ***
$\hat{\beta}_i$	4.65 *	0.75 ***	0.47 ***	0.41 **	0.84 **	0.51 ***	0.41 ***
$\hat{\theta}_i$	2.44	0.58 ***	0.41 ***	0.42 ***	0.41 *	0.07 ***	0.10
$\hat{\alpha}$	0.82	0.43	0.32	0.29	0.46	0.34	0.29
$\hat{\tau}_j$	141.88 ***	56.1 ***	142.13 ***	122.12 ***	80.6 ***	18.51 ***	32.21 ***
$Wald_{coint.}$							10.90 ***
CD test	11.38 ***	10.31 ***	47.48 ***	19.94 ***	9.24 ***	-2.2 **	-1.16
avg ρ	0.09	0.08	0.40	0.16	0.07	-0.02	-0.01
avg |ρ|	0.18	0.17	0.49	0.22	0.18	0.18	0.17
RMSE	0.0340	0.0326			0.0271	0.0291	0.0209
F / Wald tests	55.90 ***	49.23 ***		282.61 ***	191.70 ***		173.12 ***
R^2	0.344	0.339				0.577	
$R^2_{adj.}$	0.341	0.336				0.471	
Log Likelihood			2580.28				
Test of parameter constancy				668.95 ***			
N	1070	1070	1070	1070	1070	1070	1070
Countries	30	30	30	30	30	30	30

Notes: The constants terms are included but not reported. POLS stands for Pooled Ordinary Least Squares, DFE for Dynamic Fixed Effects, PMG for Pooled Mean Group, RCM for Random Coefficients Model, MG for mean group estimates while CCEP and CCEMG denote the Common Correlated Effects Pooled estimates and Mean Group, respectively. $\hat{\tau}_j = (\hat{\tau}_{1,j}, \hat{\tau}_{2,j})$. *Standard errors are given in parentheses. * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%.*

Table 4.3 - *Estimation for soft IT (sample 1960-2007)*

Variables	1960-2007 Estimators POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0028	-0.0283	-0.0288	-0.0349	-0.0413	-0.1342	-0.1479
	(0.0015) *	(0.0044) ***	(0.0076) ***	(0.0109) ***	(0.0074) ***	(0.0216) ***	(0.0249) ***
$\ln kinv_{i,t-1}$	0.0162	0.0334	0.0163	0.0212	0.0207	0.0678	0.0606
	(0.0044) ***	(0.0072) ***	(0.0053) ***	(0.0103) **	(0.0113) *	(0.0105) ***	(0.0165) ***
$soft\ IT_{i,t-1}$	0.0078	0.0202	0.0112	0.0190	0.0197	0.0088	0.0123
	(0.0034) **	(0.0048) ***	(0.0032) ***	(0.0053) ***	(0.0046) ***	(0.0035) **	(0.0044) ***
$\Delta\ln y_{i,t-1}$	0.1274	0.0461	0.1610	0.1288	0.1256	-0.0167	0.0611
	(0.1273)	(0.1317)	(0.0302) ***	(0.0332) ***	(0.0341) ***	(0.0538)	(0.0383)
$\Delta\ln kinv_{i,t}$	0.1334	0.1357	0.1659	0.1755	0.1893	-0.0156	0.1869
	(0.0225) ***	(0.0217) ***	(0.0223) ***	(0.0173) ***	(0.0166) ***	(0.0156) ***	(0.0135) ***
$\hat{\beta}_i$	5.71 *	1.18 ***	0.57 ***	0.93 ***	0.99 **	0.51 ***	0.32 ***
$\hat{\theta}_i$	2.76	0.71 ***	0.39 ***	0.48 ***	0.44 ***	0.07 **	0.11 **
$\hat{\alpha}$	0.85	0.54	0.36	0.48	0.50	0.34	0.24
$\hat{\tau}_j$	2.47	1.21	65.18 ***	58.29 ***	68.93 ***	5.59 **	37.25 ***
$Wald_{coint.}$							8.54 ***
CD test	15.43 ***	11.06 ***	47.12 ***	27.41 ***	9.71 ***	-1.43	0.79
avg ρ	0.12	0.09	0.36	0.20	0.06	-0.02	0.00
avg |ρ|	0.19	0.18	0.45	0.25	0.17	0.16	0.15
RMSE	0.0405	0.0386			0.0309	0.0322	0.0252
F / Wald	10.60 ***	22.46 ***		265.59 ***	197.02		249.80
R^2	0.165	0.189				0.525	
$R^2_{adj.}$	0.162	0.186				0.432	
Log Likelihood			3050.76				
Test of parameter constancy				656.03 ***			
N	1316	1316	1316	1316	1316	1316	1316
Countries	30	30	30	30	30	30	30

