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Inflation Targeting and Economic Performance: The Case of Mexico

Summary: In the paper we analyze the impact of Inflation Targeting (IT) in Mexico. The objective is to evaluate the impact of the implementation of inflation targeting and full-fledged inflation targeting (FFIT) on the level and the variability of the inflation and the output in the Mexican economy. We conclude that inflation rates had been reduced in Mexico before the introduction of IT and FFIT. In our opinion, the structural reforms, including the Banxico reforms, are the main determinants of the decrease in inflation and its variability. The main impact of IT would have been the lock-in of inflation expectations around a low rate of inflation.

Key words: Inflation, Mexico, Inflation targeting.

JEL: E31, E52, E58, N16.

Since its introduction in 1990 in New Zealand, Inflation Targeting (IT) has been gradually implemented worldwide, becoming the dominant monetary policy strategy. Although at a first stage IT was implemented in developed economies (Ben S. Bernanke et al. 1999), this monetary strategy expanded to an increasing number of developing economies. These economies adopted IT as a result of the failure of pegged exchange rates to permanently reduce inflation rates, mainly because of the impossibility to maintain a stable exchange rate (Bernanke et al. 1999; Frederic S. Mishkin 2000; International Monetary Fund - IMF 2005; Charles Freedman and Inci Ötker-Robe 2009; Scott Roger 2009). The significant reduction of the level and variability of inflation in developing and developed economies and the high output stability would be the proof of the effectiveness of this monetary strategy (Bernanke et al. 1999; Mark R. Stone and Ashok J. Bhundia 2004; IMF 2005; Mishkin and Klaus Schmidt-Hebbel 2007; Carlos E. Gonçalves and Joao M. Salles 2008; Roger 2009). However, the theoretical and empirical evaluation of the performance of the IT monetary framework is controversial. A first set of criticisms is related to the ability of IT to stabilize simultaneously the output and the inflation, and to meet other objectives like low unemployment rates or high rates of economic growth (Ricardo D. Brito and Brianne Bystedt 2010). A second group of criticisms focuses on the capacity of IT to generate and maintain low inflation rates (Joseph E. Stiglitz 2008). A third set of criticisms relates to the inability of IT to fight asset bubbles (Jeffrey A. Frankel 2009; Philip Arestis 2009). Finally, other criticisms argue that the results obtained by inflation-targeters are not significantly different from those non-inflation

targeters (Laurence Ball and Niamh Sheridan 2005), in particular the countries with pegged exchange rate regimes (Atish R. Ghosh and Jonathan D. Ostry 2009).

A number of papers argue that the performance of inflation targeters in terms of the price level stability is not significantly different from that achieved by countries with other monetary strategies (Alvaro Angeriz and Arestis 2007a, 2007b, 2008; John McDermott and Peter McMenamin 2008; Carlos Capistrán and Manuel Ramos-Francia 2009). For these studies, the low and stable inflation rates registered during the "Great Moderation" are explained by a combination of international factors, like the process of globalization and the stronger immersion in the world economy of developing countries like China and India (IMF 2005; Angeriz and Arestis 2008). At most, IT would have contributed to anchor expectations around a low inflation rate achieved before IT implementation (Refet S. Gürkaynak, Andrew T. Levin, and Eric T. Swanson 2006; Gürkaynak et al. 2007; Capistrán and Ramos-Francia 2010). Moreover, non-targeters recently have also seen their inflation expectations anchored at lower levels than in the past. Efrem Castelnuovo, Sergio Nicolerri-Altimari, and Diego Rodriguez-Palenzuela (2003), Ball and Sheridan (2005), and Angeriz and Arestis (2008) argue that the lock-in effect is similar in both groups of economies. In the words of the current Governor of the Bank of England (Mervyn King 2009): *"Inflation targeting is a necessary but not sufficient condition for stability in the economy as a whole."*

In addition, other authors argue that IT effects on inflation would not be explained by the own strategy but by some of their features, like transparency and accountability, the increased autonomy granted to the central banks, and the restrictions to finance public budgets (Marco Arnone et al. 2007; Carl E. Walsh 2007; Alex Cukierman 2008). IT effectiveness would be a function of a set of preconditions: institutional independence, a well-developed technical infrastructure, economic structure and a healthy financial system (IMF 2005). In this sense, although some authors argue that the success do not depend on these preconditions, they also argue that success depends on the policy-makers' commitment and ability to apply institutional reforms once the IT has been implemented (Nicoletta Batini and Douglas Laxton 2007). In sum, the better performance of price stability would be the result of the existence of these preconditions and/or the existence of a proper political-institutional framework and not of the implementation of IT.

