INFLATION TARGETING WORKS WELL IN LATIN AMERICA

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ABSTRACT:

This paper analyses the extent to which inflation targeting (IT) has improved macroeconomic performance in a group of Latin American countries during the period 2000-2007. We apply statistical tests with data from eighteen Latin American countries, and show that the five inflation targeters obtained both better short-term macroeconomic results and higher medium-term economic growth than the other countries in the sample.

Key Words: Monetary policy, Inflation Targeting, Exchange-rate systems, Economic growth.

JEL Classification*:* E52, F21, F33.

1. Introduction

Over the past fifteen years, an increasing number of emerging market economies (EMEs) have adopted and implemented inflation targeting (IT), as a framework for policymaking, combined with flexibility in the exchange rate[1]. According to IMF (2006), some sixteen emerging market economies were Inflation Targeters (ITers) in 2006, with five Latin American countries leading the move. Chile and Colombia had pursued some looser form of IT since the early 1990s, and Peru and Mexico did so since mid 1990s. The five ITers adopted a full-fledged IT between 1999 and 2002.

It is well known that in such regimes price stability is the primary objective of monetary policy, and the central bank is responsible for achieving a publicly announced target for the inflation rate. Since the choice of the monetary regime is important for both the effectiveness of stabilisation policies and longer run growth effects, it is justified to investigate the extent to which the shift toward the new regime has improved the economic performance of emerging market economies.

While there have been numerous studies of IT in industrial countries, the analysis referred to emerging market economies are much less abundant. One reason is that EMEs, many of which adopted complete IT in the very late 1990s or in the beginning of the 2000s, have shorter statistical records. The available studies for EMEs may be classified in two broad groups. The first one compares economic results of inflation targeters, before and after adopting inflation targeting, with the performance of countries that did not adopt this regime. The results are not totally conclusive. In fact, some authors do not find significant benefits in EMEs from adopting IT. For instance, Bernanke et al. (1999) obtained that IT does not make a difference in cost and speed of price stabilisation compared to alternative regimes. Cecchetti and Ehrmann (2002) found that countries under IT do not exhibit higher inflation aversion than countries under alternative monetary policy frameworks. Mishkin and Schmidt-Hebbel (2002) recognised positive macroeconomic effects in EMEs that adopted IT, but they emphasize that this positive influence owes more to some structural features of these countries than to the assumed virtues of the IT regime.

Mello and Moccero (2007) focussed on Latin American countries and found mixed results. Their analysis show that IT is associated with quicker reactions by monetary authorities to changes in expected inflation in Brazil and Chile, while in Colombia and Mexico monetary policy has become less counter-cyclical. They also obtained that the effects of IT on both interest rate and output volatility are unclear in all countries. The finding of McDermott and

[1] The volume edited by Bernanke and Woodford (2005) explores many dimensions of IT for both developed and emerging market economies.

McMenamin (2008), also referred to Latin American countries, indicate that although the central banks have probably been more aggressive in responding to inflation in countries with IT than in countries that do not adopt this regime, this has not resulted in lower inflation expectations in the ITers of the area.

In contrast to the previous results, there is a set of contributions suggesting that IT has been associated with improved macroeconomic performance in EMEs. Thus, Calderón and Schmidt-Hebbel (2003a), (2003b) showed that IT countries have been able to reduce both inflation rates and inflation-target misses systematically after adopting the new monetary regime in a group of Latin America and Caribean countries. Corbo, Landerrechte and Schmidt-Hebbel (2002) discovered that IT did contribute to improve macroeconomic results in a large sample of industrial and developing countries. Finally, Batini and Laxton (2005), IMF (2005) and IMF (2006) showed that IT in EMEs brings significant benefits to the countries that adopt it compared to those that follow other strategies, such as money or exchange rate targeting. Furthermore, the latter studies demonstrate that, since IT is linked to an improvement in macroeconomic performance, it also brings about lower risk of currency crises relative to other alternative regimes.

The second group of empirical studies focuses on the implications of some specific features of the IT regime. Céspedes and Soto (2005), for example, investigate the influence of different degrees of credibility on the trade-off between output and inflation in IT countries, and apply their theoretical analysis to the Chilean experience during the nineties. Gallego and Jones (2005) analyse the extent to which "fear of floating" is an optimal policy choice in emerging market economies that adopt IT. Libanio (2005) examines the pro-cyclical and asymmetric nature of monetary policy in three IT Latin American countries (Brazil, Chile and Mexico) and derives some implications for economic stabilisation and growth in these economies. Finally, Leiderman et al. (2006) study the extent to which IT may be a successful strategy in highly financial dollarised economies.

The very bulk of available studies on the effects of IT – in both industrial countries and EMEs – focus on inflation, financial variables and vulnerability to crisis. To date, the effects of IT on real variables have been only marginally considered. Typically, the results related to real variables are presented as general theoretical statements applied to developed countries, and conclusions drastically differ depending on the strand of thought. On the one hand, proponents of inflation targeting argue that, by anchoring expectations and enforcing credibility, this policy regime reduces variability in the output gap (King 2005) and lowers the sacrifice-ratio. In addition, these authors consider that, since IT improves the overall economic conditions, it also sets the basis for higher economic growth. For example, using simulations of a macroeconomic model that embeds flexible IT, Apergis et al (2005) show that IT may increase

overall growth performance in the European Union. On the other hand, detractors of the IT framework emphasize that the aggressive responses of the central banks to curb inflationary pressures could temporarily reduce output. In fact, when the central bank is obliged to hit the target very restrictively, IT can unnecessarily restrain growth (Blanchard 2005). However, no formal analysis has been presented to elucidate relationships between adoption of IT and economic growth in EMEs, and rigorous empirical tests to back these propositions are also lacking in the literature.

In this paper we fill this gap and investigate empirically the effects of IT on a set of relevant macroeconomic variables that includes economic growth of the five Latin American countries that are currently conducting their monetary policy under the IT framework. As a basis for comparison, we take another group of LA countries that have not adopted this monetary policy regime. Latin America provides, indeed, an interesting case study for assessing the effects of IT on emerging market economies for several reasons. First, they have pursued a number of stabilisation strategies since the early 1990s, under very different monetary and exchange rate regimes. Second, the five Latin American ITers have been the forerunners of IT in the worldwide group of emerging market economies.

Since IT is a qualitative variable that can not be adequately proxied by time series indicators, we apply the two-step model suggested by Heckman (1979), Maddala (1983) and Greene (2003) to assess the effects of IT on economic growth. The method consists of estimating two equations: a treatment equation (probit) in a first stage and an outcome equation in a second stage.

An additional novelty of this paper is that we apply statistical tests – not applied so far in this strand of literature – to analyse the macroeconomic stabilisation properties of IT, which allows us to grasp more accurately the links between IT and economic conditions. As an advance of our main results, we obtain that IT in the countries of our sample is associated with improvements in macroeconomic stability and reductions in the volatility of domestic output. The effects of IT on medium-term economic growth is not clear in various tests that we apply here, but our treatment effects analysis, intended to capture the impact of qualitative analysis on GDP growth, reveals that IT also contributes to increase overall growth in the IT countries of our sample.

The rest of the paper is organised as follows. In Section 2 we present a descriptive analysis. In section 3 we perform a battery of statistical and econometric tests to assess the effects of IT on the most important macroeconomic variables including economic growth. Finally, section 4 summarises the main theoretical and empirical results.

2. Descriptive analysis

In this section we apply descriptive calculus to get a first impression on the likely macroeconomic effects of the adoption of IT in five Latin American countries (Brazil, Chile, Colombia, Mexico and Peru). The general methodology is as follows: a) for each ITer, we compare the results referred to some relevant macroeconomic variables during the pre-IT era with those of the post-IT period of the same country, and b) we liken the results – referred to the same set of variables – that each group of countries (ITers and NTIers) obtained during the post-IT period of the first group. The group of NTers selected as a benchmark comprises 13 countries: Argentina, Bolivia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Uruguay and Venezuela. The two groups of countries are Latin American with the aim of comparing areas that share not only analogous geographical context, but also similar degrees of economic development.