Notes: The constants terms are included but not reported. POLS stands for Pooled Ordinary Least Squares, DFE for Dynamic Fixed Effects, PMG for Pooled Mean Group, RCM for Random Coefficients Model, MG for mean group estimates while CCEP and CCEMG denote the Common Correlated Effects Pooled estimates and Mean Group, respectively. $\hat{\tau}_j = (\hat{\tau}_{1,j}, \hat{\tau}_{2,j})$. *Standard errors are given in parentheses. * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%.*

To enhance the robustness in the analysis we increase the size of the sample starting at 1960 (see tables 4.3 and 4.4). The previous results are confirmed in these estimations for both classifications of IT (soft and full-fledge). With a larger size, the model CCEP eliminated the cross-section dependence among the countries probably due to the increase in the degrees of freedom.[75] The coefficients remain significant and with expected signs. Moreover, the IT remains effective in almost all estimations.

[75] It is important to observe that the consumption of degrees of freedom is large in this type of model. Each interaction among variable, lag, and cross-section unit demands an additional parameter to control the underlying common factor.

Table 4.4 - ***Estimation for full-fledged IT (sample 1960-2007)***

Variables	1960-2007						
	Estimators						
	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0027	-0.0256	-0.0290	-0.0320	-0.0336	-0.1202	-0.1463
	(0.0016) *	(0.0046) ***	(0.0073) ***	(0.0086) ***	(0.0067) ***	(0.0219) ***	(0.0207) ***
$\ln kinv_{i,t-1}$	0.0163	0.0330	0.0154	0.0179	0.0218	0.0612	0.0588
	(0.0044) ***	(0.0071) ***	(0.0050) ***	(0.0102) *	(0.0108) **	(0.0136) ***	(0.0174) ***
$full\ IT_{i,t-1}$	0.0072	0.0181	0.0126	0.0145	0.0139	0.0084	0.0088
	(0.0037) *	(0.0051) ***	(0.0034) ***	(0.0056) ***	(0.0030) ***	(0.0044) *	(0.0035) **
$\Delta\ln y_{i,t-1}$	0.1280	0.0502	0.1574	0.1319	0.1233	-0.0226	0.0464
	(0.1276)	(0.1322)	(0.0303) ***	(0.0337) ***	(0.0343) ***	(0.0618)	(0.0399)
$\Delta\ln kinv_{i,t}$	0.1342	0.1380	0.1678	0.1758	0.1912	0.1560	0.1885
	(0.0226) ***	(0.0221) ***	(0.0218) ***	(0.0171) ***	(0.0168) ***	(0.0137) ***	(0.0181) ***
$\hat{\beta}_i$	5.92 *	1.29 ***	0.53 ***	1.45 *	1.21 **	0.51 ***	0.36 ***
$\hat{\theta}_i$	2.61	0.71 ***	0.43 ***	0.55 ***	0.78 ***	0.07 **	0.23
$\hat{\alpha}$	0.86	0.56	0.35	0.59	0.55	0.34	0.27
$\hat{t}_j$	2.51	1.72	63.97 ***	60.2 ***	67.93 ***	4.61 **	28.73 ***
$Wald_{coint.}$							10.46 ***
CD test	15.32 ***	11.78 ***	47.28 ***	27.36 ***	10.12 ***	-1.37	0.73
avg ρ	0.12	0.09	0.37	0.20	0.07	-0.01	0.00
avg |ρ|	0.18	0.18	0.46	0.24	0.17	0.16	0.15
RMSE	0.0405	0.0387			0.0316	0.0325	0.0252
F / Wald	10.31 ***	18.68 ***		198.21 ***	194.26 ***		177.78 ***
R^2	0.164	0.182				0.517	
$R^2_{adj.}$	0.161	0.179				0.423	
Log Likelihood			3050.03				
Test of parameter constancy				651.81 ***			
N	1316	1316	1316	1316	1316	1316	1316
Countries	30	30	30	30	30	30	30