In the case of emerging market and developing countries, there are additional criticisms to the effectiveness of IT. Some papers conclude that, although IT generates good outcomes in developed economies, the performance in developing and emerging market countries is not clear (Brito and Bystedt 2010; Irineu E. de Carvallho Filho 2010). In the case of Latin America countries, although papers like Schmidt-Hebbel and Alejandro Werner (2002), Carmen Broto (2008), and McDermott and McMenamin (2008), conclude that IT has succeeded in reducing inflation, other studies question the role of IT as a major determinant of the inflation reduction recorded in the nineties. These papers argue that the implementation of IT was preceded and accompanied by Central Bank independence and for a set of structural reforms that changed the way of conducting the macroeconomic policy. They conclude that, once that control for the structural reforms and policies is undertaken, the

impact of IT on inflation significantly diminishes (Freedman and Douglas Laxton 2009). Thus, for example, although Gonçalves and Salles (2008) argue that the implementation of IT had a significant effect on inflation in developing countries, it would only explain between 17.5% and 22.2% of the total inflation decrease in 13 developing economies that implemented this strategy. In a paper that studies the impact on inflation of the independence of central banks, Luis I. Jácome and Francisco Vazquez (2008) conclude that the impact of structural reforms is 10 times higher than the impact of the central bank independence.

Brito and Bystedt (2010) conclude, analyzing 46 developing countries, that the impact of IT on inflation is limited and not significant. Moreover, IT has a negative effect on output growth, thus doubting the effectiveness of this monetary strategy. Focusing on the Mexican case, some papers (Luis M. Galindo and Jaime Ros 2006, 2008; Victor M. Cuevas Ahumada 2008; Carlos A. Ibarra 2008; Eduardo Loria 2009; Guadalupe Mantey de Anguiano 2009) argue that the implementation of IT in Mexico may have negatively affected economic growth through its impact on the appreciation of the real exchange rate (Arestis 2009). Nelson H. Barbosa-Filho (2008) and Gerald Epstein and Erinc Yeldan (2008) reach a similar conclusion for Brazil and for a sample of developed and developing economies, respectively. Actually, defenders of IT emphasize the key role played by the exchange rate in IT emerging market economies (Mishkin 2000), and, in a recent paper, Osvaldo Kacef and Rafael López-Monti (2010) show that in some Latin American targeters, concerns about the real exchange rate have led central banks to intervene in the currency markets.

The above analysis shows that the conclusions about the impact of IT are not conclusive and generalized. This leads to the need for particular studies on concrete cases to assess the IT effectiveness in each country. The aim of this paper is to analyze whether the implementation of IT in Mexico had a significant effect on inflation, or whether the inflation performance of this country is mainly related to other factors, such as increased Central Bank autonomy or the structural reforms. Full-Fledged Inflation Targeting[1] in Mexico was preceded by a change in the monetary strategy, firstly by the reform in 1993 of Banco de Mexico's Act increasing its autonomy, and, secondly, by adopting IT in 1999 as its monetary strategy.

The analysis of the Mexican case can shed light on the debates on the reasons of the generalized disinflation process registered in advanced and emerging and developing economies, and on the role placed by IT in this process.

Moreover, the analysis contributes to distinguish the impact of the implementation in 2001 of FFIT from the effects of the earlier implementation of IT in 1999. By proceeding this way, we can asses the impact generated by the change in the strategy of monetary policy. With the implementation of the FFIT in 2001, Banxico set the inflation target on 3% (with a margin of ±1%). Thus, we can know whether

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[1] Alina Carare and Stone (2003) propose a classification for countries adopting IT with three regimes according to their credibility and commitment, FFIT: countries with a high commitment controlling inflation, and medium and high levels of credibility; Eclectic Inflation Targeting (EIT): countries with high credibility allowing them to maintain low and stable inflation without a high level of transparency and accountability; Inflation Targeting Lite (Lite IT): characterized by low levels of credibility and clarity, as well as having high flexibility in achieving other goals.

the effects of IT in Mexico come from the permanent setting of an inflation target or from the institutional (central bank independence) and policy (inflation as priority objective of monetary policy) framework conforming the IT monetary strategy.

Our objective is to test whether the implementation of IT (in 1999) and/or FFIT (in 2001) have influenced inflation performance in Mexico.

The paper structures as follows. First, we make a short description of the main features of the implementation of the inflation targeting in Mexico. Second, we model inflation outcomes in Mexico following the methodology proposed by George E. P. Box and Gwilym Jenkins (1976) for univariate series and Box and George C. Tiao (1975) for intervention analysis, which allows to analyze the impact of the implementation of IT and FFIT monetary strategies. Third section compares the inflation performance in Mexico and the United States, both in terms of the levels and variability of inflation rates. We also check whether IT has affected the performance in terms of the Mexican economic growth. The final section summarizes and concludes. The evidence shows that the introduction of FFIT occurred in a context of stabilized inflation and the key change came from the changes in Banco de Mexico's laws with IT serving as nominal anchor once inflation was reduced.

1. The Implementation of Inflation Targeting Monetary Strategy in Mexico

Recent Mexican economic history can be classified into two periods according to the growth strategy implemented. The first period corresponds to the implementation of the "imports substitution industrialization", which started with the administration of the President Lázaro Cárdenas in 1936 and ended at the beginning of the 1980s with the debt crisis and the private bank expropriation. In this strategy, the public sector was at the core of the whole economic process, driving the economic development and growth process. This growth strategy finished in the early eighties with the fall of international oil prices and the debt crisis. Forced by the debt crisis and the contraction of the credit, Mexico adopted a new exports-led growth strategy.