TABLE 1: Exchange rate regimes in Latin America

	1985	2002	2007
Countries IT	Exchange rate regimes		
Brazil	Intermediate	Flotation	Flotation (IF)*
Chile	Intermediate	Flotation	Flotation (IF)*
Colombia	Intermediate	Flotation	Flotation (MF)*
Mexico	Intermediate	Flotation	Flotation (IF)*
Peru	Intermediate	Flotation	Flotation (MF)*
Countries NIT	Exchange rate regimes		
Argentina	Intermediate	Flotation	Flotation (MF)
Bolivia	Flotation	Intermediate	Intermediate (CP)
Costa Rica	Intermediate	Intermediate	Intermediate (CP)
Dominican Rep.	Intermediate	Intermediate	Flotation (MF)
Ecuador	Intermediate	Rigid peg	Rigid peg (NS)
El Salvador	Intermediate	Rigid peg	Rigid peg (NS)
Guatemala	Intermediate	Flotation	Flotation (MF)
Honduras	Flotation	Intermediate	Intermediate (CB)
Nicaragua	Intermediate	Intermediate	Intermediate (CP)
Panama	Rigid peg	Rigid peg	Rigid peg (NS)
Paraguay	Intermediate	Flotation	Flotation (MF)
Uruguay	Flotation	Flotation	Flotation (MF)
Venezuela	Intermediate	Flotation	Rigid peg (CS)

1/ Source: Berg, Borensztein and Mauro (2002, p.25) and own elaboration.
2/ CP: *Crawling peg.* CB: *Rates within crawling bands.* IF: *Independently floating.*
MF: *Managed float with no pre-announced exchange rate path.* NS: *No separate legal tender. CF: convencional fixed peg.*

As a previous step it is convenient to describe the exchange rate regimes in force in the countries of the sample over the whole period of analysis. The 18 selected countries offer not only a variety of different exchange rate regimes, but also a number of very different monetary and institutional arrangements. Table 1 reports the exchange rate regimes declared by these

countries to the IMF, in three different years: 1985, 2002 and 2007. As can be seen, the general tendency is a switch from intermediate regimes toward corner solutions: while in 1985 intermediate arrangements represented 14 over the total of 18 exchange rate regimes, in 2007 the share fell down to 4/18. According to the empirical study of Calderón and Schmidt-Hebbel (2003b), the structural break took place in 1998, immediately after the Asian crisis.

Among the 10 currently floaters in 2007, three of them operate independent and free flexibility in the exchange rate and the other seven exhibit managed floats with no pre-announced exchange rate path. The three central banks with independent floating belong to the IT group, and do not recognize systematic interventions to dampen the fluctuations of their exchange rate.

2.1. Inflation targeting in Latin America

Five Latin American countries have adopted so far inflation targeting strategies with more o less intensity. Mishkin and Savastano (2002) present a detailed analysis of the characteristics of these regimes up to 2001. Table 2 updates, for the five countries, the main features to 2007. Starting dates within parenthesis indicate the moment at which the central bank begun the publication of inflation reports.

TABLE 2: Inflation targeting regimes of individual countries

Country	Starting date and main features
Brazil	**Starting date:** June 1999, (September 1999). **Inflation targets:** 8% ± 2% (1999), 6% ± 2% (2000), 4% ± 2% (2006-2007). **Inflation Report and announcement of multi-year inflation targets.** **Weak fiscal position and relatively sound financial system.**
Chile	**Starting date:** January 1991, (May 2000). **Inflation targets:** 15-20% (1991), 3.5% (2000), 2-4% (2001-2007). **Inflation Report and announcement of multi-year targets.** **Strong fiscal position and sound financial system.**
Colombia	**Starting date:** January 1991, **(**January 1999). **Inflation targets:** 22% (1991), 10% (2000), 4.5% ± 0.5% (2006), 4% ± 0.5% (2007). **Inflation Report and announcement of multi-year targets.** **Strong fiscal position and sound financial system.**
Mexico	**Starting date:** January 1996, (April 2000). **Inflation targets:** 20.5% (1996), <10% (2000), 3% ± 1% (2003-2007). **Inflation Report and announcement of multi-year targets** **Strong fiscal position and relatively sound financial system at today.**
Peru	**Starting date:** January 1994, (June 2002). **Inflation targets:** 15-20% (1994), 3.5-4% (2000), 2.5% ± 1% (2002-2006), 2% ± 1% (2007). **Inflation Report and announcement of multi-year targets.** **Weak fiscal position, but relatively sound financial system.**

Chile is the first country (January 1991) that gave independence to its central bank and announced price stability as one of their primary objectives. As a result, the domestic inflation rate decreased gradually. However, it was only in 1999 when the central bank explicitly announced multi-year target for inflation. In May 2000 the central bank began to elaborate an *Inflation Report* in which it publishes its baseline inflation forecasts. Healthy public finances and a sound financial system are two key features of the Chilean economy that have supported a full-fledged inflation targeting regime in this country.

In 1999 Brazil started a monetary policy regime with all the key ingredients of an IT regime. The central bank published immediately a comprehensive Inflation Report. However, in order to assure the success of the IT scheme in Brazil, independence of the central bank needs to be enhanced and increased. Moreover, fiscal deficits must be brought back to levels that remove any possibility of fiscal dominance.

As of 1991 the central bank of Colombia started to announce explicit numerical targets for the one-year rate of inflation. The anti-inflationary strategy failed until 1999 because the central bank continued to give priority to other objectives, especially output stabilisation and external competitiveness, whenever these goals were threaten by the inflation target. Furthermore, the budget deficit was not sufficiently controlled until that year. The strategy changed positively since January 1999 when the central bank of Colombia published the Report of Inflation, Moreover in September 1999 the exchange rate began to float freely. The announcement of multi-year inflation targets since October 2000 has also contributed to the success of the new regime in the last years.

The central bank of Mexico waited until it acquired sufficient anti-inflationary credibility to put in place a full fledged IT regime. This occurred in January 1999, when the annual rate of inflation (12.3%) underscored the 13% target. In April 2000 the Mexican central bank started to publish its monthly Report on inflation.

The announcement of IT in 1994 initiated a period of anti-inflationary success in Peru. The inflation rate fell from levels over 20% in 1994 to 3% in 2001. However, the Peru's monetary authorities did not gain sufficient credibility during that period because their monetary framework lacked many crucial features of an IT regime. For instance, the announcement of multi-year inflation targets, publication of inflation reports and mechanisms for making the central bank accountable. In June 2002 these drawbacks were almost completely corrected, and the monetary policy started to fulfil the key elements of a true IT regime.

2.2. Macroeconomic performance

In order to get a first insight on the extent to which IT regime may have contributed to improve macroeconomic results in the incumbent five Latin American countries, we investigate the results in terms of inflation, interest rates of bank deposits and GDP growth. We apply descriptive calculus for both time series and cross-section variables of the two groups of countries.

2.2.1. Descriptive analysis of time series variables

We assembled a database of monthly data for the relatively long period going from 1981-1 to 2007-12 and computed annualised rates for three relevant variables: inflation, short-term interest rate (bank deposits of one year maturity) and GDP growth. For reasons of data availability, the rates of GDP growth were calculated using both annual and quarterly observations. The sample is split in two periods in each country, taking into account the starting date of the IT regime. The starting IT date is the moment at which the central bank begun to publish an inflation report. According to this, the five ITers started a complete IT regime between January 1999 and June 2002 (see Table 3)[2].

The details concerning the length of each sub-sample are presented in Table 3. The sample 1, corresponding to the period preceding IT, excludes the years of hyperinflation of each country, and the sample 2 comprises the period after the adoption of IT.

TABLE 3: Sub-samples for each country

Country	Sample1: before IT	Hyperinflation period	IT start	Sample 2: after IT
Brazil	1981:01-1999:08	1988:09-1991:02 1992:04-1995:01	1999:09	1999:09-2007:12
Chile	1981:01-2000:04		2000:05	2000:05-2007:12
Colombia	1981:01-1998:12		1999:01	1999:01-2007:12
Mexico	1981:01-2000:03		2000:04	2000:04-2007:12
Peru	1981:01-2002:05	1988:09-1991:07	2002:06	2002:06-2007:12

1/ Sample 1 comprises the years before the adoption of IT. Sample 2 comprises the years after the adoption of IT.
2/ *Sample 1 excludes the years of hyperinflation and exchange-rate crises.
3/ Se define la hiperinflación cuando la tasa de inflación anual es superior al 600%

Table 4 reports the average and standard deviation of the monthly rates of **inflation** computed over twelve months (annual basis) for each sub-sample and country. As far as level values are concerned, it is clearly apparent that the inflation rate decreased sharply from the first to the

[2] The assumption that the beginning of the full-fledged IT regimes took place after some initial attempts is also argued by other authors. The suggested starting dates are not coincident between authors but remain relatively close. Thus, according to Mishkin and Schmidt-Hebbel (2007), the *stationary target period* starts at some moment between January 2001 and January 2003, whereas Batini and Laxton (2006) consider that the date is between the second quarter of 1999 and the first quarter of 2002.

second sub-period in each country. Brazil reaped the best results even without taking into account the huge inflation numbers of his hyperinflation years. On average, the inflation rate fell in the second period down to 1/13 of the value achieved during the first sample.