Notes: The constants terms are included but not reported. POLS stands for Pooled Ordinary Least Squares, DFE for Dynamic Fixed Effects, PMG for Pooled Mean Group, RCM for Random Coefficients Model, MG for mean group estimates while CCEP and CCEMG denote the Common Correlated Effects Pooled estimates and Mean Group, respectively. $\hat{t}_j = (\hat{t}_{1,j}, \hat{t}_{2,j})$. *Standard errors are given in parentheses. * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%.*

The third sample incorporates ten more years of data (Table 4.5 and Table 4.6). Again, we find a significant adjustment of the short-term dynamics to the equilibrium. The signs of the coefficients are in agreement with what is observed in the standard literature. In addition, after adoption of IT, the positive effect on the output and its growth is observed independently of soft IT or full-fledged IT is considered. The CD test confirms the control over cross-section correlation by CCEP estimator that, in turn, suggests that, in the smaller sample, the same does not occur only by asymptotic reason.

Table 4.5 - *Estimation for soft IT (sample 1950-2007)*

Variables	1950-2007						
	Estimators						
	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0022	-0.0191	-0.0161	-0.0256	-0.0309	-0.0953	-0.1056
	(0.0014)	(0.0048) ***	(0.0032) ***	(0.0099) ***	(0.0064) ***	(0.0126) ***	(0.0224) ***
$\ln kinv_{i,t-1}$	0.0134	0.0287	0.0264	0.0186	0.0187	0.0517	0.0484
	(0.0044) ***	(0.0066) ***	(0.0058) ***	(0.0111) *	(0.0115)	(0.0116) ***	(0.0148) ***
$soft\ IT_{i,t-1}$	0.0080	0.0181	0.0116	0.0182	0.0179	0.0107	0.0162
	(0.0035) **	(0.0044) ***	(0.0027) ***	(0.0052) ***	(0.0049) ***	(0.0038) ***	(0.0049) ***
$\Delta\ln y_{i,t-1}$	0.0983	0.0318	0.1365	0.1155	0.1073	-0.0321	0.0368
	(0.1093)	(0.1119)	(0.0334) ***	(0.0336) ***	(0.0352) ***	(0.0472)	(0.0309)
$\Delta\ln kinv_{i,t}$	0.1332	0.1365	0.1734	0.1728	0.1799	0.1533	0.1761
	(0.0198) ***	(0.0192) ***	(0.0183) ***	(0.0164) ***	(0.0169) ***	(0.0182) ***	(0.0169) ***
$\hat{\beta}_i$	6.00 *	1.50 ***	1.64 ***	0.62	0.62 **	0.54 ***	0.42 **
$\hat{\theta}_i$	3.59	0.95 ***	0.72 ***	0.10	0.15 *	0.11 ***	0.24 ***
$\hat{\alpha}$	0.86	0.60	0.62	0.38	0.38	0.35	0.30
$\hat{\tau}_j$	2.44	1.91	61.51 ***	50.55 ***	53.98 ***	6.96 ***	36.6 ***
$Wald_{coint.}$							4.52 **
CD test	14.3 ***	12.25 ***	35.41 ***	26 ***	8.84 ***	0.33	-0.1
avg ρ	0.11	0.09	0.27	0.19	0.05	0.00	-0.01
avg |ρ|	0.18	0.17	0.39	0.23	0.16	0.16	0.15
RMSE	0.0412	0.0397			0.0326	0.0342	0.0275
F / Wald	12.89 ***	21.66 ***		240.11 ***	161.51		151.64 ***
R^2	0.150	0.166				0.467	
$R^2_{adj.}$	0.147	0.163				0.377	
Log Likelihood			3329.19				
Test of parameter constancy				615.62 ***			
N	1491	1491	1491	1491	1491	1491	1491
Countries	30	30	30	30	30	30	30

Notes: The constants terms are included but not reported. POLS stands for Pooled Ordinary Least Squares, DFE for Dynamic Fixed Effects, PMG for Pooled Mean Group, RCM for Random Coefficients Model, MG for mean group estimates while CCEP and CCEMG denote the Common Correlated Effects Pooled estimates and Mean Group, respectively. $\hat{\tau}_j = (\hat{\tau}_{1,j}, \hat{\tau}_{2,j})$. *Standard errors are given in parentheses. * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%.*