The process of structural adjustment began with the administration of the President Miguel de la Madrid Hurtado. However, some of the most significant changes were made during the administration of the President Carlos Salinas de Gortari. Among these changes, in 1993 the Act of Banco de México (Banxico) and the Constitutional Article 28 of the Mexican Constitution were reformed in order to give higher autonomy to Banxico, and price stability was established as the main objective of the Mexican Central Bank. Thus, the amended article 28 of the Mexican Constitution limited government funding by Banxico, and gave higher autonomy to Banxico from politicians. Moreover, the Act of Banco de México was also amended. Article 2 of the Act set price stability as the main goal of Banxico. Article 38 established that the Board of Governors of Banxico was formed by five members: the Governor and four sub-governors. Article 40 set out the mandates of each member of the governing board, dissociating the mandates of the members of the Board of Governors from the electoral calendar. According to the article 40 of the Banco de Mexico Law: *"The Governor will be appointed for a term of six years and Deputy Gov-*

ernors for eight years. The term of the Governor will start on the first of January of the fourth year of the President of the Republic's term. The terms of the Deputy Governors will be staggered, with one starting every other year on the first of January of the first, third and fifth years of the President's term. The individuals occupying these posts may be appointed members of the Board of Governors for more than one term." In addition, like in article 28 of Mexican Constitution, it was also approved that the President of Mexico made the appointment of the members, but that this appointment had to be ratified by the Mexican Senate.

Table 1 Inflation Outcomes and Targets (1995-2008)

Year	Actual inflation	Inflation target
1995	51.97%	42.0%
1996	27.70%	20.5%
1997	15.72%	15.0%
1998	18.61%	12.0%
1999	12.32%	13.0%
2000	8.96%	10.0%
2001	4.40%	6.5%
2002	5.70%	4.5%
2003	3.98%	3% (±1%)
2004	5.19%	3% (±1%)
2005	3.33%	3% (±1%)
2006	4.05%	3% (±1%)
2007	3.76%	3% (±1%)
2008	6.53%	3% (±1%)

Source: Banco de México and Banco de Información Económica, INEGI, Mexico (1995-2008).

The independence of the Banco of Mexico and the priority given to price stability as the main objective of the monetary policy paved the way for a later implementation of the inflation targeting, which took place in 1999. FFIT monetary strategy was adopted two years later in 2001. Whilst in 1999 and 2000 the Banco of Mexico set the inflation targets on an annual basis, the implementation of the FFIT made that the Banco of Mexico set the target of inflation rate at 3% (within a range of ±1%). In the transition to this long-term objective, the Banco of Mexico also set the targets for the years 2001 (6.5%) and 2002 (4.5%). Table 1 shows the evolution since 1995 of the inflation rates and the inflation targets.

2. Modelling Inflation Performance in Mexico

In this section we will use monthly data of inflation since 1993:01 to 2009:09 to evaluate the introduction of IT and FFIT. The use of monthly data allows a more precise analysis of the impact of the implementation of IT and FFIT on Mexican inflation. Moreover, by using monthly data we can know better the impact of inflation of the peso crisis happened in early 1995.

Although there are available data of monthly inflation since 1970 (see Figure 3), our analysis starts in 1993. The reason is that we want to control for the influence of current economic activity on inflation, that is, we want to control that part of the

inflation rates that have a cyclical nature related to the business cycle. Since we are using monthly date of inflation we should also use monthly data of GDP. Since these data are not available, we have substituted GDP values by one proxy that measures on a monthly basis the level of economic activity: the General Index of Economic Activity (IGAE).

Figure 1 shows the series of annual and monthly (Figure 1a and 1b, respectively) inflation rates in Mexico. The highest figures are registered during the 1995 crisis. Since then, we observe a strong disinflationary process during the period 1996-2000. The figures of monthly inflation show that the instability after the crisis boils down to the end of 1998, the beginning of the transition to FFIT. Since the implementation of FFIT in 2001 the inflation rates stabilize around a low rate close to the target of inflation.
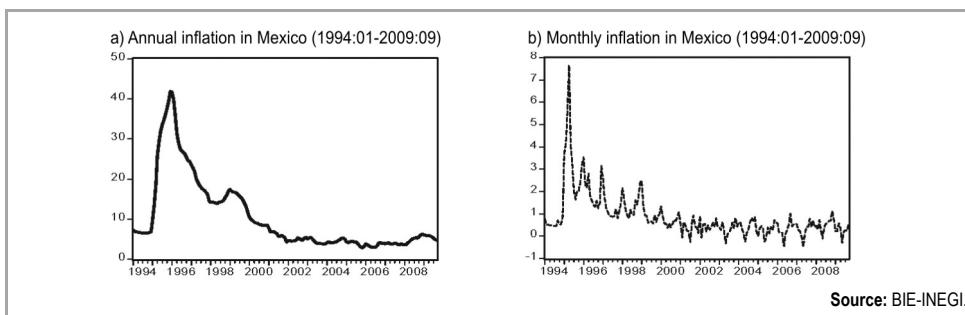

Source: BIE-INEGI.

