Monetary policy and macroeconomic performance in Chile and Mexico

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1. Introduction

In the early 1990s, Chile and Mexico began disinflation processes that took off from similar levels of inflation. In Chile, this process was steady but very gradual, and did not conclude until late 1999 when the country moved from a crawling band to a floating exchange rate regime. In Mexico, the pace of disinflation was from the beginning faster, but at the same time the period required to reach the medium-term target of 3% has proven longer, an apparent contradiction that is in part explained by the costly collapse of the Mexican peso's exchange rate band in late 1994. Besides these differences in their recent inflationary histories, Chile has outperformed Mexico in other important macroeconomic dimensions such as economic growth, which has been higher and more stable in the former country; moreover, the phenomenon of real currency appreciation linked to disinflation was milder and less persistent in Chile.

The purpose of this paper is to examine the role that monetary policy has played in the different macroeconomic performances of Chile and Mexico. The paper is organized as follows. Section 2 presents an overview of growth and inflation in the two countries, while section 3 considers the relationship between these two variables and the real exchange rate. Section 4 focuses on monetary management. It begins with a qualitative analysis of episodes that featured a clear shift in the stance of monetary policy; this is then complemented with a quantitative analysis based on the estimation of country interest-rate equations. Finally, section 5 presents a summary of results.

2. Macroeconomic overview

a) Growth The growth performance of Mexico has been persistently below that of Chile. During 1985-1995, the average annual GDP growth rate, in per capita terms, was 6.03% in Chile but a minus 0.16% in Mexico. More recently, during 1995-2003, the gap between the countries became smaller but Chile remained well above Mexico (3.22% versus 1.06%). For the entire period of 1985-2003, Chile has had an advantage of almost four percentage points (4.54 versus 0.83) over Mexico (source: *World Development Indicators*).

As is well known, Mexico suffered a financial crisis after the collapse of its exchange rate band system in December 1994. This led to a severe contraction of GDP in 1995. Chile suffered no comparable trauma during its disinflationary process. However, it must be noted that the difference in growth performance between the two countries cannot be accounted by the single effect of the Tequila crisis. Rather, a look at growth averages over five-year periods shows that Mexico has consistently underperformed Chile (see table 1). The growth gap between the two countries has gradually narrowed down, from 4.5 points in the second half of the 1980s to 1.6 points in the first half of the 2000s. However, with the exception of the early 1990s, this reduction in the gap must be attributed to a fall in the growth rates of Chile's economy rather than to an increase in Mexico.

In addition to being slower, growth in Mexico has been more volatile than in Chile. In particular, during the period of 1985Q1-2005Q2 the coefficient of variation of the GDP growth rate of Mexico has practically doubled that of Chile (1.3 vs. 0.67). Again, this is not due to unusual behavior on specific dates but a rather consistent phenomenon. Looking at the coefficients of variation for five-year periods, Mexico has always been above Chile except for the first half of the 1990s (see table 1).

b) Inflation During the 1980s, inflation in Chile was relatively high and fluctuated widely but around a constant mean; the average annual inflation rate during the period of 1981Q1-1990Q4 was 20.5%. During the same interval, inflation in Mexico was higher and in addition showed a clear upward trend.

Table 1. Economic growth

	Average GDP growth rate 1/:		
	(A) Chile	(B) Mexico	(A)-(B)
1985Q1-2005Q2	5.70	2.67	3.03
1985Q1-1989Q4	5.71	1.25	4.46
1990Q1-1994Q4	7.36	3.87	3.49
1995Q1-1999Q4	5.68	2.92	2.76
2000Q1-2005Q2	4.19	2.63	1.56
	Coefficient of variation of GDP growth rate 2/:		
	(A) Chile	(B) Mexico	(B)/(C)
1985Q1-2005Q2	0.67	1.30	1.94
1985Q1-1989Q4	0.69	2.30	3.34
1990Q1-1994Q4	0.52	0.41	0.77
1995Q1-1999Q4	0.84	1.82	2.16
2000Q1-2005Q2	0.40	1.03	2.61

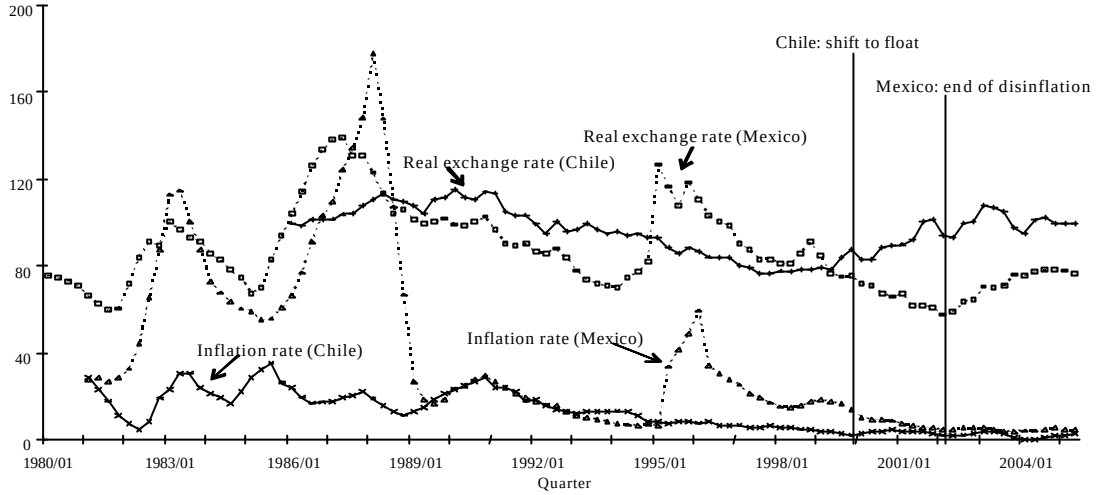
Notes: 1) Simple average of Q/Q rates. 2) Standard deviation over average of GDP growth rates.

Thus, while in early 1981 both countries had a similar annual inflation rate of about 28%, by mid 1983 the Mexican rate was almost 115% and reached a peak of 177% in the first quarter of 1988 (see figure 1).

This was the setting for the introduction of a new anti-inflationary program in Mexico (based on the so-called social pacts), which led to an immediate discrete fall in the inflation rate. As a consequence, by late 1989 the two countries had again essentially the same annual rate of inflation (of about 19%). For some time, Chile and Mexico had remarkably similar inflation trajectories, and in that way both countries started processes of gradual disinflation taking off from an inflation rate of close to 30% in the last quarter of

1990. Disinflation was faster in Mexico; as a result, by the end of 1994 this country had reached an annual inflation rate of 6.9%, while the corresponding rate was 8.7% in Chile.