Table 4.6 - *Estimation for full-fledged IT (sample 1950-2007)*

Variables	1950-2007 Estimators POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0021	-0.0169	-0.0130	-0.0220	-0.0257	-0.0915	-0.1126
	(0.0014)	(0.0048) ***	(0.0033) ***	(0.0077) ***	(0.0061) ***	(0.0143) ***	(0.0219) ***
$\ln kinv_{i,t-1}$	0.0135	0.0280	0.0237	0.0155	0.0192	0.0486	0.0471
	(0.0044) ***	(0.0066) ***	(0.0065) ***	(0.0111)	(0.0107) *	(0.0075) ***	(0.0148) ***
$IT\ full_{i,t-1}$	0.0073	0.0157	0.0096	0.0133	0.0112	0.0085	0.0078
	(0.0038) *	(0.0048) ***	(0.0028) ***	(0.0056) **	(0.0024) ***	(0.0030) ***	(0.0036) **
$\Delta\ln y_{i,t-1}$	0.0990	0.0351	0.1340	0.1193	0.1050	-0.0344	0.0177
	(0.1096)	(0.1123)	(0.0339) ***	(0.0341) ***	(0.0353) ***	(0.0439)	(0.0321)
$\Delta\ln kinv_{i,t}$	0.1340	0.1381	0.1728	0.1730	0.1846	0.1528	0.1760
	(0.0199) ***	(0.0194) ***	(0.0195) ***	(0.0163) ***	(0.0169) ***	(0.0151) ***	(0.0207) ***
$\hat{\beta}_i$	6.37	1.66 ***	1.82 ***	0.19	0.94 *	0.53 ***	0.79 ***
$\hat{\theta}_i$	3.42	0.93 ***	0.74 ***	0.49 ***	0.06	0.09 **	0.39 *
$\hat{\alpha}$	0.86	0.62	0.65	0.16	0.48	0.35	0.44
$\hat{\tau}_j$	0.864316 ***	2	60.01 ***	52.31 ***	54.63 ***	6.36 **	25.73 ***
Wald $_{coint.}$							6.13 **
CD test	14.25 ***	12.69 ***	31.29 ***	24.45 ***	9.27 ***	0.2	-0.37
avg ρ	0.11	0.10	0.24	0.17	0.06	0.00	-0.01
avg $\lvert\rho\rvert$	0.18	0.18	0.38	0.22	0.16	0.16	0.15
RMSE	0.0413	0.0398			0.0332	0.0344	0.0275
F / Wald	12.61 ***	19.47 ***		166.52 ***	170.18 ***		113.59 ***
R^2	0.148	0.160				0.463	
$R^2_{adj.}$	0.145	0.157				0.372	
Log Likelihood			3326.65				
Test of parameter constancy				601.58 ***			
N	1491	1491	1491	1491	1491	1491	1491
Countries	30	30	30	30	30	30	30

Notes: The constants terms are included but not reported. POLS stands for Pooled Ordinary Least Squares, DFE for Dynamic Fixed Effects, PMG for Pooled Mean Group, RCM for Random Coefficients Model, MG for mean group estimates while CCEP and CCEMG denote the Common Correlated Effects Pooled estimates and Mean Group, respectively. $\hat{\tau}_j = (\hat{\tau}_{1,j}, \hat{\tau}_{2,j})$. *Standard errors are given in parentheses. * Indicate the significance level of 10%, ** the significance level of 5% and *** the significance level of 1%.*

Since there is not a consensus on the best size of the sample for capturing the long-term effect in an environment of panel data that also considers the relation among the relation of the countries, we understand that there are advantages and disadvantages using more extensive data sets. On way of reducing the trade-off, and thus applied for us, is the use of samples with different sizes.

In spite of the difference of magnitude among the estimators, the findings denote that the effect of the adoption of IT (interpreted here as an institutional change in the North's sense) on output is relevant even in the case of the smallest sample. In brief, the models confirmed the permanent changes in the output per capita determined by changes in the level of investment through a cointegrating relationship as considered in the Solow model.

Furthermore, we also make the estimation of all models with inclusion of deterministic trends embedded in the coefficients. The results are equally favorable to the adoption of IT and the coefficients are significant for a wide range of estimators and specifications tested (see Table A.4.5 - appendix).