Figure 1 Annual and Monthly Inflation in Mexico (1994:01-2009:09)

Figure 2a presents an upward trend of Consumer Price Index (INPC). Figure 2b shows the logarithms of the INPC, also showing an increasing trend (logarithms are used henceforth).
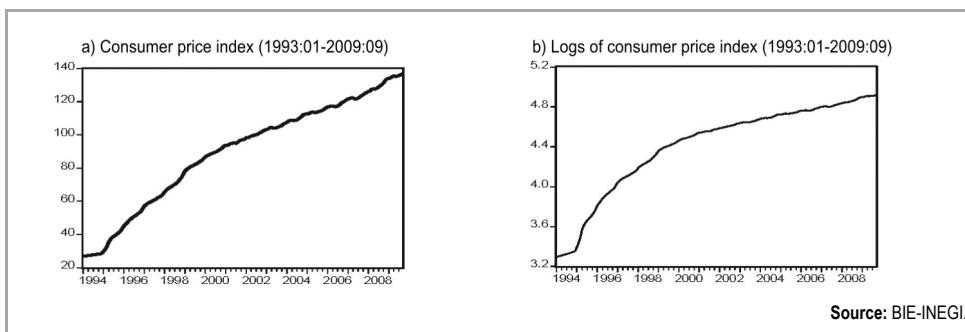

Source: BIE-INEGI.

Figure 2 Evolution of the Consumer Price Index

For the ARIMA analysis we need to know the integration order of the variables. Looking at the figures, we observe that the series of Log(INPC) is not stationary. We apply unit root tests to Log(INPC) and Log(IGAE). The tests used are Aug-

mented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). ADF and PP have as null hypothesis the presence of unit root while KPSS has as null hypothesis that the tested series is stationary. Results of these tests are summarized in Table 2.

Table 2 Testing Unit Root in Log(INPC) and Log(IGAE) (1993:01- 2009:09)

Log(INPC)				
	Levels	Prob.	1st difference	p-value
Augmented Dickey-Fuller (ADF)	-1.406	0.856	-4.649	0.001
Phillips-Perron (PP)	-0.936	0.949	-4.446	0.002
Kwiatkowski-Phillips-Schmidt-Shin (KPSS)	0.412	0.146*	0.112	0.146*
Log(IGAE)				
	Levels	Prob.	1st difference	p-value
Augmented Dickey-Fuller (ADF)	-2.7383	0.223	-2.6567	0.256
Phillips-Perron (PP)	-5.0310	0.000	-41.553	0.000
Kwiatkowski-Phillips-Schmidt-Shin (KPSS)	0.1499	0.146*	0.099	0.146*

Notes: * asymptotic critical values for the KPSS test at 5% level.

Source: Authors' calculations.

For Log(INPC) the ADF and PP tests do not reject the null hypothesis of unit root at levels, and KPSS test does reject the null hypothesis of a stationary series. The tests applied to first level differences indicate the absence of unit root, that is, Log(INPC) is integrated of first order [Log(INPC)~I(1)]. In the case of Log(IGAE), the ADF and PP tests reach opposite results: ADF for levels and for first differences indicates the existence of unit root, but the PP tests show the absence of unit root. In this case, and with the aim to use IGAE as control variable, we use the KPSS tests and the correlograms to know the order of the series. According to both proofs, Log(IGAE) is integrated of order 1, that is, Log(IGAE)~I(1).

Once we know that Log(INPC)~I(1) and Log(IGAE)~I(1), it is possible to observe the AC and PAC for the Log(INPC) and propose an ARIMA model: Log(INPC)~$(1,1,0)(12,0,0)_S$ with d(Log(IGAE),1) as control variable.

We estimate the parameters considering:

$$Log(INPC) \sim ARIMA(1,1,0)(12,0,0)_s \tag{1}$$

During the period observed, the Mexican economy experienced a strong crisis in 1995. Because of the Tequila crisis, we introduce a dummy variable (D1) to control the impact of this crisis:

$$D1 \begin{cases} 1 \sim 1995:01 - 1995:05 \\ 0 \sim Otherwise \end{cases} \tag{2}$$

We also use two types of impulse dummies (D2 and D3), as intervention analysis, looking for the effect of the introduction of IT (D2) and FFIT (D3):

$$D2 \begin{cases} 1 \sim 1998:12 \\ 0 \sim Otherwise \end{cases} \tag{3}$$

$$D3\begin{cases} 1 \sim 2001:01 \\ 0 \sim Otherwise \end{cases} \tag{4}$$

In sum, we estimate the following model:

$$\Delta_s^0 \Delta^1 Log(INPC)_t = \alpha_1 + \alpha_2 Z_t + \mu_t$$
$$(1 - \phi L)(1 - \Phi L^{12})_s \mu_t = (1 + \theta)\varepsilon_t \tag{5}$$

Where Z_t is a vector of exogenous variables including $\Delta_s^0 \Delta^1 Log(IGAE)_t$, D1, D2 and D3. Therefore, our model assumes that the Mexican inflation depends on the level of economic activity (proxied by IGAE), and that this relationship has been influenced by the shock of the Tequila crisis and by changes in the monetary policy strategy (proxied by the implementation of the IT and FFIT strategies). The results are presented in Table 3.