Figure 1. Real exchange rate and inflation



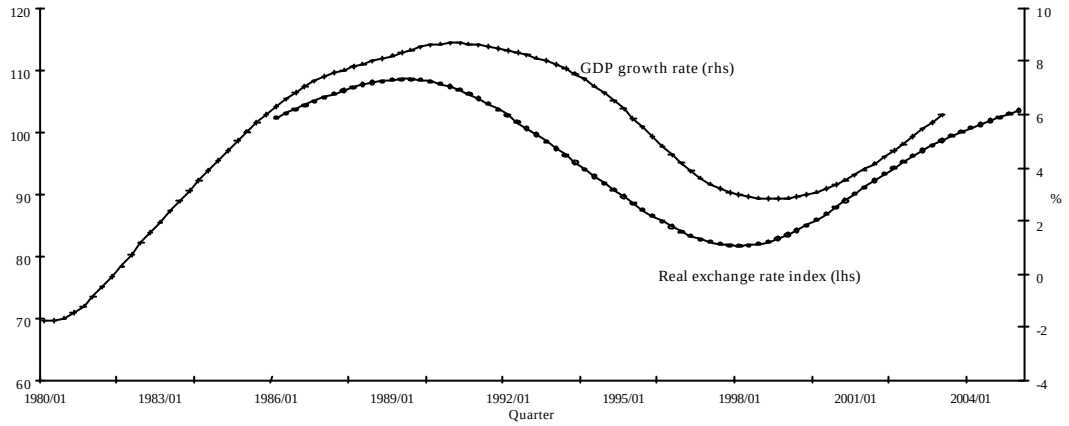
Notes: 1) Annual inflation rates in percentage. 2) A rise in the real exchange rate index (1990=100 in Mexico, April 1993=100 in Chile) is a depreciation.

The disinflation process was interrupted in Mexico by the currency crisis of December 1994. The heavy depreciation of the peso's exchange rate was transmitted to inflation, which surged to 60% in early 1996. After this, the country returned to its disinflation path, again at a faster pace than Chile but from a considerably higher level. By late 1999, Chile had practically concluded its disinflation process, with an inflation rate of about 3%. Mexico, in contrast, did not reach a situation of basically stable and low inflation rates until 2002 (although with inflation still above the 3% medium-term target).

3. Real exchange rate, growth and inflation

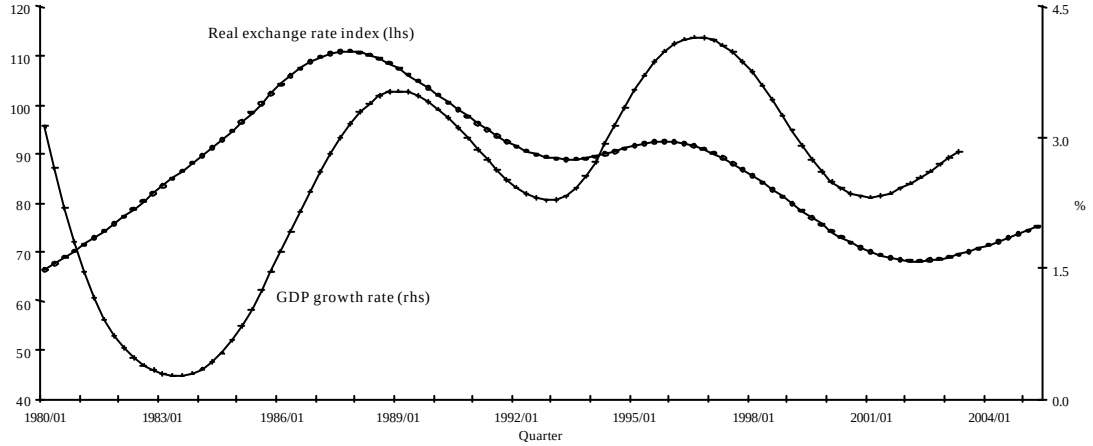
a) RER and growth As is well known, the effect of the real exchange rate on activity levels in developing countries can be a complex one, particularly because of the possibility of contractionary effects. Recently, for instance, some authors have found evidence of short-term contractionary effects but positive effects in the long run in Mexico (see Galindo & Ros 2005). Although it is not

Figure 2. Chile: real exchange rate index and output growth rate



Notes: 1) The series correspond to Hodrick-Prescott trends. 2) The GDP growth rate series is shown lagged eight quarters.

Figure 3. Mexico: real exchange rate index and output growth rate



Notes: 1) The series correspond to Hodrick-Prescott trends. 2) The GDP growth rate series is shown lagged eight quarters.

possible to conduct a detailed analysis here (see, for instance, Frenkel 2004 and Aguirre & Calderón 2005), the time series in figures 2 and 3 clearly suggest the existence of a positive relationship between the real exchange rate and the GDP growth rate. It can be seen that in both countries --abstracting from short-term fluctuations-- growth accelerations take place after periods of real currency depreciations, while growth decelerations follow periods of appreciation.

Focusing on trend values, the real exchange rate has had a smaller range of fluctuation in Chile than in Mexico (more on this below). Moreover, since the beginning of disinflation in the early 1990s the real exchange rate has shown no evident trend in Chile while it is following a clear downward trend in Mexico. These different stylized facts can provide at least part of the explanation as to why growth in Mexico has been lower and more unstable than in Chile.

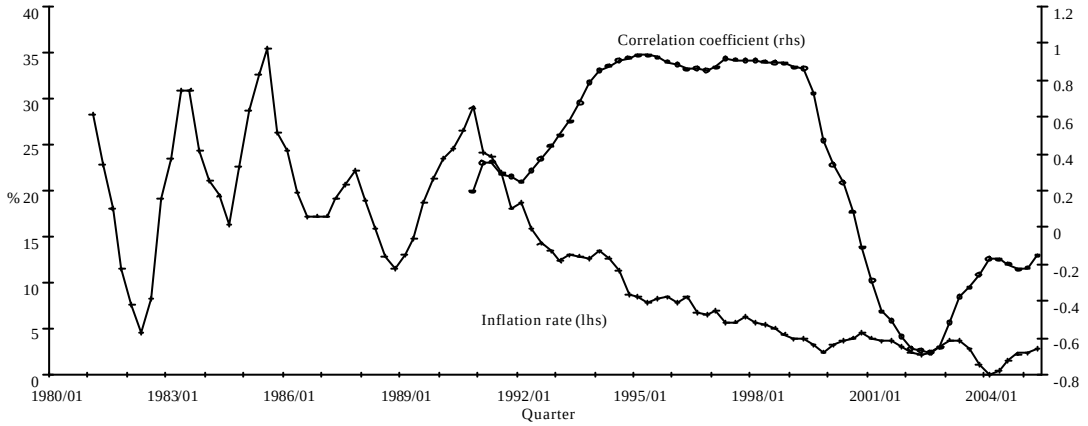
b) RER and inflation The evolution of the real exchange rate has been closely linked to the dynamics of inflation in the two countries. The most distinguishing feature is that the local currency has tended to appreciate in real terms during disinflation. Importantly, this has happened irrespective of the specific type of exchange rate regime in operation; in Mexico, for example, this association has appeared both during the band and float periods of disinflation. A second characteristic of this link is that the real appreciation has tended to revert after disinflation concluded.