Finally yet importantly, the use of different dates of adoption presents results that are convergent regarding the impact of IT on economic growth and its accumulated effect in the long-term.

4.4. Concluding observations

The increasing number of countries that adopted IT and the growing experience of the same over the years create conditions for robust empirical evidence. In light of different methods of analysis of macroeconomic data, we are here looking forward to finding an answer to the following question: for those countries which adopted the set of rules and behaviors characterizing IT was there any change regarding output and economic growth? To this end, we make use of several models of data generating process, which allow dealing the heterogeneity and inter-relationship among the countries, has the ability to capture the effects of long term and to explain the short-run dynamics and adjustment.[76]

The results are favorable to the presence of a structural change to the countries that adopted IT. In a general way, in the equilibrium, average long-term output is greater due to an accumulation of higher economic growth rates in the short term. Thus, viewed as a whole, IT has provided an increase in the output and economic growth of the countries that have adopted it. Thus, the criticism about the possibility that such a conduct of monetary policy is focused on controlling inflation even at the cost of the output is not confirmed in practice. It is noteworthy that this result was obtained without considering the recession faced by countries in recent years due to the subprime crisis. Hence, a natural extension of this study should

[76] One advantage of this methodology over the other is the possibility of a joint analysis of the effect of this monetary policy regime, without the need for *ad hoc* segmentation of countries (developed and developing countries, for example).

verify if during the financial crisis the ITers had a different performance in comparison with countries under alternative monetary regimes.

4.5. Appendix

Table A.4.1 - *Dates of IT adoption*

Countries	*soft IT*	*full IT*	Countries	*soft IT*	*full IT*
Armenia	2006	2007	New Zealand	1990	1990
Australia	1993	1994	Norway	2001	2001
Brazil	1999	1999	Peru	1994	2002
Canada	1991	1994	Philippines	2002	2002
Chile	1991	2000	Poland	1999	1999
Colombia	2000	2000	Rep. of Korea	1998	2001
Czech Republic	1998	1998	Romania	2005	2006
Finland	1993	1995	Slovakia	2005	2005
Ghana	2003	2007	South Africa	2000	2000
Guatemala	2005	2006	Spain	1995	1995
Hungary	2001	2001	Sweden	1993	1995
Iceland	2001	2001	Switzerland	2000	2000
Indonesia	2005	2006	Thailand	2000	2000
Israel	1992	1997	Turkey	2002	2006
Mexico	1995	2001	United Kingdom	1993	1993

Notes: The dates of IT adoption are based on Chapter 2 and Hammond (2012). Finland and Spain have left IT to join the European Monetary Union (EMU) in 1999.

Table A.4.2 - *CD test on series*

Samples	1970-2007				1960-2007				1950-2007			
Variable	CD-test	p-value	avg ρ	avg $\lvert\rho\rvert$	CD-test	p-value	avg ρ	avg $\lvert\rho\rvert$	CD-test	p-value	avg ρ	avg $\lvert\rho\rvert$
$\ln y_{i,t}$	91.75	0.00	0.769	0.775	112.70	0.00	0.858	0.858	124.18	0.00	0.889	0.889
$\ln kinv_{i,t}$	11.83	0.00	0.104	0.314	11.25	0.00	0.094	0.300	11.13	0.00	0.088	0.309
$soft\ IT_{i,t}$	75.48	0.00	0.587	0.614	87.40	0.00	0.605	0.625	97.76	0.00	0.615	0.631
$full\ IT_{i,t}$	71.90	0.00	0.559	0.586	82.79	0.00	0.573	0.593	92.33	0.00	0.581	0.598
	Observations (average):			37.34	Observations (average):			46.11	Observations (average):			54.09
$\Delta\ln y_{i,t}$	19.82	0.00	0.169	0.227	20.76	0.00	0.164	0.222	19.05	0.00	0.147	0.212
$\Delta\ln kinv_{i,t}$	10.73	0.00	0.090	0.177	10.08	0.00	0.079	0.165	10.72	0.00	0.079	0.158
$\Delta\ soft\ IT_{i,t}$	3.81	0.00	0.030	0.087	4.96	0.00	0.034	0.082	5.94	0.00	0.037	0.079
$\Delta\ full\ IT_{i,t}$	5.96	0.00	0.046	0.103	7.36	0.00	0.051	0.098	8.57	0.00	0.054	0.095
	Observations (average):			37.18	Observations (average):			45.89	Observations (average):			53.57

Notes: Under the null hypothesis of cross-section independence CD $\sim N(0,1)$.