As regards variability of the inflation rate, the third and forth columns of Table 5 illustrate reductions of similar order as those of the average in each country. The fall in the variability is especially pronounced in the countries with highest initial inflation levels. To sum up, the improvement in inflation is very remarkable in all countries, and has taken place in both levels and variability.

TABLE 4: Inflation (%)
(monthly observations)

	Average level inflation on annual basis		Standard deviation	
Country	Before-IT	After-IT	Before-IT	After-IT
Brazil	158.68	7.32	150.95	3.35
Chile	15.43	3.07	8.42	1.39
Colombia	23.32	6.93	4.34	2.26
Mexico	45.73	5.05	39.89	1.67
Peru	36.96	2.11	63.18	1.13
Average	56.02	4.29	53.36	1.53

Table 5 provides similar information as that of the preceding table but referred to the annualised **nominal interest rate** of bank deposits. As can be seen, both average levels and standard deviations also decrease substantially in each country. These changes contradict completely the results of Calvo and Reinhart (2002), according to which the "fear of floating" of most EMEs has impinged increased volatility to their internal interest rates. In fact, for the countries that we include in the empirical analysis, IT clearly contributes to easy the task of monetary policy and to reduce tensions in money and credit domestic markets. Consequently, it is not strange that IT creates a favourable environment for investment decisions, which in turn should contribute to increase economic growth in the medium and long term.

TABLE 5: Annualised interest rate of bank deposits (%)
(monthly observations)

	Average rate of interest		Standard deviation	
Country	Before-IT	After-IT	Before-IT	After-IT
Brazil	268.86	16.80	432.25	3.54
Chile	23.02	4.57	13.87	2.06
Colombia	31.16	10.19	4.35	4.82
Mexico	36.78	4.10	24.85	1.83
Peru	18.57	2.96	26.76	0.40
Average	86.81	10.36	100.42	3.40

Finally, Table 6 reports the same information for annualized **economic growth** computed with annual and quarterly observations of the real GDP. It seems that the adoption of an IT regime is accompanied by a generalized increase in growth –only Mexico presents a clear decrease– and a substantial reduction in the dispersion of this variable in each country except for Colombia and Mexico.

TABLE 6: GDP growth (%)
(Annual and quarterly observations)

	Average rate of GDP growth		Standard deviation	
Country	Before-IT	After-IT	Before-IT	After-IT
Brazil	2.00	3.49	3.61	1.76
	1.67	*3.09*	*1.78*	*1.49*
Chile	4.82	4.37	5.78	1.24
	3.80	*4.47*	*3.70*	*1.28*
Colombia	3.50	3.65	1.63	3.50
	2.70	*2.93*	*1.38*	*3.35*
Mexico	2.50	2.99	3.82	2.20
	5.45	*2.94*	*1.52*	*2.02*
Peru	1.56	5.06	6.98	2.74
	2.23	*6.08*	*2.74*	*1.65*
Average	2.88	3.91	4.36	2.29
	3.17	*3.90*	*2.22*	*1.96*

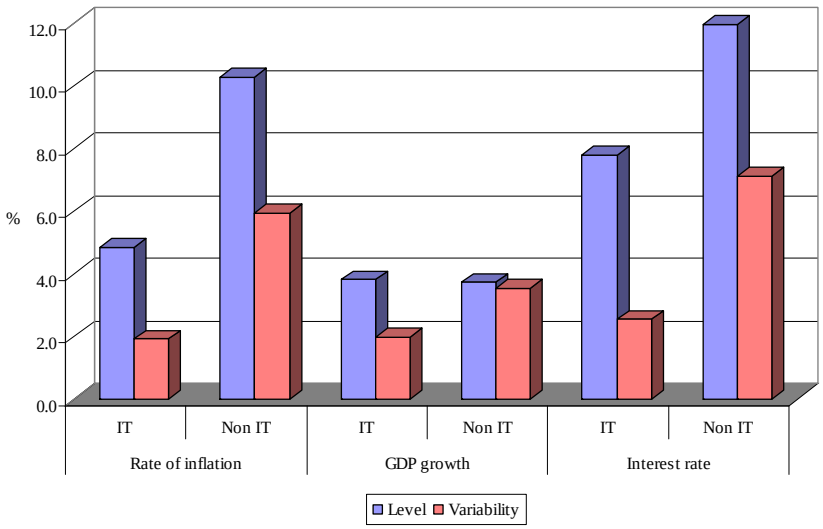
1/ Numbers in the upper part of cells are annual rates of GDP growth, with annual observation.
2/ Numbers in the lower part of cells (italics) are annual rates of GDP growth, with quarterly observations.

2.2.2. Descriptive analysis of cross-section variables

In order to get a more comprehensive understanding of the results derived from the adoption of the IT regime, it is useful to compare the macroeconomic performance of two groups of Latin American economies: countries with IT on the one hand, and countries without IT on the other hand. In the first group we include the five countries considered in the preceding section; the second group is composed of thirteen countries. Argentina, Bolivia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Uruguay and Venezuela. We compute cross-sectional monthly values (inflation and interest rate) and quarterly rates of change (GDP growth) for the period 2000:01-2007:12 and for the two groups of countries.

Figure 1 presents the results for three variables and the two groups of countries. As can be seen, the results support the conclusions of the preceding analysis based on time series variables: compared with countries that did not adopt IT regimes during the sample period, those that engineered IT frameworks with flexible exchange rates obtained: a) lower and less volatile rate of inflation, b) higher rates of GDP growth coupled with lower variability in this variable, and c) much lower levels and variability in short-term interest rates.

FIGURE 1: Average and variability of inflation, economic growth
and interest rates in IT and non-IT countries
2000:01–2007:12



3. Statistical and econometric analysis

3.1 Time series with dummy variable.

In this section we perform regressions with dummy variables to assess whether the levels and variabililty of thee macroeconomic variables (the rate of inflation, the interest rate and the rate of GDP growth) have significantly changed between the pre-IT and post-IT periods of the ITers.

We estimate the following equation:

$$x_{i,t} = \alpha_i + \delta_i F_{i,t} + \gamma_i x_{LAT,t} + \varepsilon_{i,t} \qquad (1)$$

Where $x_{i,t}$ is the variable under analysis of country *i* corresponding to period *t*, and $F_{i,t}$ is one dummy that takes the value 1 during the years where country *i* applies IT, and the value 0 during the rest of the sample. Parameter δ_i measures the effect of IT on variable $x_{i,t}$.

The variable $x_{LAT,t}$ stands for the average of $x_{i,t}$ of a large group of Latin American countries. It is included to avoid the biased estimations of parameter δ_i that arise when the variable $x_{i,t}$ converges towards a common mean in the sample of countries. For instance, if $x_{i,t}$ is the inflation rate of Chile, the observed reduction in the value of this variable between the pre and post IT periods could, in fact, be created by a general trend in the whole group of countries and not by the implementation of IT. The inclusion of $x_{LAT,t}$ allows the estimated δ_i measure the pure effect of IT on the rate of inflation. Ball and Sheridan (2004) perform a similar methodology to analyse the effects of IT in a group of industrialised countries. They add variables to control for regressions to the mean in the whole area, but do not conduct separate estimations for each country.

We first estimate equation (1) for the level and standard deviation of the rate of inflation. Inflation is measured by the annual rate of CPI variation, and its variability is approximated by its standard deviation. In order to unveil more accurately the incidence of IT on these variables, we perform regressions for three period samples that differ in the starting date. The first one starts in 1981:1, the second begins in 1992:1, and the third starts in 1996:4. If the instauration of IT significantly changes the evolution of the variables – in a similar way as a structural change – we would expect that the effects of IT will manifest stronger, and more statistically significant, for longer pre-IT sub-periods.