Figures 4 and 5 elaborate on these observations. They show, separately for each country, the value of the correlation coefficient between the real exchange rate and the inflation rate for 5-year rolling windows of quarterly observations. Thus, the first observation in the series for Chile corresponds to the correlation coefficient calculated for the period of 1986Q1-1990Q4, the second observation corresponds to 1986Q2-1991Q1, and so on. The first observation for Mexico

corresponds to 1981Q1-1985Q4. The figures also show the quarterly series for the annual inflation rate in each country.

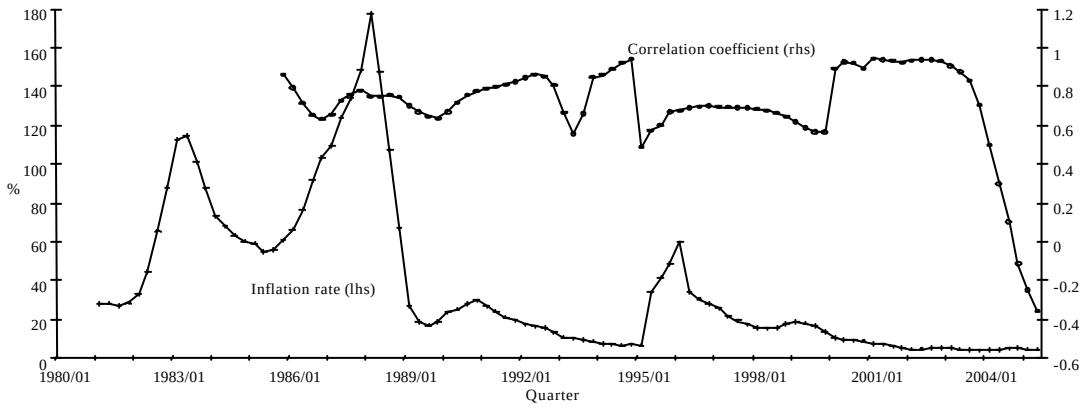
As the series make clear, the correlation coefficients tended to increase, and remain high, as each country entered into a phase of disinflation. This rise can be quite dramatic, as revealed most clearly by the Chilean case, where the correlation coefficients increased from 0.35 before disinflation to more than 0.90 in the midst of the process. This simply captures the fact that as inflation fell,

Figure 4. Chile: Inflation rate and moving real exchange rate-inflation rate correlation coefficients



Note: The correlation coefficient is calculated for 5-year rolling windows of quarterly observations.

Figure 5. Mexico: Inflation rate and moving real exchange rate-inflation rate correlation coefficients



Note: The correlation coefficient is calculated for 5-year rolling windows of quarterly observations.

there was real currency appreciation, irrespective of whether there was an exchange rate band --as in Chile or in the first phase of disinflation in Mexico--, or a float --as in the second stage in Mexico. The figures also show that once disinflation ends, the correlation coefficients collapse and in fact become negative.

The end of the fight against inflation has a potentially important implication for macroeconomic management. During disinflation, there is no sustained positive relationship between the nominal and the real exchange rate. In that setting, the exchange rate cannot play a major role in the stabilization of economic activity because the positive effect of a nominal depreciation on the real exchange rate is quickly reversed and what predominates is a negative correlation between the two rates.

During the disinflation period in Chile (1991Q1-1999Q4) the correlation coefficient between the nominal and the real exchange rate was minus 0.70; in contrast, during the previous five years, with high but relatively stable inflation, the correlation had been 0.87 (see table 2). The situation in Mexico was similar. After having been positive and large during the high inflation period, the correlation between the real and nominal exchange rate during 1989Q1-2001Q4 was minus 0.34. This is, in absolute terms, considerably lower than the Chilean coefficient; however, its value is affected by the sharp rise in the nominal exchange rate during the Tequila crisis. If we subtract from the sample the observations corresponding to the currency crisis (1994Q4-1995Q1) and calculate the correlation coefficients for the two sub-periods separately, the coefficients turn out much higher (in absolute terms): minus 0.75 for the pre-crisis period, and minus 0.80 in the post-crisis.

Thus, in a context of disinflation there is no significant transmission from changes in the nominal exchange rate to the real exchange rate. This situation disappears as the countries abandon the phase of disinflation. The nominal-real exchange rate correlation in Chile since 1998Q1 has been a very high 0.80; in Mexico, the correlation has been 0.99 calculated for the period since 2002Q1. Naturally, this implies that the nominal exchange rate can be used as a tool of macroeconomic management with activity levels goals rather than inflation goals.

Table 2. Real exchange rate

	Chile	Mexico
RER-NER correlations 1/		
High-inflation period	0.8686	0.6859
Disinflation period	-0.6855	-0.7498 (a) -0.7971 (b)
Low inflation	0.8002	0.9852
RER variability: Period: 1989Q1-2005Q2		
Coeff of variation 2/	0.1128	0.1847
Max-min spread 3/	0.4110	0.8259

Notes: 1/ RER=real exchange rate. NER=nominal exchange rate. High-inflation period is 1986Q1-1990Q4 in Chile and 1980Q1-1988Q4 in Mexico. Disinflation period is 1991Q1-1999Q4 in Chile; in Mexico, it is split into (a) 1989Q1-1993Q3 and (b) 1995Q2-2001Q4. Low-inflation period is 2000Q1-2005Q2 in Chile and 2002Q1-2005Q2 in Mexico. 2/ Standard deviation over period average. 3/ As proportion of period average.

Within these broad similarities in the relationship between inflation and the real exchange rate, there are however also important differences in our two countries. In particular, similar reductions in inflation were accompanied by greater currency appreciation in Mexico than in Chile (see, for instance, the early 1990s, or the level of the real exchange rate index at the end of disinflation in each country in figure 1). Moreover, the Chilean authorities showed a willingness to let the nominal exchange rate depreciate before inflation reached stationary levels. This is important because Chile avoided some further appreciation in the final stage of disinflation (1998-1999). This stands in contrast

to the Mexican case, in which the nominal exchange rate didn't begin to depreciate until inflation reached stationary levels in 2002.

As a result, the real exchange rate has been more stable in Chile. Considering the period from the first quarter of 1989 (a period with relatively similar real exchange rate and inflation rate positions in both countries) to the second quarter of 2005, the coefficient of variation of the real exchange rate has been more than 50% higher in Mexico than in Chile (18.5 vs. 11.3 percent, respectively; see table 2). Similarly, the spread between the maximum and the minimum values of the real exchange rate during the entire period was equivalent to 41.1% of the period average in Chile, but 82.6% in Mexico. As figure 1 shows, this larger spread in Mexico persists even if one abstracts from the abrupt change in the real exchange rate associated to the Tequila crisis.