Table 3 Results of the Estimation (1993:01-2009:09)

Dependent variable: $\Delta_s^0\Delta^1$Log(INPC)$_t$				
	Model 1	Model 2	Model 3	Model 4
Constant	0.008***	0.008***	0.008***	0.008***
D1	0.021***	0.0210***	0.021***	0.021***
D2		0.005		0.005
D3			-0.003	-0.003
ΔLog(IGAE)	-0.024***	-0.024***	-0.023***	-0.024***
AR(1)	0.772***	0.771***	0.771***	0.770***
SAR(12)	0.350***	0.356***	0.3641***	0.370***
R²	0.808	0.810	0.809	0.811
Adjusted R²	0.803	0.805	0.804	0.805
F-stat	191.195***	154.284***	153.178***	128.782***
DW	2.143	2.159	2.149	2.165
Akaike Information Criterion (AIC)	-7.940	-7.941	-7.935	-7.936
Schwarz Criterion (BIC)	-7.854	-7.837	-7.831	-7.815
ADF (for residuals)	-14.623***	-14.739***	-14.663***	-14.781***
Phillips-Perron test (for residuals)	-14.623***	-14.738***	-14.663***	-14.780***
Q(12): Ljung-Box statistics at lag 12	9.453	9.698	9.837	10.216
Jarque-Bera	770.099***	802.251***	797.490***	832.030***

Notes: *** null hypothesis rejected at 1%; ** null hypothesis rejected at 5%; * null hypothesis rejected at 10%.

Source: Authors' calculations.

Coefficients D1, AR (1), SAR (12) and $\Delta_s^0 \Delta^1 Log(IGAE)_t$ are statistically significant in all the models. D2 and D3 are not statistically significant in any model, and, consequently, the introduction of IT and FFIT in Mexico did not significantly affect the inflation trend. DW statistic rejects the null hypothesis of serial autocorre-

lation. The residuals of all the models do not present unit root according to ADF and PP tests. The Jarque-Bera normality test rejects the null hypothesis of normality in residuals. In a recent paper, Miguel A. Díaz Carreño and Reyna Vergara González (2009) find that normality is presented in the inflation rate in the period 2000-2007: they show the presence of a normal distribution on the Mexican rate of inflation during the period 2000-07, finding that in this period inflation would converge to a rate within a range (4.1%-5.6%) higher than the inflation target set by the Banco of Mexico. Nonetheless, the shocks of the debt crisis, via the inflationary impact of the peso devaluation, and the adjustment policy in 1980s and the tequila crisis in 1990s affect the behavior of the trend before the referred period[2].

In sum, the above analysis shows that the introduction of IT and FFIT did not significantly affected the inflation performance in Mexico. However, although we cannot argue that the introduction of IT affected inflation performance, since 2000 the inflation rates have remained at unprecedented low level below or close to the upper limit of the target range (i.e., 4%). Therefore, the above conclusion does not deny the possibility that IT has anchored the inflation expectations close to the inflation target.
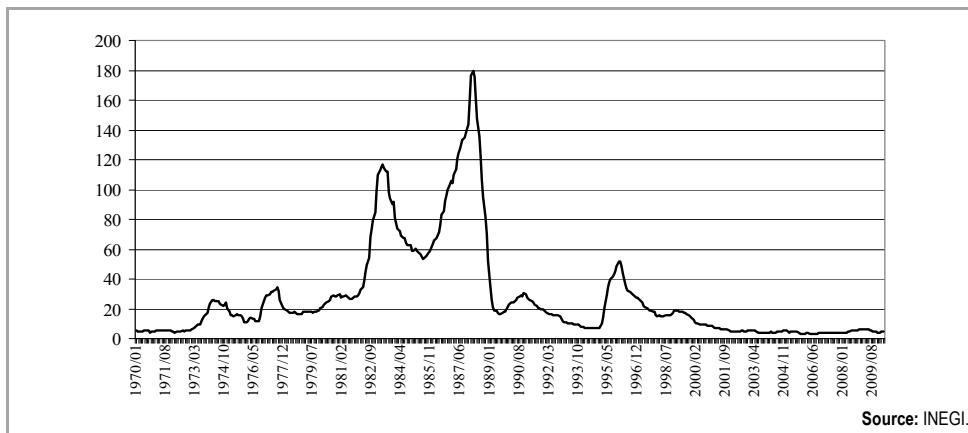

Source: INEGI.

Figure 3 Annual Rates of Inflation 1970:1-2010:3

As argued in the first section, one of the advantages of IT would be that, by anchoring inflation expectations around the inflation target, the volatility of inflation would fall. As Figure 3 shows, since 2000 Mexico has recorded an unparalleled period of low (below 10%) and stable inflation. Thus, during the period 1970:1-1999:12 the average annual inflation rate was 35.03%, with a standard deviation of 35.38. However, in the period 2000.1-2010:3, the average annual inflation rate fell to 5.21% with a standard deviation of 1.73: inflation is not only lower but also significantly more stable than in the past.