TABLE 7: Inflation rate

	Inflation rate					
	1981:01-2007:12		1992:01-2007:12		1996:04-2007:12	
Country	Level	Standard deviation	Level	Standard deviation	Level	Standard deviation
Brazil	-72.85	-29.88	41.98	6.25	5.71	-0.53
	(-6.05)*	(-4.12)*	(6.87)*	(3.14)*	(8.04)*	(-1.60)***
	0.55	0.07	0.85	0.97	0.45	0.21
	250	224	158	148	141	141
Chile	-8.12	-1.45	-3.44	-0.02	-0.91	0.11
	(-9.94)*	(-6.28)*	(-8.76)*	(-0.35)	(-2.70)*	(2.17)**
	0.50	0.31	0.66	0.37	0.42	0.02
	286	277	192	189	141	141
Colombia	-14.33	-0.55	-13.29	-0.30	-9.26	-0.08
	(-31.54)*	(-5.74)*	(-33.27)*	(-2.86)*	(-21.08)*	(-0.57)
	0.84	0.31	0.91	0.07	0.92	0.09
	286	277	192	189	141	141
Mexico	-34.15	-6.42	-18.44	-3.03	-8.30	-2.09
	(-7.34)*	(-8.50)*	(-16.10)*	(-7.52)*	(-13.50)*	(-8.19)*
	0.31	0.23	0.58	0.24	0.91	0.51
	286	277	192	189	141	141
Peru	-25.56	-6.07	-9.28	-0.78	-0.33	-0.07
	(-4.50)*	(-1.85)*	(-3.36)*	(-2.21)*	(-1.00)	(-1.03)
	0.54	0.14	0.35	0.38	0.76	0.01
	283	273	192	189	141	141

1/ Monthly data

2/ The first raw offers the estimated value of δ_i.

3/ The second row presents the *t*-statistics under the null hypothesis $H_0 : \delta_i = 0$. The significance levels are: 1%(*), 5%(**) and10%(***), respectively.

4/ The third and forth rows show the $\bar{R}^2$ statistics and the number of observations, respectively.

Table 7 reports the regression results for the inflation rate of each IT country. The first two columns offer the estimation of δ_i for both the level and the standard deviation, corresponding to the longest period sample: 1981:01-2007-12. According to the estimated values of these parameters and of their *t* statistics, IT has been very effective in reducing both inflation, and its variability, in each country. For instance, in the case of Chile, the values $\delta_{Chile} = -8.12$ and $\delta_{Chile} = -1.45$ mean that the inflation rate and its variability declined 8.12 and 1.45 percentage points in average, respectively, in the post-IT period compared with the pre-IT period. The *t* statistics (-9.94 and -6.28) allows us to clearly reject the null hypothesis of non-significance in each of these estimations. As expected, the effects of IT on both the level and variability of inflation, and their degree of significance, decrease as the period sample shortens. Furthermore, the sign of the estimated parameter of the inflation level becomes incorrect for Brazil in the two shorter periods.

To sum up, the regression results indicate that both the level and variability of inflation have clearly declined in each of the IT countries after the adoption of the IT regime.

TABLE 8: Interest rate and GDP growth

	Interest rate		GDP growth	
	1996:04-2007:12		1997:I-2007:IV	
Country	Level	Standard Deviation	Level	Standard deviation
Brazil	-5.63	-3.63	1.77	0.10
	(-5.49)*	(-9.32)*	(2.94)*	(0.43)
	0.58	0.47	0.43	0.24
	141	141	44	41
Chile	-6.34	-2.29	0.56	-1.26
	(-9.68)*	(-15.17)*	(0.81)	(-5.05)*
	0.63	0.66	0.40	0.46
	141	141	44	41
Colombia	-13.97	-1.04	2.28	-0.81
	(-14.38)*	(-3.13)*	(2.77)*	(-2.02)**
	0.82	0.17	0.65	0.09
	141	141	44	41
Mexico	-9.26	-2.38	-2.70	-0.05
	(-13.06)*	(-11.38)*	(-4.20)*	(-0.24)
	0.79	0.53	0.42	0.03
	141	141	44	41
Peru	-5.95	-0.30	2.78	-1.41
	(-15.35)*	(-4.83)*	(3.01)*	(-5.73)*
	0.82	0.35	0.45	0.44
	141	141	44	41

1/ Data are monthly for the interest rate and quarterly for the GDP growth.
2/ The first raw offers the estimated value of δ_i.
3/ The second row presents the *t*-statistics under the null hypothesis $H_0 : \delta_i = 0$.
The significance levels are: 1%(*), 5%(**) and10%(***), respectively.
4/ The third and forth rows show the $\bar{R}^2$ statistics and the number of observations, respectively.

Table 8 shows the results of the regressions of equation (1) for the annualised rate of interest of bank deposits and the GDP growth, respectively. For reasons of data availability, the sample for the interest rate is 1996:04-2007:12, and for the GDP growth it is 1997:I-2007:IV. As explained above, observations are monthly for the interest rate and quarterly for the GDP growth.

As far the results for the interest rates are concerned, we observe that both the level and variability of the nominal interest rate decreased in all cases very significantly after the adoption of IT. Regarding GDP growth, we also find that the effects are generally positive, especially in the reduction of variability. There are, however, some exceptions to the general rule: GDP growth decreases in Mexico, and it is not statistically significant in Chile. Variability of growth decreases in three countries, but the effects in Brazil and Mexico are not statistically significant.

3.2. Cross-section regressions and analysis of independence

In this section we analyse the macroeconomic effects of IT taking as a benchmark the results of different monetary policy strategies applied in the group of NITers. Among these countries, ten have applied some kind of exchange rate flexibility (Argentina, Bolivia, Costa Rica, Dominican Republic, Guatemala, Honduras, Nicaragua, Paraguay, Uruguay and Venezuela) and three have adopted hard pegs (Ecuador, El Salvador and Panama).

We perform two types of cross-section analysis: first, we estimate an equation that includes one dummy variable deemed to capture the differences in the macroeconomic results between ITers and NITers. Second, we do an independence analysis to ascertain whether the events a) adopting IT and b) the results exhibited by some macroeconomic variable, such as inflation, are not independent.

3.2.1. Cross-section regressions

Consider the following equation:

$$x_{i,t} = \alpha + \delta F_{i,t} + \varepsilon_{i,t} \qquad (2)$$

Where $x_{i,t}$ is the variable of interest. $F_{i,t}$ is a dummy variable, which takes the value 1 for data from IT countries, and the value 0 for data from NIT economies. The parameter δ measures the difference – in average – between the $x_{i,t}$ values of the two groups of countries.

We run regressions for the three variables of interest, the rate of inflation, the bank deposits interest rate, and the GDP growth, using monthly and quarterly data over the

period 2000:01–2007:12. The variables are defined and measured in the same way as in the preceding section. However, before presenting the results, one observation is in order: as it is well known, *inflation* and *interest rates* are crucially affected by the exchange rate regime in economies that have liberalised their trade and capital accounts. Under contexts of high mobility in assets and goods, fixed exchange rates invariably give rise to increased stability in both interest and inflation rates. For this reason, our analysis referred to these variables includes one sub-sample composed of the countries and/or years that have operated with some degree of flexibility in the exchange rate. Consequently, in the analysis corresponding to inflation and interest rates, we have dropped from the NITers the following countries: Ecuador, El Salvador and Panama and some years of Argentina (2000 and 2001) and Venezuela (2004-2007), during which these countries operated one currency board and one hard peg, respectively. The resulting group is denoted NITb.

Table 9 shows the results for all of the regressions. As can be seen the estimated value of δ is always statistically significant except for the level of GDP growth. The results referred to the rate of inflation (presented in the first two columns) indicate that the IT group obtained an average rate of inflation 4.86 pp lower than that of the NIT group. The IT group also improves the results concerning the variability of the inflation rate: the standard deviation decreases 1.48 pp with respect to the NIT countries. As regards the nominal interest rate (third and fourth columns), the improvements afforded by the IT regime are also evident in terms of both lower levels and decreased variability.

Finally, as far as GDP growth is concerned, it is apparent from columns fifth and sixth that IT contributes to clearly reduce growth variability, but its effects on the level of growth are not statistically significant.

TABLE 9: Cross section regressions

	2000:01–2007:12		2000:01–2007:12		2000:I–2007:IV	
	Inflation rate		Interest rate		GDP growth	
	Level	Standard deviation	Level	Standard deviation	Level	Standard deviation
	-4.86	-1.48	-3.61	-1.31		
IT	(-12.71)*	(-9.61)*	(-7.18)*	(-6.91)*		
NIT	0.11	0.06	0.04	0.03		
	1358	1358	1358	1358		
					0.09	-0.31
IT					(0.25)	(-3.18)*
NIThp					-0.01	0.02
					576	576

1/ The data for inflation and interest rates are monthly. The data for GDP growth is quarterly.
2/ The first raw offers the estimated value of δ_i .
3/ The numbers in parenthesis show the *t*-statistics under the null hypothesis $H_0 : \delta_i = 0$. The significance levels are: 1%(*), 5%(**) and10%(***), respectively.
4/ The third and forth rows show the $\bar{R}^2$ statistics and the number of panel observations, respectively.
5/ The NIT group includes: Argentina (period with exchange rate flexibility), Bolivia, Costa Rica, Dominican Republic, Guatemala, Honduras, Nicaragua, Paraguay, Uruguay and Venezuela (period with exchange rate flexibility). The NIThp comprises the NIT countries plus the three hard peggers: Ecuador, El Salvador and Panama.