4. The role of monetary policy

This section looks into the conduct of monetary policy in Chile and Mexico with the purpose of establishing possible links with the differences in macroeconomic performance observed between the two countries. It is organized in two parts. The first part presents a qualitative analysis that focuses on those episodes that clearly correspond to shifts in the stance of monetary policy. The goal is to identify specific features of the macroeconomic setting in which these shifts took place. The second part presents a quantitative assessment based on the estimation of an interest rate equation --in the form of an error correction model-- that distinguishes between the long-run --or "levels"-- relationship and short-run dynamics. Both parts consider macroeconomic determinants that are standard in the literature: the inflation rate, the output growth rate and/or the output gap (that is, the difference between actual output and its trend level), the exchange rate, and the US interest rate.

4.1 Qualitative analysis

a) Chile The analysis in this section is based on the evolution of the Central Bank of Chile's monetary policy rate. From May 1995 to July 2001, the policy rate was set directly in real terms; since August 2001 it has been set in nominal terms. The analysis is complemented with the use of a longer series for a market real interest rate, defined as the difference between an average of short-term lending and deposit rates and the current inflation rate.

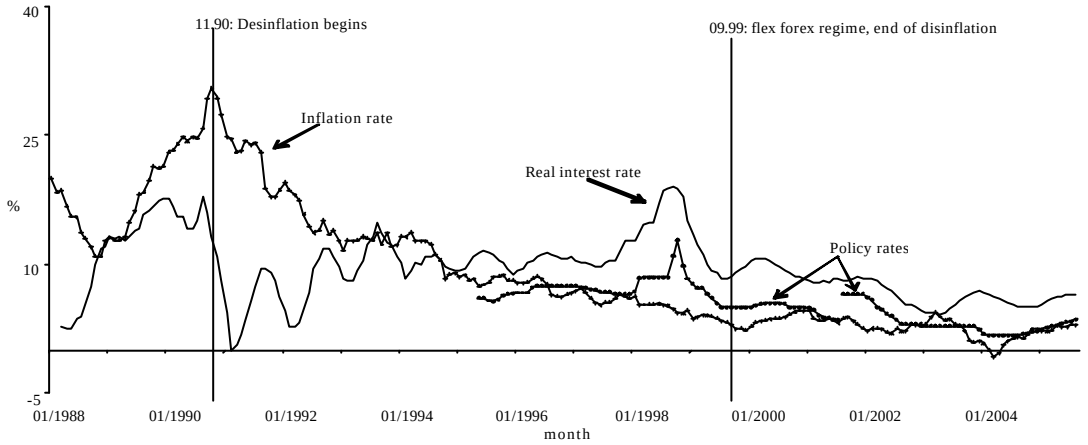
Based on the behavior of interest rates, it is possible to distinguish the following episodes in the conduct of monetary policy in Chile (see figure 6): *episode 1*) the steady rise of the market real interest rate in the initial years of the disinflation period (1991-1993); *episode 2*) the policy rate rises from September 1995 to May 1996; *episode 3*) the reductions of the policy rate during 1997; *episode 4*) the monetary tightening that began in early 1998 and gained force with the Russian crisis; *episode 5*) the period of low interest rates surrounding the shift from an exchange rate band to a float in September 1999, followed by the monetary loosening of 2001-2002; and finally, *episode 6*) the interest rate rises of late 2004, early 2005.

The inflation rate clearly was a factor in these episodes. The episodes featuring a rise in the policy rate typically were characterized by a deceleration (or even a stop) in the disinflation process. Frequently the exchange rate also played a role, so that rises in the policy rise took place in contexts of acceleration in the rate of currency depreciation (see figures 6 and 7).

Thus, for example, during *episode 2*, when the policy rate was raised from 5.7 to 7.5%, the disinflation process had stopped and an incipient upward trend in inflation emerged in the second half of 1995. In addition, the nominal

exchange rate had depreciated from about 372.5 pesos per dollar in June 1995 to 411.1 in November 1995. Importantly, this 10% depreciation only took the exchange rate closer to its central parity; moreover, after the depreciation the rate was at about the same level observed in early 1995 and well below the levels of 1994. Thus, the exchange rate band was safe and there was no possible concern of an excessive real currency depreciation. This suggests that the interest rate rise by the central bank was motivated not by the change in the exchange rate itself but by its possible inflationary impact.

Figure 6. Chile: inflation and interest rates

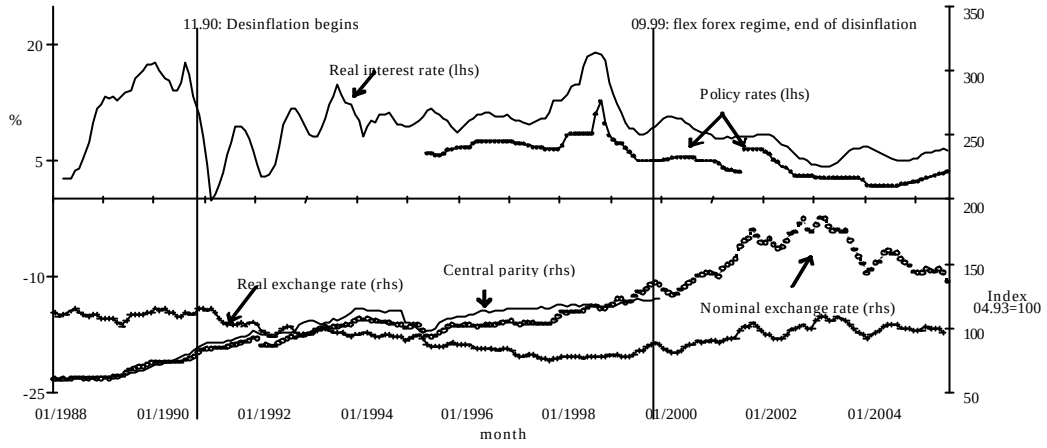


Note: The first part of the policy rate series is defined in real terms, while the second part is in nominal terms. The real interest rate series corresponds to the difference between an average of short-term lending and deposit rates, and current inflation.

The setting for *episode 4* was similar. The exchange rate had depreciated rapidly during the second half of 1997, in the aftermath of the Asian crisis. Again, the movement in the exchange rate itself does not appear as a sufficient factor to trigger an interest rate rise, because the exchange rate was only moving closer to central parity and there had been a significant amount of real appreciation accumulated since the early 1990s. However, probably as a result of the higher rate of currency depreciation, the disinflation process stopped during the first

half of 1998. In this context, the Chilean central bank raised its policy rate from 6.5% in December 1997 to 8.3% the following February. This stance was reinforced by the Russian crisis, which again resulted in rapid currency depreciation. Thus, by October 1998 the policy rate had reached a level of 12.8%.

Figure 7. Chile: interest and exchange rates



Note: A rise in the exchange rate indexes represents a currency depreciation.

The reaction of monetary policy to the exchange rate appeared to change over time as the country approached a situation of low and stable inflation. In the final months of 1998 and early 1999, the central bank embarked in a series of reductions in the policy rate at the same time that the US interest rate was increasing. As could be expected, during this time there was an acceleration in the rate of currency depreciation that eventually resulted in real exchange rate depreciation.