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[2] Moreover, even when the JB does reject the null hypothesis of normality, according to Greta M. Ljung and George E. P. Box (1978, p. 302): *"Circumstances occur where this assumption is not true (normality in the residuals)... Results by Anderson and Walker (1964) show that the asymptotic normality of the r_k's does not require normality of the a_t's only that var(a_t) is finite."*

As we have done for the level of inflation rates, in the next section we will analyze if the introduction of IT and FFIT explain the higher inflation stability registered in the last decade in Mexico. This is a relevant matter, since, in many respects, the effectiveness of the IT monetary strategy should be evaluated in terms not of its ability to reduce inflation rates to low levels, but, mainly, in terms of its ability to stabilize inflation once that low inflations rates have been achieved. Actually, Mishkin (2000) and Paul R. Masson, Miguel Savastano, and Sunil Sharma (1997) argue that in the case of emerging and developing economies with a record of high inflation rates, IT is an effective monetary strategy only when a successful disinflation has happened before the implementation of the IT. If we accept this hypothesis, IT and FFIT in Mexico should be evaluated not in terms of their capacity to reduce inflation rates but in terms of their capacity to keep and stabilize inflation performance at a low rate.

3. Has the Implementation of IT Stabilized Mexican Inflation?

In this section, the objective is to analyze whether the implementation of the inflation targeting strategy has helped to stabilize the Mexican inflation. With this aim, we will apply a number of statistical tests to the inflation performance in Mexico. We will also compare the performance of inflation in Mexico with that of the United States (USA), the Mexico's main trading partner.

To make this analysis, we have extracted inflation trends using a Hodrick-Prescott filter. Figure 4 shows the trends in annual inflation rates in Mexico and the United States during the period 1970:01 to 2009:01. Since the early 1970s until the late nineties, the inflation trend in Mexico has been much higher than that observed in United States. However, since 2000 a clear convergence in Mexican inflation trend to that of the USA is detected.
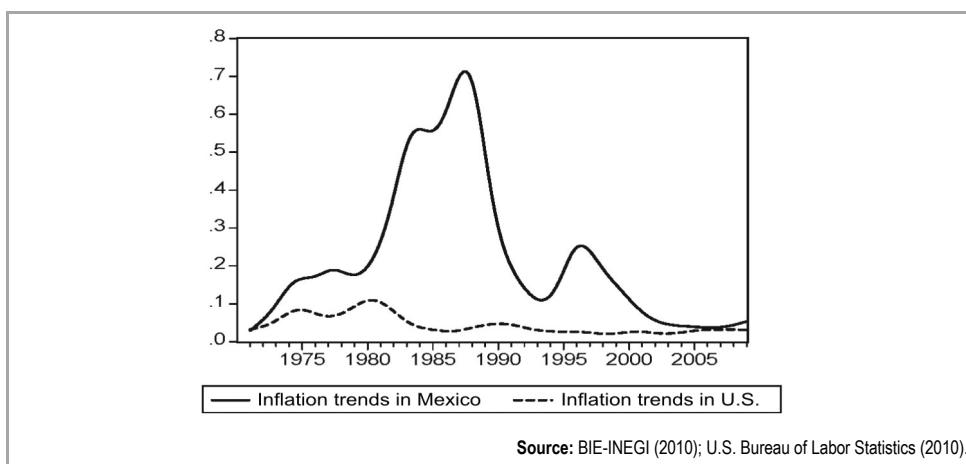

Source: BIE-INEGI (2010); U.S. Bureau of Labor Statistics (2010).

Figure 4 Trends of Annual Inflation Rates in Mexico and USA (1970-2008)

Table 4 divides the whole period analyzed into 5 sub-periods (1970:02-1980:12, 1981:01-1990:12, 1991:01-1998:12, 1999:01-2009:01, 1970:02-2009:01), and gives the mean and standard deviation of monthly inflation rates of United States and Mexico. Tests of equality of means (ANOVA F-statistic) and variances (F-test) are also used. The period 1999:01-2009:1 shows the behavior of inflation in both economies during the working of IT in Mexico.

Average inflation in Mexico is higher and statistically different in all periods. The variance is different in the periods 1970:02-1980:12, 1981:01-1990:12, 1991:01-1998:12 and in 1970:02-2009:01 (for the full sample). However, in the period under the IT strategy (1999:01-2009:01) not only the standard deviation of Mexican inflation is lower than in the USA, but also the F-test does not reject the null hypothesis of equal variances. Therefore, in that period the volatility of Mexican inflation during the IT period is statistically similar to that registered in the USA economy. As data show, the sizes of the standard deviation and the mean are directly related. Coefficient of variation (standard deviation divided by the mean) helps to offset this bias. Since 1999 the coefficients of variation of Mexican and USA inflation are 0.830 and 2.095, respectively, thus showing a more stable behaviour of Mexican inflation (although at a higher level than in the USA). This outcome would support the argument that IT has helped to reduce the inflation volatility in Mexico.