3.2.2. Independence analysis

In this section we undertake an analysis of statistical independence to ascertain whether there is a relationship between the fact of adopting an IT regime and some economic results related to nominal variables such as the inflation rate, the domestic interest rate and the nominal exchange rate. We use the independence test χ^2 in the same way as it was applied by Edwards (2004) to analyse the independence between flexible exchange rates and current account crises. The composition of the NIT group was adapted in the analysis of these variables for the reasons explained in the preceding sub-section.

To undertake the test of independence between the event "adopting the IT regime" and another variable let say "low rate of inflation", we follow these steps: a) build the probability distribution of the random variable, b) compute the quartile 1 and the percentile 10 of the distribution of the variable, c) define the variable in a dichotomy way, d) tabulate the two-dimensional observations of the two events using a two-entry table, and finally, e) calculate the χ^2 statistics. If this statistics generates significantly low p-values, then we may reject the null hypothesis of independency between the incumbent variables.

i) Low inflation and IT

Here we test the following independence hypotheses:

H_0: "Low rate of inflation" is independent from "Adoption of IT".

H_1: "Low rate of inflation" is not independent from "Adoption of IT".

We build first the probability distribution of the variable *Inf* (rate of inflation) using the whole set of observations for the 15 countries along the indicated period sample; then we calculate the quartile 1 and the percentile 10, and define the variable "low rate of inflation" under two forms A and B:

$$Low\ Inf(A) = \begin{cases} 1 & if \quad Inf_{i,t} \le Q_1(Inf) \\ 0 & EOC \end{cases} \tag{3}$$

$$Low\ Inf(B) = \begin{cases} 1 & if \quad Inf_{i,t} \le P_{10}(Inf) \\ 0 & EOC \end{cases} \tag{4}$$

The first definition is presented by (3). It establishes that, it the rate of inflation of country *i* and of period *t* ($Inf_{i,t}$) is smaller that the first quartile of the probability distribution of that

variable, then the variable *Low Inf(A)* takes the value 1; in the opposite case, the variable takes the value 0. In other words, we characterise the case of low inflation as that in which the observed rates of inflation are within the interval that contains 25% of the observations with the lowest rates of inflation. The second definition, given by (4), is stricter than the first one, because it requires that all observations be smaller than the percentile 10.

The tabulated values are reported in Table 10. The left part of the table presents the results for the first definition of low inflation, and the right part offers the results obtained using the second definition. The first column distinguishes between countries that have not adopted IT, to which we assign the value 0, and countries that operate with IT, to which we give the value 1.

TABLE 10: Independence between
"Adopting the IT regime" and "Low rate of inflation"
2000:01–2007:12

		Low inflation rate					
		Low Inf(A)			Low Inf(B)		
Inflation Targeting		(Without) 0	(With) 1	Total	(Without) 0	(With) 1	Total
(Without IT)	0	774 88%	104 12%	878 100%	843 96%	35 4%	878 100%
(With IT)	1	244 51%	236 49%	480 100%	378 79%	102 21%	480 100%
Total		1018	340	1358	1221	137	1358
χ^2 *p-value*			230.32 0.00*			101.97 0.00*	

$Q_1 = 4.21\%$ and $P_{10} = 2.79\%$

As far the results for the first definition of low inflation are concerned, countries that have not adopted IT have 12% probability of having low inflation. On the contrary, for countries with IT the probability of low inflation is 49%.

As regards the second definition of low inflation, countries without IT report only 4% probability of having low inflation against the case of 21% probability in countries with IT.

Since the value of the χ^2 statistics enables us to reject (for both definitions of low inflation) the null hypothesis of independence, we accept that the event of "Low rate of inflation" is related to the event of "having adopted the IT scheme".

Consequently, under either definition of "Low inflation", it is apparent that the probability of having lower rates of inflation is unambiguously higher in countries with IT than in countries without IT. It seems, then, that the shift from state NIT to state IT leads to lower rates of inflation.

ii) Low interest rate and IT

In this section we test the following hypothesis of independence:

H_0: "Low interest rate" is independent from "Adoption of IT".

H_1: "Low interest rate" is not independent from "Adoption of IT".

Following the same methodology as for the case of the rate of inflation, we use two alternative definitions of the random variable "Low interest rate":

$$Low\ IR(A) = \begin{cases} 1 & if \quad IR_{i,t} \le Q_1(IR) \\ 0 & EOC \end{cases} \tag{5}$$

$$Low\ IR(B) = \begin{cases} 1 & if \quad IR_{i,t} \le P_{10}(IR) \\ 0 & EOC \end{cases} \tag{6}$$

The tabulation of observations is presented in Table 11 with the same structure and meaning that Table 10. According to the first definition, in countries and periods where IT is not adopted, only 17% observations have "Low interest rate", against 39% in countries and periods with IT. For the second definition, the probabilities are 7% and 15%, respectively. The values of the χ^2 statistics are relatively large, implying very small p-values, which allow us to reject the null hypothesis of independence. We accept then that the events "Low interest rate" and "adoption of IT" are related.

TABLE 11: Independence between
"Adopting the IT regime" and "Low interest rate"
2000:01–2007:12

		Low interest rate					
		Low IR(A)			Low IR(B)		
Inflation Targeting		(Without) 0	(With) 1	Total	(Without) 0	(With) 1	Total
(Without IT)	0	728 83%	150 17%	878 100%	818 93%	60 7%	878 100%
(With IT)	1	291 61%	189 39%	480 100%	407 85%	73 15%	480 100%
Total		1019	339	1358	1225	133	1358
χ^2			82.32			24.64	
p-value			0.00*			0.00*	

$Q_1 = 4.44\%$ and $P_{10} = 2.90\%$

Consequently, the probability of having low interest rates is higher in countries that have adopted the IT regime, compared to those that operated with alternative monetary policy schemes.

iii) High GDP growth and IT

We test here the independence between "Adopting IT" and "High GDP growth" considering two definitions of high GDP growth:

$$High\ \ GDPG(A) = \begin{cases} 1 & if \quad GDPG_{i,t} \geq Q_3(GDPG) \\ 0 & EOC \end{cases} \tag{7}$$

$$High\ \ GDPG(B) = \begin{cases} 1 & if \quad GDPG_{i,t} \geq P_{90}(GDPG) \\ 0 & EOC \end{cases} \tag{8}$$

We use quarterly data of the period 2000:I - 2000:IV for the two groups of countries, IT and NIThp. As can be seen in Table 12, the low value of the χ^2 statistics for both definitions of high GDP growth (0.13 and 2.67, respectively) does not allow us to reject the hypothesis of independence between the two events.

This result agrees with the conclusions drawn from the cross-section analysis, presented in Table 9.

TABLE 12: Independence between
"Adopting the IT regime" and "High GDP growth"
2000:I–2007:IV

		High GDP growth					
		High GDPG(A)			High GDPG(B)		
Inflation Targeting		(Without) 0	(With) 1	Total	(Without) 0	(With) 1	Total
(Without IT)	0	248 59%	168 41%	416 100%	261 63%	155 37%	416 100%
(With IT)	1	98 61%	62 39%	160 100%	112 70%	48 30%	160 100%
Total		346	230	576	373	203	576
χ^2			0.13			2.67	
p-value			0.72			0.11	

$Q_3 = 4.84\%$ and $P_{90} = 8.24\%$

iv) Low variability in the inflation rate

Let us now test the null hypothesis of independence between "Low variability of the inflation rate" and "Adopting an IT regime", and consider the two definitions of small variability explained in the former statistical tests.

The results, presented in Table 13, indicate that small variability in the inflation rate goes more frequently with countries that adopt IT than with countries without IT. The probabilities are in

fact, 45% versus 15%, respectively when we adopt the first definition of low variability, and 18% versus 5%, respectively, when we use the second definition of low variability.

TABLE 13: Independence between
"Adopting the IT regime" and "Low variability in the inflation rate"
2000:01–2007:12

		Low variability of the inflation rate					
		Low Inf. Var.(A)			Low Inf. Var.(B)		
Inflation Targeting		(Without) 0	(With) 1	Total	(Without) 0	(With) 1	Total
(Without IT)	0	752 85%	126 15%	878 100%	832 95%	46 5%	878 100%
(With IT)	1	262 55%	218 45%	480 100%	393 82%	87 18%	480 100%
Total		1014	344	1358	1225	133	1358
χ^2			158.35			58.33	
p-value			0.00*			0.00*	

$Q_1 = 0.56\%$ and $P_{10} = 0.41\%$

v) Low variability in the domestic interest rate

Let us test the null hypothesis of independence between "Low variability in the nominal interest rate" and **"**Adopting the IT regime", and consider two definitions of **"**Low variability in the domestic interest rate" in the same statistical way as in the preceding tests.