The decision to reduce the interest rate and thus allow for a higher rate of currency depreciation continued for some time. In September 1999 Chile moved from its crawling band to a floating exchange rate regime, a decision that

probably reflects the increasing cost of maintaining the band in a situation of low inflation and weak growth.[1] Around the time of transition, the policy rate was kept at the relatively low level of 5%. Further monetary loosening began in January 2001, and by July of that year the policy rate was only 3.5%. As a result of this change in policy stance, there was significant nominal and real currency depreciation during 1999-2001. This was important because it protected domestic activity from the adverse international scenario associated to the growth deceleration of the US economy that began in the second half of 2000.

The adjustments in the interest rate can also be linked to the output growth situation (see figure 8). In the initial stage of disinflation, raises in the interest rate were carried out in a context of high output growth rates (and positive values for the output gap). This was the case, for instance, of the rise in the market real interest rates in the first years of disinflation (*episode 1)*. During this episode, the nominal interest rate fluctuated widely but around a constant mean; however, because the inflation rate fell very rapidly (particularly during 1991-1992), the real interest rate tended to rise. This increase in the real interest rate occurred simultaneously with a recovery in domestic growth; in fact, the output growth rate peaked at more than 10% in late 1992.[2]

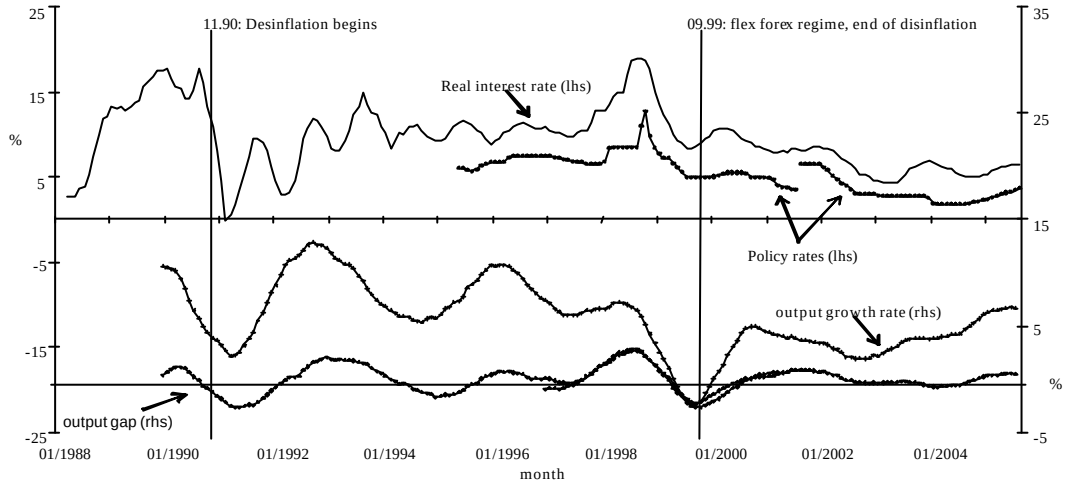
Another example is the monetary tightening of late 1995, early 1996 (*episode 2*). During this episode growth was high, with an annual rate of about 10% in the final months of 1995; moreover, a process of recovery had started in

[1] With an upward trend in the exchange rate --which was approaching the band's ceiling--, the defense of the band required increasing the interest rate. This would have a disinflationary effect, but inflation was already well within the desired range --it was 2.9% in September 1999, and falling--; the rise in interest rates would also depress growth, but growth was around zero at the time. Abandoning the band would allow for further currency depreciation and avoid having to increase local interest rates; furthermore, the recent experience suggested that currency depreciation would not be translated to domestic inflation (see de Gregorio and Tokman 2004).
[2] As could be expected, eventually growth started to decline, reaching rates of close to 5% by the end of 1994. By the same token, the output gap became negative and increasing in absolute terms in the second half of 1994.

the final months of 1994. As could be expected, the output gap was positive in early 1995.[3]

A concern for activity levels also shows up in the monetary loosening that took place in 1997 (*episode 3*). The previous monetary tightening --which was a response to a stop in the disinflation process-- had been successful, and disinflation had resumed in the second half of 1996. Moreover, the exchange rate moved again to the floor of its band during most of 1996 and 1997. On the other hand, there had been a deceleration of growth. The authorities reacted to this

Figure 8. Chile: interest rates, and output growth rate and output gap



Note: The series for the output growth rate and the output gap are 12-month, left-sided moving averages. The output gap is the difference between actual output and its Hodrick-Prescott trend.

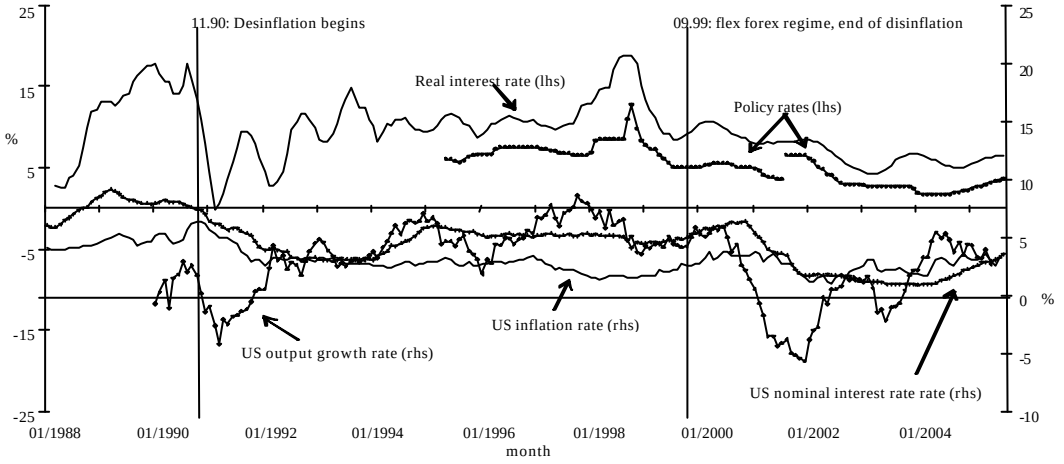
scenario with a series of policy rate reductions that began in February 1997 and that by the end of the year had taken it from 7.5 to 6.5%.

[3] Again, following the sustained rise in the policy rate there was a fall in output growth, which declined to about 6% by mid 1997.

However, there were also occasions when priority was given to the control of inflation over the protection of economic activity levels. The monetary tightening of 1998, for instance, took place in a context of low growth rates (by the country's standards). The same can be said of the rise in the policy rate during late 2004, early 2005.

Finally, the US rate appears to have played a role in some episodes (see figure 9). Clear examples are the monetary tightening of late 2004, early 2005 (*episode 6*) and the loosening of 2001 and 2002 (*episode 5*). But there are as well counter-examples. The interest rate rises of late 1995, early 1996 (*episode 2*) were carried out in a context of falling US interest rates, while the interest rate reductions leading to the change of exchange rate regime in 1999 (*episode 5*) took place as the US rate was rising.