Table 4 Tests of Mean and Variance Equality of the Monthly Inflation in Mexico and United States (1970:02-2009:01)

1970:02-1980:12						
	Mean	Standard deviation	ANOVA F- statistic	Prob.	F-Test	Prob.
Mexico	0.013	0.010				
USA	0.006	0.004	49.418	0.000	7.031	0.000
1981:01-1990:12						
	Mean	Standard deviation	ANOVA F- statistic	Prob.	F-Test	Prob.
Mexico	0.042	0.026				
USA	0.004	0.003	248.902	0.000	83.227	0.000
1991:01-1998:12						
	Mean	Standard deviation	ANOVA F- statistic	Prob.	F-Test	Prob.
Mexico	0.015	0.012				
USA	0.002	0.001	110.561	0.000	59.692	0.000
1999:01-2009:01						
	Mean	Standard deviation	ANOVA F- statistic	Prob.	F-Test	Prob.
Mexico	0.005	0.004				
USA	0.002	0.004	23.650	0.000	1.280	0.178
1970:02-2009:01						
	Mean	Standard deviation	ANOVA F- statistic	Prob.	F-Test	Prob.
Mexico	0.018	0.021				
USA	0.004	0.004	227.567	0.000	30.666	0.000

Source: Authors' calculations.

However, the more stable performance of inflation in Mexico during the IT period may be due to a previous convergence in the Mexican and USA inflation volatility. To find the date when the null hypotheses of equality of means and/or variance are/is not rejected, we have applied the mean and variance equality tests in an iterative way to the monthly inflation rates in Mexico and the USA. Table 5 shows the results. The null hypothesis of equality of means is rejected for all the periods tested but null hypothesis of equality of variance is not rejected since July 1997 onwards. This date is well before the introduction of IT in 1999. Therefore, the volatility of Mexican inflation rates fell before the IT implementation. This conclusion agrees with the papers by Angeriz and Arestis (2007a, 2007b, 2008), and McDermott and McMenamin (2008), which conclude that inflation level and volatility is reduced before IT in some assessed countries (IT Lite countries, UK, OCDE and some Latin American countries, respectively).

To summarize, our results show that the reduction both in the level and the volatility of Mexican inflation was achieved before the introduction of the inflation targeting monetary strategy. Although IT is not the main determinant of the improvement in the inflation performance in Mexico, this does not mean that it has not had any impact on inflation. The data show the long lasting of the current phase of low and stable inflation. IT may well have contributed to lock-in these results by anchoring the expectations to this new environment of low inflation. Nonetheless, testing this hypothesis is beyond the scope of this paper.

Table 5 Convergence in Variability in Mexican and U.S. Inflation

	ANOVA F- statistic	Prob.	F-Test	Prob.
1998:12-2009:01	25.191	0.000	1.062	0.742
1998:11-2009:01	26.895	0.000	1.010	0.958
1998:10-2009:01	28.193	0.000	1.047	0.800
1998:09-2009:01	29.758	0.000	1.099	0.599
1998:08-2009:01	30.946	0.000	1.108	0.568
1998:07-2009:01	32.158	0.000	1.116	0.539
1998:06-2009:01	33.584	0.000	1.134	0.479
1998:05-2009:01	34.545	0.000	1.137	0.467
1998:04-2009:01	35.684	0.000	1.144	0.444
1998:03-2009:01	37.060	0.000	1.162	0.393
1998:02-2009:01	38.658	0.000	1.224	0.248
1998:01-2009:01	40.1210	0.000	1.336	0.097
1997:12-2009:01	42.143	0.000	1.360	0.077
1997:11-2009:01	43.926	0.000	1.369	0.070
1997:10-2009:01	44.864	0.000	1.371	0.068
1997:09-2009:01	46.284	0.000	1.390	0.056
1997:08-2009:01	47.481	0.000	1.394	0.052
1997:07-2009:02	48.780	0.000	1.398	0.050
1997:06-2009:03	50.117	0.000	1.402	0.047

Source: Authors' calculations.

4. Has the Implementation of IT Affected the Mexican Economic Growth?

Defenders of the IT monetary strategy argue that IT contributes to a better macro-economic performance in terms of price and output stability. By anchoring inflation expectations to the inflation target, the output stabilizes around its potential level, that is, the stability of inflation rates also leads to the stability of the output, reducing the volatility of the output gap. By itself, in this framework, inflation targeting does not affect the path of economic growth. However, if, like IT defenders argue, high and volatile inflation rates have a negative impact on output, the better inflation performance may have a positive impact on the economic activity, raising the rates of economic growth and reducing their volatility.
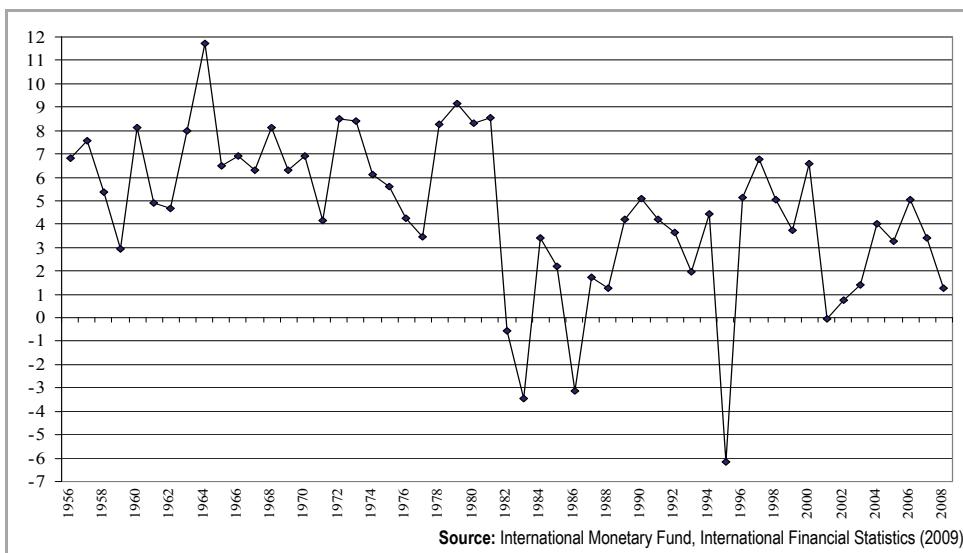