TABLE 14: Independence between
"Adopting the IT regime" and "Low variability in the nominal interest rate"
2000:01–2007:12

		Low nominal interest rate variability					
		Low IR. Var. (A)			Low IR. Var. (B)		
Inflation Targeting		(Without) 0	(With) 1	Total	(Without) 0	(With) 1	Total
(Without IT)	0	698 79%	180 21%	878 100%	805 92%	73 8%	878 100%
(With IT)	1	320 67%	160 33%	480 100%	417 87%	63 13%	480 100%
Total		1018	340	1358	1222	136	1358
χ^2			27.23			7.97	
p-value			0.00*			0.00*	

$Q_1 = 0.30\%$ and $P_{10} = 0.098\%$

The results tabulated in Table 14 show that, taking the first definition of interest-rate variability, countries without IT exhibit low variability in 21% of the observed cases, whereas in countries with IT the probability for this result is 33 %. The results obtained with the second definition of low interest-rate variability show that this event takes place with 8% probability in the NIT group and with 13% probability in the IT set of countries. In both cases the p-value allows us to reject the null of no independence with a probability lower than 1%. Consequently, the event "Low variability of the nominal interest rate" goes together with "Adopting the IT regime".

vi) Low output variability

As in the case of economic growth, we use here quarterly data of the period 2000:I – 2007:IV, for the two groups of countries IT and NIThp. The results for the test of independence between "Adopting IT" and "Low output variability", considering the two habitual definitions of low variability, are reported in Table 15.

TABLE 15: Independence between
"Adopting the IT regime" and "Low output variability"
2000:I–2007:IV

		Low output variability					
		Low GDPG Var.(A)			Low GDPG Var.(A)		
Inflation Targeting		(Without) 0	(With) 1	Total	(Without) 0	(With) 1	Total
(Without IT)	0	280 67%	136 33%	416 100%	370 89%	46 11%	416 100%
(With IT)	1	93 58%	67 42%	160 100%	148 92%	12 8%	160 100%
Total		373	203	576	518	58	576
χ^2			4.27			1.62	
p-value			0.03**			0.20	

$Q_1 = 0.48\%$ and $P_{10} = 0.22\%$

As can be seen, the value of the χ^2 statistics enables us to reject the independence between adopting the IT regime and the less strict definition of low output variability.

vii) Low nominal exchange rate variability

We test here the following hypothesis:

H_0: "Low nominal exchange rate variability" is independent from "Adoption of IT".

H_1: "Low nominal exchange rate variability" is not independent from "Adoption of IT".

Variability of the nominal exchange rate is computed with the Standard deviation of this variable over the last 12 months. We consider the two definitions of *"Low nominal exchange rate variability"* that we used in the preceding cases.

The results of tabulation are reported in Table 16. The values presented in the left-hand side of the table correspond to the less strict definition of "Low variability in the nominal exchange rate". Using this definition, the probability for countries without IT of having low variability in the exchange rate is 27%, against 21% for countries with IT. When the stricter definition is considered, the probabilities are 12% and 5%, respectively.

TABLE 16: Independence between
"Adopting the IT regime" and "Low variability in nominal exchange rate"
2000:01–2007:12

		Low nominal exchange rate variability					
		Low ER Var. (A)			Low ER Var. (A)		
Inflation Targeting		(Without) 0	(With) 1	Total	(Without) 0	(With) 1	Total
(Without IT)	0	644 73%	234 27%	878 100%	775 88%	103 12%	878 100%
(With IT)	1	381 79%	99 21%	480 100%	454 95%	26 5%	480 100%
Total		1025	333	1358	1229	129	1358
χ^2			6.09			14.39	
p-value			0.01*			0.00*	

$Q_1 = 0.015$ and $P_{10} = 0.008$

The values of the statistics χ^2 allow us to reject the null hypothesis of independence between the two events. Taking into account the p-values presented in the last row of the table, we may assert that the IT group exhibits higher exchange rate variability than the NIT group.

At this point, it is interesting to ascertain whether the higher variability detected in the Latin American countries that apply the IT scheme relieves them from intervening more frequently and/or with higher intensity in the foreign exchange market. We verify this question with two different procedures. The first one is a test of variance of international reserves, and the second one is the Siegel-Tukey non-parametric test.

Test of variance of international reserves

In a first step, we calculate the monthly rate of change of international reserves between two consecutive months (Ch RES) along the whole period (2000:01-2007:12). Reserves include all means of international payments excepting gold. As in the previous tests the group of non-IT is composed of countries which adopted some type of flexibility in the exchange rate without adhering to the IT regime.

In a second step, we compute the sample variances of the variable Ch RES for each group of countries, $\sigma^2_{RES}(IT)$ and $\sigma^2_{RES}(NITb)$, respectively.

The hypothesis to test is:

H_0: $\sigma^2_{RES}(IT) \geq \sigma^2_{RES}(NIT)$

H_1: $\sigma^2_{RES}(IT) < \sigma^2_{RES}(NIT)$

Or, in an equivalent way:

H_0: $\frac{\sigma^2_{RES}(IT)}{\sigma^2_{RES}(NIT)} \geq 1$

H_1: $\frac{\sigma^2_{RES}(IT)}{\sigma^2_{RES}(NIT)} < 1$

Assuming that the population distribution of the variable Ch RES fits a normal distribution in each group of countries, we perform our variance tests using the statistics of the variances ratio which adjusts to the left tail of a Snedecor F distribution. The results are summarised in Table 17.

It is apparent that the values of the p-value statistics allow us to reject the null hypothesis. It follows then that international reserves exhibit lower volatility in IT countries than in countries without IT. The 95% confidence intervals indicate that the variability of international reserves in countries NIT multiplies that of IT countries by a factor between 3.16 and 6.35.

TABLE 17: Tests of variance of international reserves
2000:01–2007:12

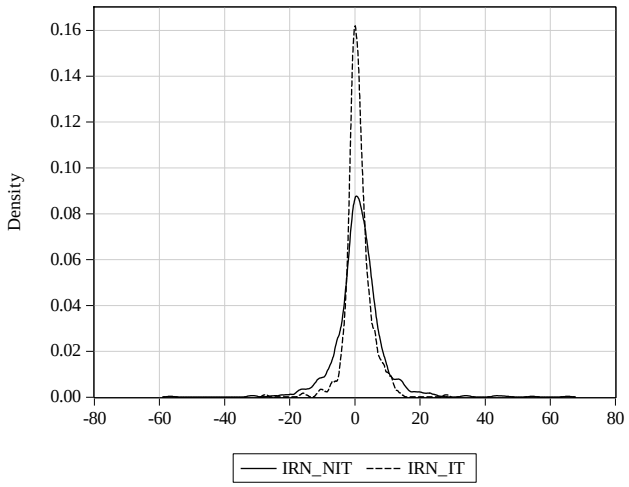
Parametric test of variance ratio	
$\hat{\sigma}^2_{RES}(IT)$	16.91
$\hat{\sigma}^2_{RES}(NIT)$	63.48
F	0.27
p-value	(0.00)
CI: $\frac{\sigma^2_{RES}(IT)}{\sigma^2_{RES}(NIT)}$	0.23 – 0.32
CI: $\frac{\sigma^2_{RES}(NIT)}{\sigma^2_{RES}(IT)}$	3.16 – 4.35
Siegel-Tukey non-parametric test of differences in the variance	
Z	8.50
p-value	(0.00)

The F statistics distributes with 479 and 877 degrees of freedom in the numerator and denominator, respectively. The CI was calculated with 95% level of confidence.

The Siegel-Tukey non-parametric test

The parametric test of variance ratio requires that the variance of the growth rate of reserves follow a normal distribution. Since we are not sure that this requirement is satisfied, we apply here the Siegel-Tukey test, which is especially suited in cases were normality in the random variable is not guaranteed. The Siegel-Tukey Z statistics follows a standard normal distribution. The results, presented in the last row of Table 18, indicate that the null hypothesis of variances equality can be rejected at lower than 1% significance level. This conclusion reinforces the results of the former test and demonstrates that countries with IT have experienced higher variability in foreign reserves than NIT countries. The distributions of the monthly growth rate in international reserves of both groups of counties, presented in Figure 2, graphically ratify this general result.