Figure 9. Chile: interest rates and the US business cycle



b) Mexico Since 1996, monetary policy in Mexico has been conducted under a system of zero average reserve requirements for commercial banks (see Yacamán 1999 for a detailed description). The Banco de Mexico is committed to satisfy whatever level of reserves is demanded by the commercial banks. But the

conditions under which such reserves are supplied are indicative of the central bank's policy stance. In particular, if the Banco de Mexico announces a so-called short ("corto") of some amount, it means that such volume of commercial bank reserves will be supplied at penalty rates. A rise in the short has the purpose of pushing up market interest rates since it induces banks to compete for funds and avoid the penalization. In fact, it has been documented that such action does have a very short-run, transitory impact on local interest rates (see Díaz de León and Greenham 2000 for an analysis of the Treasury bill rate).

The effect of short changes on the interest rate is clearly shown by the series in figure 10. Interest rate rises (falls) are associated to short rises (falls). Note, however, that short rises have far outnumbered short reductions. This may be interpreted as a reflection of the fact that Mexico was immersed in a disinflationary process during this period. In Chile, however,, there were clearly defined periods of both increments and reductions in the real policy rate. Thus, the bias in short changes also reflects the fact that Mexico has followed a strategy of more rapid disinflation than Chile.

On the basis of changes in the short, we can clearly identify four episodes of monetary tightening: *episode 1*) March 1998 to January 1999, *episode 2*) May 2000 to January 2001, *episode 3*) December 2002 to March 2003, and *episode 4*) February 2004 to March 2005. These cases are characterized not by a single rise in the *short*, but rather by a whole series of consecutive rises.

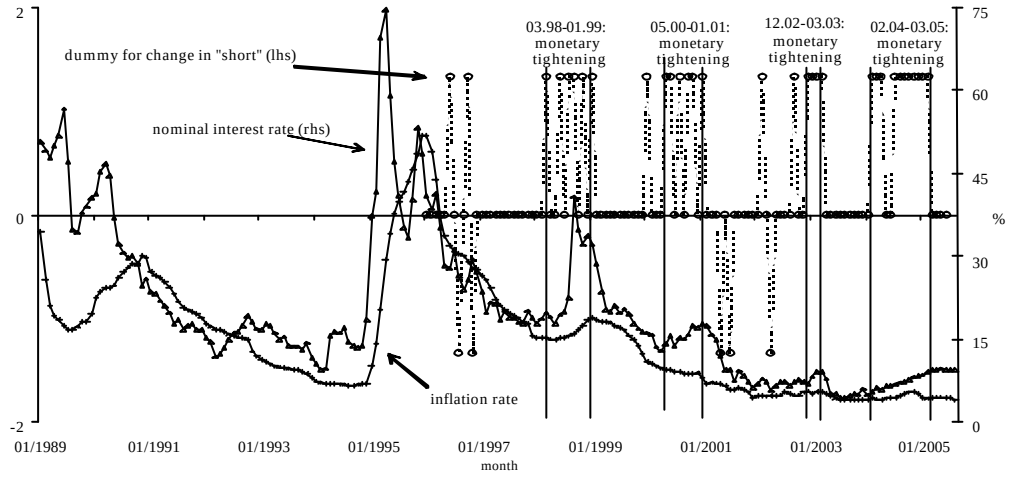
As in the case of Chile, inflation and the exchange rate appear as key influences on monetary policy (see figures 10 and 11). In particular, all cases of sustained monetary tightening took place in a setting where disinflation had decelerated or stopped (as in *episodes 2* and *3*) or where in fact there had been a

reversal (*episodes 1* and *4*). In all cases, the tightening was successful and inflation fell.

The reaction to the nominal exchange rate is also evident, although --as in the Chilean case-- a look at the behavior of the real exchange rate suggests that the reaction is not to the exchange rate itself but rather to its possible inflationary impact. Before *episode 1*, the peso had begun to depreciate in November 1997 --in the aftermath of the Asian crisis--, after a year of being practically constant. In that single month the currency depreciated in 5%, and by July 1998, before the Russian crisis, it had accumulated a depreciation of more than 12%.

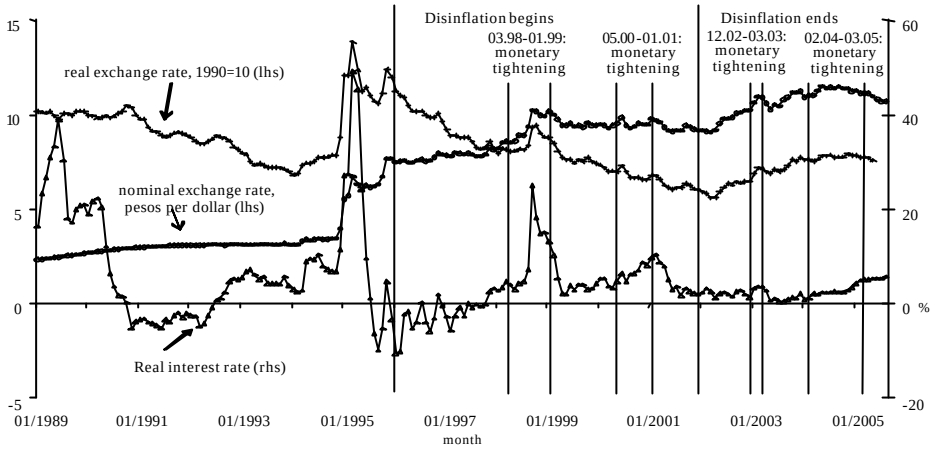
Importantly, the authorities fought the ongoing currency depreciation despite the fact that in the immediately preceding period of disinflation the peso had accumulated a large degree of appreciation in real terms. The real exchange

Figure 10. Mexico: interest rate, inflation rate and changes in "corto"



Notes: a positive value for the short dummy indicates a rise (fall) in the size of the short. A short rise indicates the adoption of a tighter monetary policy stance.

Figure 11. Mexico: nominal and real exchange rate, and real interest rate



Notes: 1) A rise in the exchange rate indicates a depreciation. 2) The real interest rate is the difference between the nominal rate and current inflation.

rate index calculated by the central bank had a value of 82.2 in October 1997, while it had started from a level of 112.6 in January 1996 when disinflation began; the October 1997 level was similar to the level observed in November 1994, just one month before the collapse of the Mexican peso band.

Episode 3 shows that the reaction to the exchange rate is not necessarily immediate, particularly in a context of low inflation. Starting in the second quarter of 2002, the nominal exchange rate had begun to depreciate, increasing from 9.1 in March to 10.2 in December 2002. With a stable inflation rate, this discrete adjustment in the nominal exchange rate resulted in real depreciation of close to 17%. During this time, the nominal and real interest rates had remained mostly unchanged. Thus, it appears that, with inflation having fallen to about 5%, the authorities were initially willing to tolerate some currency depreciation, even if this meant no further progress in the reduction of inflation. However, an acceleration in the rate of currency depreciation finally induced a series of *short*

rises in early 2003. This took place despite the substantial degree of real currency appreciation accumulated in the previous years[4].