Source: International Monetary Fund, International Financial Statistics (2009).

Figure 5 Annual Rate of Growth of Mexican GDP (%)

Figure 5 shows the annual rates of economic growth in Mexico during the last six decades. The only clear conclusion we can get from the observation of these data is that since 1980 the economic growth is lower than in the sixties and the seventies, but it is difficult to say anything about the behavior in the more recent decades, and, consequently, about the impact of IT on the Mexican output.

To analyze whether IT and FFIT have affected the output growth and its volatility we have analyzed the economic growth in Mexico in the period 1981-2007 using statistical tests of equality of means and variances. We have used annualized data of quarterly GDP growth dates, splitting the whole period in 3 sub-periods, with the last sub-period (1999-2007) collecting the data corresponding to the implementation of the IT. Table 6 shows the results of this analysis.

Table 6 Tests of Mean and Variance Equality on Mexican GDP (1981-2007)

Period	Mean	Standard deviation	ANOVA F- statistic (regarding the entire period)	Prob.	F-Test (regarding the entire period)	Prob.
1981:01-1990:04	1.912	5.981	0.554	0.457	1.187	0.550
1991:01-1998:04	3.075	6.733	0.331	0.740	1.504	0.192
1999:01-2007:04	3.205	3.315	0.284	0.594	2.740	0.000
1981:01-2007:04	2.687	5.489				

Source: Our calculations based on Centro de Estudios de las Finanzas Públicas, Cámara de Diputados, México.

As Table 6 shows, the assumption of equal variances over the full period is not rejected during the periods 1981:01-1990:04 and 1991:01-1998:04, but it is rejected for the period 1999:01-2007:04. During the period 1999-2007 the volatility of the Mexican output was significantly lower than in the preceding years. Therefore, in this period there is a relationship between the low volatilities of output and inflation and the implementation of the IT, a conclusion in line with the postulates of this monetary strategy. In the case of the figures of the rates of economic growth, however, the hypothesis of equality of means is not rejected in any sub-period, involving that the lower inflation rates and higher price stability has not significantly affected the rates of economic growth.

Therefore, the better inflation performance has not led to a better economic growth outcome. That is, IT may have contributed to stabilize inflation at low rates, but it has not led to higher economic growth. Although the object of this paper is not to explain this outcome, we want to point out that it could be related to the behavior of the Mexican peso exchange rate and its relationship with the monetary policy[3]. The reason is that the impact of the changes in the exchange rate of the Mexican peso on economic activity is not symmetric. Thus, when monetary policy relaxes and the Mexican interest rate fall, leading to a depreciation of the exchange rate of the peso the positive effects on economic growth are limited, smaller than those registered in other economies like Brazil (Cuevas Ahumada 2009). The reason would be that the main determinant of Mexican exports is not their price but the USA demand of Mexican exports. But when Banxico raises the interest rates the appreciation of the peso has a negative impact on Mexican net exports (Galindo and Ros 2006, 2008).

5. Summary and Conclusions

After the debt crisis in 1982, Mexico started a process of adjustments and reforms that led to implement an export-led growth strategy. A key institutional and policy element of this strategy was the reform of the Banco de Mexico that increased the autonomy of the institution, the setting of an inflation target and the freedom to choose the policy tools. After the loss of credibility due to the Tequila crisis in 1995, and following the worldwide trends in monetary policy and central banking, Banxico decided to adopt inflation targeting as its monetary strategy.

According to our findings, both the level and volatility of inflation had begun to fall before the introduction of IT and Full-Fledged Inflation Targeting. Moreover,

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[3] See Stone et al. (2009) for a deep analysis of the role of the exchange rate in IT emerging economies.

since 1997, again before the implementation of IT, a convergence process of Mexican inflation to USA inflation is also detected. Regarding the impact of IT and FFIT on economic activity, during the targeting period there is no significant change in the rates of economic growth, although we detect a lower volatility of the economic growth; in sum, the economic growth has not been affected, although it is more stable than in the past.

In sum, the improvements in terms of lower and more stable inflation in Mexico cannot be solely (or mainly) attributed to the adoption of IT. This does not involve, mean, that the IT strategy has had no impact. The recent unparalleled stability of the low Mexican inflation might well be influenced by the IT, and this would have been the main contribution of this monetary strategy: the anchoring of inflation expectations to the inflation target.

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