Table A.4.3 - *CIPS – Unit root tests for panel data*

Samples		1970-2007		1960-2007		1950-2007	
		Z_{test}		Z_{test}		Z_{test}	
Variable	Lags	Constant	Const.Trend	Constant	Const.Trend	Constant	Const.Trend
$\ln y_{i,t}$	0	1.71	2.43	0.59	1.64	0.90	1.87
	1	-0.55	-1.00	-0.52	-1.20	0.44	0.34
	2	0.94	1.20	0.71	0.50	0.15	0.08
	3	0.25	1.03	0.74	0.29	0.42	0.67
	4	1.95	2.54	2.01	1.53	2.01	1.80
$\ln kinv_{i,t}$	0	-2.57 ***	-1.18	-3.78 ***	-2.08 **	-4.03 ***	-3.20 ***
	1	-2.26 **	-0.97	-3.14 ***	-1.19	-2.94 ***	-1.50 *
	2	-1.52 *	-0.51	-2.14 **	-0.08	-1.50 *	0.47
	3	-0.96	0.31	-1.63 *	0.93	-0.89	2.09
	4	-0.02	1.45	-1.80 **	0.94	-0.63	2.71
$\Delta\ln y_{i,t}$	0	-15.44 ***	-13.79 ***	-18.56 ***	-16.82 ***	-21.44 ***	-19.89 ***
	1	-10.63 ***	-8.76 ***	-13.39 ***	-11.13 ***	-15.97 ***	-14.26 ***
	2	-6.87 ***	-5.42 ***	-9.02 ***	-7.15 ***	-11.32 ***	-9.90 ***
	3	-4.09 ***	-1.93 **	-5.81 ***	-3.49 ***	-7.55 ***	-5.26 ***
	4	-2.68 ***	-0.57	-4.12 ***	-2.12 **	-5.49 ***	-3.30 ***
$\Delta\ln kinv_{i,t}$	0	-20.18 ***	-18.53 ***	-22.97 ***	-21.63 ***	-24.40 ***	-23.51 ***
	1	-13.12 ***	-10.78 ***	-16.98 ***	-14.81 ***	-19.74 ***	-17.91 ***
	2	-8.53 ***	-6.30 ***	-11.69 ***	-9.65 ***	-14.71 ***	-12.72 ***
	3	-5.07 ***	-2.72 ***	-7.46 ***	-5.41 ***	-9.68 ***	-7.59 ***
	4	-2.01 **	1.15	-3.59 ***	-1.28	-5.36 ***	-3.03 ***

Notes: Z_{test} is the inverse normal test. Symbols denote *10%, **5%, ***1% rejections.

Table A.4.4 - *CIPS – Unit root tests for panel data*

Samples		1970-2007		1960-2007		1950-2007	
		χ^2_{test}		χ^2_{test}		χ^2_{test}	
Variable	Lags	Constant	Const.Trend	Constant	Const.Trend	Constant	Const.Trend
IT soft							
	0	276.06 ***	182.20 ***	294.20 ***	198.25 ***	305.61 ***	200.95 ***
	1	292.65 ***	194.93 ***	283.40 ***	187.96 ***	362.62 ***	244.13 ***
$v_{i,t}$	2	212.56 ***	131.47 ***	245.26 ***	160.38 ***	280.05 ***	183.48 ***
	3	191.34 ***	129.66 ***	193.89 ***	130.37 ***	222.98 ***	149.65 ***
	4	137.28 ***	94.37 ***	176.48 ***	118.15 ***	184.84 ***	118.74 ***
IT full							
	0	276.21 ***	188.37 ***	299.52 ***	206.89 ***	310.04 ***	209.44 ***
	1	273.71 ***	191.06 ***	260.04 ***	176.75 ***	340.92 ***	234.31 ***
$v_{i,t}$	2	182.49 ***	109.38 ***	219.70 ***	139.22 ***	263.67 ***	170.23 ***
	3	162.15 ***	105.20 ***	173.06 ***	111.04 ***	204.65 ***	132.11 ***
	4	112.12 ***	74.51 *	146.00 ***	93.02 ***	167.74 ***	104.61 ***

Notes: χ^2_{test} is the chi-squared test. Symbols denote *10%, **5%, ***1% rejections.