During the final episode of monetary tightening to be considered in this paper (February 2004 to March 2005), our measure of the real interest rate increased from 1 to 5%. An important factor in the policy decision was the difficulties faced to achieve the central bank's 3% inflation target. In fact, despite the tightening, inflation fell from 4.53% in February 2004 to only 4.47% in July 2005 and 3.95% in August 2005, more than a year and a half after the restriction began.

The exchange rate was also playing a role. After some appreciation during the first months of 2003, the peso began to depreciate at a rapid pace. The exchange rate increased from 10.25 in May 2003 to 11.24 in December. A series of short rises began in February 2004 and, as a consequence, by August 2005 the exchange rate had already fallen to 10.7. One way to interpret this evidence is that the currency depreciation was a factor behind the difficulties to finally attain the inflation target, and thus that the tightening was in part a reaction seeking to avoid further depreciation.

The eventual nominal appreciation that started in the last quarter of 2004 was thus a welcome development. The drawback, of course, is that the process of real currency depreciation, which was reverting the real appreciation inherited from the disinflation period, stopped too early. By May 2005, the central bank's real exchange rate index stood at 75.7, comparable to the levels observed in mid 1994 before the Tequila crisis.

[4] The real exchange rate index had fallen to an incredible level of 55.7 in March 2002, well below the lowest level –68.8– observed during the band regime before the currency crash; by December 2002, when the short rises began, the index had a value of 65.

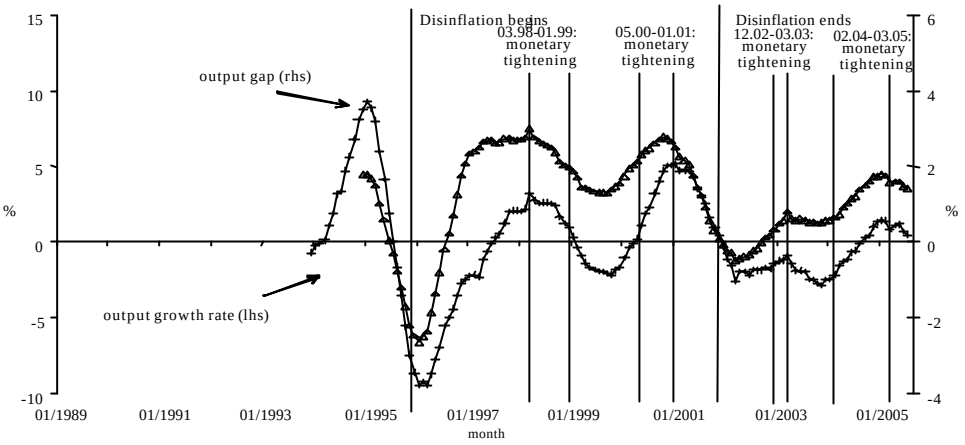
The first episodes of monetary tightening in Mexico in the floating period were characterized by the existence of relatively high levels of economic activity. When the series of short rises of *episode 1* began, the economy was emerging from a period of growth recovery, with an output growth rate well above 5% and a positive output gap; of course, as a consequence of the tightening, growth fell and the output gap eventually became negative. Exactly the same characterization can be made of *episode 2* (see figure 12).

There is no doubt, however, that control of inflation has dominated any possible concern about the growth situation (which is consistent with the lack of concern for the real exchange rate noted before). Thus, when monetary policy shifted to a more restrictive stance in December 2002, the annual rate of output growth was only 2%; unsurprisingly, the output gap was negative. By the same token, the shy process of growth recovery that had started in the first half of 2004 stopped in the context of *episode 4* of monetary tightening, and growth rates fell to between 2 and 3% during most of 2005.

Thus, Mexico's central bank has been willing to move to a more restrictive policy stance irrespective of the existence of a bad growth situation. On the other hand, there is no single example of the adoption of a series of consecutive *short* reductions intended to spur growth, even in the general situation of low growth and low inflation observed since mid 2001. In this respect, it appears that the monetary authorities are content to simply follow the US business cycle.[5]

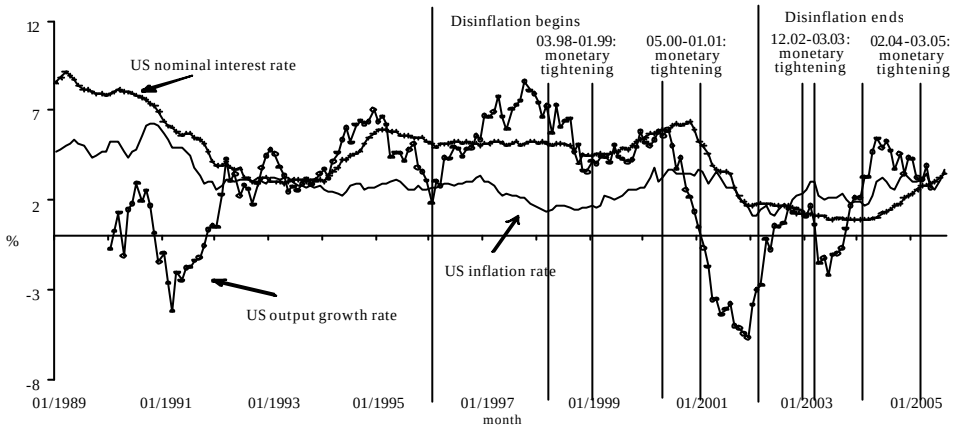
[5] The correlation coefficient between the quarterly series of annual GDP growth rates of Mexico and the US increased from 0.31 in the second half of the 1980s to 0.87 one decade later and 0.78 in the first half of the 2000s.

Figure 12. Mexico: output growth rate and output gap



Note: The series for the output growth rate and the output gap are 12-month, left-sided moving averages. The output gap is the difference between actual output and its Hodrick-Prescott trend.

Figure 13. Mexico: monetary tightening and the US business cycle



In fact, there are two important occasions in which changes in the US interest rate appear to have had an influence on Mexico's monetary policy (see figure 13). One is in *episode 2*. As an immediate response to the Russian crisis and its implications for global financial markets, there was a (mild) reduction in US interest rates in the final months of 1998; the T-bill rate fell from about 5% before

the crisis to about 4.5% in late 1998. However, as the threat to the global financial markets subsided, and at the same time US inflation began a clear upward trend, there was a reversion in US monetary policy. As a result, US interest rates began to increase in the second half of 1999, in a process that would end only in the last months of 2000, with inflation stabilized and in the beginning of a downward trend and with the US heading into recession (the annual growth rate of the monthly index of industrial production in the US would eventually fall from 6% in June 2000 to *minus* 5.7% in December 2001).