Figure 2: Distribution of monthly growth of international reserves. 2000:1-2007-12



The results of the two tests indicate that countries with IT do not interfere more than countries without IT in the value of their nominal exchange rate. This is true for either of the main weapons they use to implement intervention: selling and buying international reserves in the foreign exchange market, on the one hand, and modifying the domestic interest rate, on the other hand. This finding indicates that "fear of floating" is not more intense and/or frequent in IT countries than in the group of NIT countries with some flexibility in their exchange rates.

3.3. GDP growth and treatment effects

The statistical analysis carried out so far on the effects of IT on economic growth clearly shows that IT reduces the variability of economic growth, but it does not provide unambiguous results on the impact of IT on the levels of GDP growth. Thus, while time series regressions using dummy variables reveal that the effects on the growth levels are positive for the IT area as a whole and for three individual countries, cross-section regressions and independence tests point out that the effects are not statistically significant.

In this section we extend the empirical analysis by estimating a model of treatment effects, which is specially designed to investigate the effects of qualitative variables on economic

growth. We apply the model suggested by Heckman (1979), Maddala (1983) and Greene (2003). The method consists of estimating two equations jointly: a *probit* equation, which aims at assessing the extent to which some variables proposed in the empirical literature affect the probability of adopting the IT regime, and an *outcome* equation that relates economic growth with its main determinants. The model is as follows:

$$y_{it} = \beta' x_{it} + \delta IT_{it} + u_{it} \tag{9}$$

$$IT_{it} = \begin{cases} 1 & \text{if } IT_{it}^{*} > 0 \\ 0 & \text{otherwise} \end{cases} \tag{10}$$

$$IT_{it}^{*} = \gamma' w_{it} + \zeta_{it} \tag{11}$$

Equation (9) is the **output equation** that shows the annual rate of GDP growth of country *i* during the quarter *t* (y_{it}) as a function of vector x_{it}, which includes international openness ($open_{it}$) and gross formation of fixed capital ($gffk_{it}$), and a dichotomy variable, IT_{it} that takes the value *1* if the country *i* in period *t* is ITer, and the value *0* otherwise, as indicated by the expression (10). The parameter δ measures the effect of adopting IT on economic growth. It is expected a positive sign for both variables of vector x_{it}. The positive impact of $gffk_{it}$ on growth is extensively documented in the traditional models of economic growth, and the positive contribution of international openness to economic growth is empirically demonstrated by proponents of the export led growth hypothesis (see, for instance, Feder 1983, Helpman and Krugman 1985, and Krugman 1997) and by the endogenous growth theory (Romer 1986, Grossmann and Helpmann 1995 and Alesina and Rodrick 1999). The positive impact of international trade on economic growth of some groups of EMEs is empirically proven in Hassann (2005) and Ekanayake, Vogel and Veeramachenemi (2003).

Equation (9) is the ***probit* equation**, establishing that the probability of adopting IT depends on a set of factors included in vector w_{it}. After looking at the potential determinants of IT that have been most frequently suggested in the literature – see, for instance, Gerlach (1999), Hu (2006), Batini and Laxton (2006) and Leyva (2008) - we have selected the following variables: a) fiscal deficit, b) economic openness, c) the strength of financial development, d) the vulnerability to external shocks, and e) the amount of external liabilities denoted in foreign currency.

Let us now explain the way as the variables included in the *probit* equation are measured, and the sign of their expected influence on the probability of adopting the IT regime. The fiscal deficit is measured as a percent of GDP, and there are not definitive arguments to clearly hypothesise the sign of this variable. On the one hand, independence of the central bank – an

important ingredient of IT regimes - forces the governments to adopt more austere fiscal policies but, on the other hand, the adoption of IT might be endogenously decided as a remedy against weak public budgetary practices. Consequently, any of the two signs may be expected. Economic openness is measured with the amount of imports plus exports as a share of GDP. Since openness increases the rate of pass-through from exchange rate variations to domestic prices, it interferes with the control of inflation and discourages the central bank to adopt IT. This is especially true in emerging market economies because their pass-though coefficients are higher than those of the industrialised countries. Thus, it is reasonable to expect a negative relationship between openness and the probability of adopting IT.

The soundness, health and development of the financial system may be proxied by the total amount of bank deposits. Given that this variable is a key element – if not a prerequisite - of the IT strategy, it is logical to assume that it contributes to the adoption of IT. Then, the sign of its effects on the adoption of IT must be positive. We measure the vulnerability to external shocks with the current account deficit. High external imbalances make the central bank less inclined to adopt IT, which indicates that the sign of this variable should be negative. Finally, the amount of external liabilities in foreign currencies is measured with the stock of external debt denoted in foreign currency. It is easy to understand that, since high levels of this variable hinder the operation of flexible exchange rates, external liabilities reduce the probability of adopting IT[3]. Consequently, the minus sign is our guess.

To estimate the system (9) to (11), we may apply either the maximum likelihood method, or the two steps procedure suggested by Heckman (1979), which has been well explained by Maddala (1983) and Greene (2003) and used by Edwards (2004). Given that we have chosen the two- steps methodology, it is worth to explain it briefly. First, we apply the probit method to estimate the equation (9), which provides the estimated value of the parameter γ. Then we estimate the variable IT_{it}^{*} and construct the variable $\hat{\lambda}_{it}$ defined as the ratio between the density function and the accumulated distribution of $I\hat{T}_{it}^{*}$: $\hat{\lambda}_{it} = f\left(I\hat{T}_{it}^{*}\right) / F\left(I\hat{T}_{it}^{*}\right)$. Second, we include the variable $\hat{\lambda}_{it}$ in (7) to estimate the enlarged equation: $y_{it} = \beta' x_{it} + \delta IT_{it} + \beta_{\hat{\lambda}}\hat{\lambda}_{it} + \xi_{it}$. This provides the estimations of β , $\beta_{\hat{\lambda}}$ and δ .

[3] Although debt dollarisation is a clear obstacle to IT implementation, it does not per se preclude the use of IT as an effective policy regime. The case of the highly dollarised Peru is a good example, as shown by Leiderman, Maino and Parrado (2006).

TABLE 18: Economic growth and adoption of Inflation Targeting
2000:I–2007:IV

Treatment variable: Application of the inflation target strategy (IT^{*}_{it})		
Variable	NIThp	NIT
c	5.468 (8.769)*	11.331 (8.046)*
def_{it}	0.142 (4.305)*	0.281 (5.188)*
$open_{it}$	-0.064 (-9.631)*	-0.134 (-8.460)*
dep_{it}	0.089 (8.070)*	0.185 (7.267)*
ca_{it}	-0.214 (-7.051)*	-0.284 (-7.315)*
$extdebt_{it}$	-0.100 (-8.810)*	-0.197 (-7.372)*
Outcome variable: rate of GDP growth (y_{it})		
Variable	Coefficient	Coefficient
c	0.149 (0.148)	-2.930 (-2.757)*
gfk_{it}	0.159 (3.681)*	0.261 (4.974)*
$open_{it}$	0.010 (1.681)***	0.014 (1.441)
IT_{it}	0.062 (0.329)	0.191 (2.287)**
$\hat{\lambda}_{it}$	-0.037 (-0.139)	0.288 (2.304)**
σ	0.291	0.340
ρ	0.126	0.847

Level of significance: (*): 1%; (**): 5%, and (***): 10%
Values within parenthesis are the quantiles of the typical normal distribution (in the probit estimation) and the values of the *t* Student statistics (in the outcome estimation).

In order to derive more generalised results, in this empirical test we take the two groups of NITers as alternative benchmarks. Consequently, Table 18 reports the estimation results of the system (9)-(11) for the IT and the two groups of NITers countries: NIT and NIThp. All the variables included in the system are statistically significant, except for the IT variable in the growth equation for the NIThp group. As far as the treatment equation is concerned, the estimations have the expected signs, revealing that the probability of adopting the IT regime is favoured by the occurrence of the following factors: a) fiscal imbalances, b) small economic openness, c) strength of the domestic financial system, d) low current account deficits, e) deepness of the financial system, and f) low levels of external debt. As regards the estimation of the outcome equation, the results presented in the lower part of Table 18 indicate that economic growth is favoured by gross formation of fixed capital, by international openness and

– which is more relevant for the aim of this test – by adoption of the IT regime when the NIT countries are taken as a benchmark.

4. Concluding remarks

In this paper we have analysed the extent to which inflation targeting has improved macroeconomic performance in a group of Latin American countries during the last eight years.

In the first part of the paper we have applied descriptive statistical analysis to get a first impression of the likely results of IT on both the average levels and variability of five important macroeconomic variables: the inflation rate, three financial variables (the short run interest rate, variations in the exchange rate, and variations of foreign reserves) and GDP growth.