Table A.4.5 - *General results for estimation with inclusion of non-constant time effects*

Soft IT, 1970-2007

Variable	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0028*	-0.0444***	-0.0734***	-0.1797***	-0.2068***	-0.1369***	-0.3299***
$\ln kinv_{i,t-1}$	0.0130***	0.0267***	0.0340***	0.0617***	0.0677***	0.0747***	0.1092***
$soft\ IT_{i,t-1}$	0.0101**	0.0154***	0.0152***	0.0154***	0.0141**	0.0102***	0.0041
$\Delta\ln y_{i,t-1}$	0.3238***	0.2533***	0.1934***	0.1807***	0.1813***	0.0910**	0.1050**
$\Delta\ln kinv_{i,t}$	0.1602***	0.1590***	0.1836***	0.1932***	0.1949***	0.1740***	0.1964***
trend	-0.0002	0.0004	0.0069***	0.0041**	0.0031***	0.0007	-0.0002
Number of group-specific trends significant at 5% level					11		6
Share of group-specific trends significant at 5% level					37%		20%

Full IT, 1970-2007

Variable	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0028*	-0.0458***	-0.0744***	-0.1878***	-0.2101***	-0.1458***	-0.3498***
$\ln kinv_{i,t-1}$	0.0133***	0.0294***	0.0347***	0.0625***	0.0691***	0.0733***	0.1133***
$full\ IT_{i,t-1}$	0.0084*	0.0125***	0.0168***	0.0113**	0.0101**	0.0100**	0.0117***
$\Delta\ln y_{i,t-1}$	0.3264***	0.2572***	0.1922***	0.1894***	0.1870***	0.0897**	0.1076**
$\Delta\ln kinv_{i,t}$	0.1613***	0.1616***	0.1884***	0.1951***	0.1991***	0.1728***	0.1952***
trend	-0.0001	0.0006**	0.0072***	0.0047**	0.0034***	0.0008	0.0001
Number of group-specific trends significant at 5% level					12		7
Share of group-specific trends significant at 5% level					40%		23%

Soft IT, 1960-2007

Variable	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0023	-0.0403***	-0.0442***	-0.1238***	-0.1363***	-0.1394***	-0.1832***
$\ln kinv_{i,t-1}$	0.0159***	0.0391***	0.0221***	0.0473***	0.0474***	0.0687***	0.0520***
$soft\ IT_{i,t-1}$	0.0140**	0.0161***	0.0038**	0.0156***	0.0130**	0.0085***	0.0064
$\Delta\ln y_{i,t-1}$	0.1199	0.0498	0.1685***	0.1392***	0.1439***	-0.0149	0.0722*
$\Delta\ln kinv_{i,t}$	0.1332***	0.1367***	0.1657***	0.1799***	0.1927***	0.1567***	0.1737***
trend	-0.0003*	0.0004**	0.0085***	0.0031*	0.0021***	0.0011**	0.0008
Number of group-specific trends significant at 5% level					7		4
Share of group-specific trends significant at 5% level					23%		14%

Full IT, 1960-2007

Variable	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0023	-0.0422***	-0.0435***	-0.1305***	-0.1381***	-0.1245***	-0.1813***
$\ln kinv_{i,t-1}$	0.0162***	0.0406***	0.0221***	0.0477***	0.0493***	0.0617***	0.0478***
$full\ IT_{i,t-1}$	0.0118**	0.0132***	0.0028**	0.0102**	0.0067**	0.0081*	0.0056
$\Delta\ln y_{i,t-1}$	0.1226	0.0540	0.1695***	0.1454***	0.1456***	-0.0212	0.0659
$\Delta\ln kinv_{i,t}$	0.1345***	0.1386***	0.1669***	0.1815***	0.1963***	0.1560***	0.1740***
trend	-0.0002	0.0006**	0.0089***	0.0037**	0.0021***	0.0009*	0.0000
Number of group-specific trends significant at 5% level					8		4
Share of group-specific trends significant at 5% level					27%		14%