In the second part of this work, we have applied a variety of statistical and econometric tests that fully confirm the results pointed out by the descriptive analysis. Time series and cross-section regressions, and independence analysis coincide to show that IT causes, or it goes with, lower levels of inflation and of short-run interest rates. Furthermore, these tests also indicate that the event "low variability" not only in these variables but in output and international reserves as well, is not independent of "adopting the IT regime". The fact that less intense foreign exchange market intervention by IT central banks goes with higher volatility in exchange-rate changes, indicates that "fear of floating" is not more present in IT countries than in other non-IT countries with flexible exchange rates.

Finally, our treatment effects analysis, especially designed to assess the impact of qualitative variables on economic growth, reveals that IT has contributed to increase GDP growth in the group of IT counties of our sample taken as a whole. This result, new in this strand of literature devoted to EMEs, is compatible with the findings of Edwards and Levy-Yeyati (2003), according to which flexible exchange rate arrangements help reduce the real impact of terms of trade shocks on GDP growth. We go one step further by showing that, among the group of countries of our sample that have flexible exchange rates, IT provides a bonus in economic growth.

References

[1] Alesina, A. and Rodrik, D. (1999), "Distributive politics and economic growth", *Quarterly Journal of Economics,* 109, 443-465.

[2] Apergis, N., Miller, S.M., Panethimitakis, and Vamvakidis, A. (2005), "Inflation Targeting and Output Growth: Empirical Evidence for the European Union", IMF Working Paper, WP/05/89

[3] Ball, L. and Sheridan (2005). "Does Infaltion Targeting Matter? In B. S. Bernanke and M. Woodford (Eds), *The Inflation Targeting Debate*, 249-276. University of Chicago Press for the National Bureau of Economic Research.

[4] Batini, N. and Laxton, D. (2006), "Under what conditions can Inflation Targeting be adopted? The experience of Emerging Markets", Central Bank of Chile Working Papers, nº 406.

[5] Berg, A., Borensztein, E. and P. Mauro (2002), "An Evaluation of Monetary Regime Options for Latin America," IMF Working Paper WP/02/211. Published in *North American Journal of Economics and Finance,* 13, December 2002: 213-235.

[6] Bernanke, B.S., Laubach, T., Mishkin, F. and A. Posen (1999), *Inflation Targeting: Lessons from the International Experience,* Princeton, NJ: Princeton University Press

[7] Bernanke, B. S., and M. Woodford (Eds) (2005), *The Inflation Targeting Debate*, The University of Chicago Press.

[8] Blanchard, O. (2005). "Fiscal Dominance and Inflation Targeting: Lessons form Brazil", in F. Giavazzi, I. Goldfajn and S. Herrera, 2005. *Inflation Targeting, Debt, and the Brazilian Experience, 1999 to 2003.* MIT Press.

[9] Calderón, C., and K. Schmidt-Hebbel (2003a), "Learning the hard way: ten lessons for Latin America's turmoil", Central Bank of Chile, Mimeo.

[10] Calderón, C., and K. Schmidt-Hebbel (2003b), "Macroeconomic Policies and Performance in Latin America", Central Bank of Chile Working Papers, nº 217.

[11] Calvo, G. A., and C. Reinhart (2002), "Fear of Floating", *Quarterly Journal of Economics*, May, 117(2), 379-408.

[12] Cecchetti, S., and M. Ehrmann (1999), "Does Inflation Targeting Increase Output Volatility? An international comparison of policymakers' preferences and outcomes", NBER Working Paper 7426, December.

[13] Céspedes, L.F., and C. Soto (2005), "Credibility and Inflation Targeting in an Emerging Market: the case of Chile", Central Bank of Chile Working Papers, nº 312.

[14] Corbo, V., Landerretche, O. and K. Schmidt-Hebbel (2002), "Does Inflation Targeting Make a Difference", in Norman Loayza and Raimundo Soto (Eds), *Inflation Targeting: Design, Performance, Challenges":* 221- 269, Santiago, Chile, Central Bank of Chile.

[15] Edwards, S. (2004), Thirty years of current account imbalances, current account reversals and sudden stops", *IMF Staff Papers*, Special Issue, 51(0): 1-49.

[16] Edwards, S., and E. Levy-Yeyati (2003), "Flexible exchange rates as shock absorbers", *European Economic Review*, November, 49(8): 2079-2105.

[17] Ekanayake, E. M., Vogel, R. And Veeramacheneni, B. (2003), "Openness and economic growth: empirical evidence on the relationship between output, inward FDI, and trade", *Journal of Business Strategies*, Spring

[18] Feder, G. (1983), "On exports and economic growth", *Journal of Development Economics*, 12, 59-73.

[19] Gallego, F., and G. Jones, (2005), Exchange rate interventions and insurance: is "fear of floating" a cause for concern?" Central Bank of Chile Working Papers, nº 326.

[20] Gerlach, S. (1999), "Who targets inflation explicitly?" *European Economic Review,* 43: 1257-1277.

[21] Greene, W. (2003), *Econometric Analysis*, 5th edition, Prentice Hall.

[22] Grosssman, G. and Helpman, E. (1985), "Technology and trade", in G. Grossman and K. Rogoff (Eds), *Handbook of International Economics*, Vol III, 1279-1337. Elsevier Science, B. V.

[23] Hassan, A.F.M. K. (2005), "Trade Openness and Economic Growth: Search for a Causal Relationship", *South Asian Journal of Management*, October-December.

[24] Heckman, J. (1979), "Sample Selection Bias as a Specification Error", *Econometrica*, 47(1), January: 153-161.

[25] Helpman, E., and Krugman, P. R. (1985), *Market structures and foreign trade*, Cambridge: MIT Press.

[26] Hu, Y (2006), "The choice an inflation targeting –an empirical investigation" *International Economics and Economic Policy*, 3: 27-42.

[27] International Monetary Fund (2005), "Does Inflation Targeting Work in Emerging Markets?" World Economic Outlook, Chapter IV. September.

[28] International Monetary Fund (2006), "Inflation Targeting and the IMF", prepared by the Monetary and Financial Systems Department, Policy and Development Review Department, and Research Department, March.

[29] King, M. (2005). "Monetary Policy: Practice Ahead of Theory", Mais Lecture 2005,Cass Business School, City University, London, May 17.

[30] Krugman, P. R. (1987), *The Age of diminished expectation*, Cambridge: MIT Press.

[31] Leidermann, L., Maino, R. and E. Parrado (2006), "Inflation Targeting in Dollarized Economies", Central Bank of Chile Working Papers, nº 368.

[32] Leyva, G. (2008), "The choice of Inflation Targeting" Central Bank of Chile Working Papers, nº 475.

[33] Libanio (2005), "Good Governance in monetary policy and the negative real effects of inflation targeting in developing economies", Texto para discussao, Nº 277, CEDEPLAR/FACE/UFMG.

[34] McDermott, J. and McMenamin (2008), "Assessing Inflation Targeting in Latin America with a DSGE Model" Working Paper, Central Bank of Chile, Nº 469.

[35] Maddala, G. S. (1983), *Limited-Dependent and Qualitative Variables in Econometrics*, Cambridge University Press, New York.

[36] Mello, L. and Moccero, D. (2007). "Monetary Policy and Macroeconomic Stability in Latin America: The Cases of Brazil, Chile, Colombia and Mexico". Working Papers Nº 545. Economics Department OECD.

[37] Mishkin, F.S. (2004), "Can Inflation Targeting Work In Emerging Market Countries?", Festchrift in Honnor of Guillermo Calvo, International Monetary Fund, April 15-16.

[38] Mishkin, F.S., and M. Savastano (2002), "Monetary Policy Strategies for Emerging Market Countries: Lessons from Latin America", *Comparative Economics Studies* XLIV(2), Summer: 45-83.

[39] Mishkin, F., and K. Schmidt-Hebbel (2002), "A Decade of Inflation Targeting in Chile: Developments, Lessons, and Challenges", in Loayza, N. and R. Soto (Eds), *Inflation Targeting: Design, Performance, Challenges*, Central Bank of Chile, Santiago de Chile, 171-220.

[40] Mishkin, F., and K. Schmidt-Hebbel (2007), "Does Inflation Targeting Make a Difference?" In F. Mishkin and K. Schmidt-Hebbel (Eds), *Monetary Policy under Inflation Targeting*. 291-372. Santiago: Central Bank of Chile.

[41] Romer, P. M. (1986), Increasing returns and long run growth, *Journal of Political Economy*, 94, 1002-37.