Soft IT, 1950-2007

Variable	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0018	-0.0349***	-0.0426***	-0.1049***	-0.1108***	-0.1274***	-0.1917***
$\ln kinv_{i,t-1}$	0.0136***	0.0354***	0.0208***	0.0405***	0.0450***	0.0588***	0.0559***
$soft\ IT_{i,t-1}$	0.0115**	0.0131***	0.01223***	0.0143***	0.0157***	0.0096**	0.0073
$\Delta\ln y_{i,t-1}$	0.0950	0.0371	0.1596***	0.1241***	0.1254***	-0.0205	0.0550
$\Delta\ln kinv_{i,t}$	0.1333***	0.1376***	0.1634***	0.1778***	0.1811***	0.1533***	0.1731***
trend	-0.0002	0.0005***	0.0097***	0.0029**	0.0015***	0.0021***	0.0019**
Number of group-specific trends significant at 5% level					7		6
Share of group-specific trends significant at 5% level					23%		20%

Full IT, 1950-2007

Variable	POLS	DFE	PMG	RCM	MG	CCEP	CCEMG
$\ln y_{i,t-1}$	-0.0018	-0.0365***	-0.0387 ***	-0.1090***	-0.1050***	-0.1129***	-0.1764***
$\ln kinv_{i,t-1}$	0.0137***	0.0363***	0.0196***	0.0406***	0.0459***	0.0529***	0.0498***
$full\ IT_{i,t-1}$	0.0096*	0.0103**	0.0118***	0.0091*	0.0077**	0.0078**	0.0062
$\Delta\ln y_{i,t-1}$	0.0968	0.0404	0.1554***	0.1318***	0.1237***	-0.0272	0.0429
$\Delta\ln kinv_{i,t}$	0.1342***	0.1389***	0.1660***	0.1792***	0.1875***	0.1527***	0.1701***
trend	-0.0001	0.0006***	0.0094***	0.0034*	0.0016***	0.0017***	0.0013*
Number of group-specific trends significant at 5% level					7		5
Share of group-specific trends significant at 5% level					23%		17%

Conclusions

Walsh (2009) states: "the first lesson from the IT experience is that *inflation targeting is feasible and sustainable*" (p. 198, italics in original). In practice, no country has abandoned IT after adopting it (except Finland and Spain to join the Euro Area). In fact, the success and resilience of this framework are credited to its flexibility and its improvements concerning monetary policy credibility and institutional features.

In terms of its key aims - reduce and control inflation and inflation volatility - while monetary policy outcomes among both ITers and non-ITers developed economies have been similar, IT has enhanced monetary performance among developing economies. The evidences indicate that ITers are successful in meeting their goals by anchoring the public's beliefs about future inflation, and inflation expectations appear to be better anchored for ITers.

Under this view, credibility and reputation are essentials to successful IT. This belief has motivated ITers to undertake ongoing efforts to upgrade these two features of their policy regime. The findings denote that the traditional credibility indices and the based on reputation confirm the hypothesis that higher credibility implies lower variations in the interest rate for controlling inflation. Furthermore, the outcomes suggest that the adoption of IT is an ideal monetary regime for developing economies and, in addition to reducing inflation volatility, can drive inflation down to internationally acceptable levels. Regarding advanced economies, the adoption of IT does not appear to represent an advantageous strategy. In a few words, the overall empirical results indicate that the adoption of IT is useful for countries that must improve their credibility for the management of monetary policy.

Notwithstanding the IT sustainability, has it make a difference for economic growth? Most monetary authorities have thus far sided with the skeptical view on monetary policy impact on economic growth. As Friedman (1968, 1977) and Phelps (1968) noted, a higher rate of inflation does not lead to permanently higher economic growth and lower unemployment. In addition, there has been an increasing recognition of the benefits of low and stable inflation as a social good. Hence, the best option to a monetary authority is to focus on price stability.

The lasted international financial crisis exposed that some assumptions underlying the consensus about monetary policy strategy were no longer tenable, requiring further studies. Thereby, the discussion on the collateral effects of IT has received new stimulus after the crisis. Critics of this regime cite low economic growth as harmful. The empirical evidences on the links between IT and output growth performance supports the view that this monetary regime is associated with an improvement in real economic growth. In short, the findings denote that the adoption of IT implies gains in economic growth, or at least, it does not cause a sluggish economic growth. It is true that in the disinflationary periods the output could be below the normal level. Nevertheless, once low inflation is achieved the economic growth should return to the previous level or else promote economic growth higher than before. Therefore, the criticism about the conduct of monetary policy be focused on controlling inflation even at the cost of the output is not confirmed in practice.

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