The US interest rate increased from less than 5% in mid 1999 to 6.4% in November 2000. During the second half of 1999 and the early 2000, before the tightening in Mexico began, the Mexican nominal interest rate followed a diverging trend from the nominal US interest rate, with no major change in the Mexican policy stance but a small, one-time rise in the "short" in January 2000. Eventually, however, the Mexican authorities changed their policy stance and began to follow the US rate, perhaps due to concerns on the possible impact on the peso's exchange rate.

During *episode 4* (from February 2004 to March 2005) there is again evidence of a significant influence of US monetary conditions on Mexico. On this occasion, the progressive tightening of monetary conditions in Mexico practically mirrored the successive increases in US interest rates as the Fed adopted a stricter policy stance to fight a resumption of inflation. As mentioned before, the Mexican authorities appeared content to follow the US cycle, despite the fact that domestic growth was weak (and despite the monetary autonomy afforded by the float in a setting of low inflation). In fact, while US interest rates rose by 2 percentage points --from 0.9 to 2.8%–, the Mexican interest rate rose by almost 4 points --5.6 to 9.4%--.

4.2 Econometric analysis

The previous analysis, while suggestive of similarities and differences in monetary management between Chile and Mexico, is necessarily of a qualitative nature. This subsection presents a complementary quantitative view based on the estimation of interest rate equations. The model to be used allows for a distinction between long-run (or "levels") relationships, and short-term dynamics. Thus, for each country, the initial specification is an error-correction model of the form:

(1)

$$\Delta nir_t = \sum_{m=1}^{M} a_m \Delta nir_{t-m} + \sum_{l=0}^{L} b_l \Delta ri_{t-l} + \sum_{l=0}^{L} d_l \Delta rer_{t-l} + \sum_{l=0}^{L} t_l \Delta out_{t-l} + \sum_{l=0}^{L} f_l \Delta usr_{t-l} + \gamma (nir_{t-1} - nir^{lr}_{t-1}) + e_t$$

where *nir* is the percentage nominal interest rate, *ri* is the percentage inflation rate, *rer* is the log real exchange rate (a rise corresponds to a depreciation), *out* is the output gap, and *usr* is the percentage US real interest rate. In equation (1), nir^{lr} is the long-run value of the interest rate as determined by the following "levels" relationship:

(2) $$nir^{lr}_t = \alpha + \beta ri_t + \delta rer_t + \theta out_t + \phi usr_t$$

As is well known, this equation specification can be derived from a general unrestricted autoregressive-distributed lag model of order (M+1, L+1) (see Frankel et al 2002 for a similar specification). For our analysis, we assume M=L=2. The actual lag structure of the short-term part of the model was simplified according to the statistical significance of the individual coefficients.

Therefore, the dynamic effects on the interest rate shown below are based only on estimated coefficients with p-values below 0.10.

The term in parenthesis on the right-hand side of the equation is the deviation of the actual real interest rate from its "long-run" value. The parameter ? measures the speed of adjustment toward equilibrium. For the relationship to be meaningful, the estimated value of ? must be negative. A statistically significant long-run relationship will exist if it is possible to reject the hypothesis that ?? is equal to zero. The estimation procedure had two steps: initially, the long-run relationship (equation 2) was estimated; and next, this was used to estimate the complete ECM (equation 1).

Given the stylized facts discussed above, it was decided to estimate separate equations for the disinflation and the subsequent periods in each country. Thus, estimation periods for Chile were 1990M1-1999M12 (adjusting for the observations lost due to lags) and 2000M1-2005M6. The first period corresponds to the band regime (the disinflationary stage); the second period corresponds to the floating regime, with the country having achieved low and stable inflation. In the case of Mexico, the model was estimated for two periods: 1996M1-2001M12 – when the country was in disinflation--, and 2002M1-2005M5 --characterized by low and stable inflation rates. The results are presented in table 3.

Disinflation period We will start by discussing the results for the disinflation periods in both countries. The fit of the long-term part of the model is good: adjusted R-square levels are high (0.95 for Mexico and 0.74 for Chile), and most coefficients are statistically significant and with the expected signs.

Table 3. Interest rate equations

Dependent variable: nominal interest rate, OLS estimation

	Chile				Mexico			
	Model 1 (band)		Model 2 (float)		Model 1 (early float)		Model 2 (late float)	
Simples	1990:03 1999:12, n=118		2000:02 2005:06, n=65		1996:02 2001:12, n=71		2002:02 2005:05, n=40	
(A) Long-run coefficients:								
	coeff	p-value	coeff	p-value	coeff	p-value	coeff	p-value
inflation rate	1.2375	0.0000	0.7731	0.0000	0.6604	0.0000	0.9728	0.0003
log real exchange rate	19.3811	0.0650	-14.8547	0.0002	74.52	0.0000	---	---
output gap	181.23	0.0000	65.0464	0.0141	175.44	0.0000	209.67	0.0000
US real interest rate	1.4625	0.0012	0.5464	0.0142	1.2033	0.0006	0.4831	0.0045
Russia	8.3102	0.0104	---	---	5.1714	0.0035	---	---
linear trend	0.0963	0.0295	---	---	0.5160	0.0000	---	---
Constant	-89.46	0.0670	75.47	0.0000	-381.53	0.0000	3.8041	0.0030
adj R-sq	0.7439		0.8606		0.9485		0.7356	
ADF on residuals	-6.6637	0.0000	-3.6997	0.0063	-6.2647	0.0000	-3.4878	0.0132
(B) Short-term dynamics:								
EC coefficient	-0.5978 ***		-0.3886 ***		-0.6648 ***		-0.4537 ***	
Wald tests on differences of:								
interest rate	0.0345		0.0595		0.0008		0.0045	
inflation rate	0.0000		0.0490		0.0160		---	
log real exchange rate	0.0726		0.0214		0.0000		0.0047	
output gap	0.0402		---		---		0.2190	
US real interest rate	---		---		0.0192		---	
Russia	0.0100		---		0.0000		---	
russia*d(log RER)	0.0151		---		0.0000		---	
adj R-sq	0.4645		0.2392		0.8651		0.4431	
DW	1.8558		1.9336		2.0537		1.9935	

Notes: 1) The Russia dummy is equal to 1 in September and October 1998, and zero the rest of the sample. 2) Short-term model specifications: all variables in differences, except the error correction term and the Russia dummy; all models include one lag of the error correction term; the models for the early part of the samples include the Russia dummy alone and interacted with the log real exchange rate. Other right-hand side variables:a) Chile model 1: lagged nominal interest rate, current and lagged inflation rate, two lags of log real exchange rate, two lags of output gap. b) Chile model 2: lagged nominal interest rate, current inflation rate, current log real exchange rate, lagged output gap. c) Mexico model 1: two lags of nominal interest rate, two lags of inflation rate, current and lagged log real exchange rate, two lags of US real interest rate. d) Mexico model 2: lagged nominal interest rate, current log real exchange rate, current output gap.

Note that both country equations include a time trend and a 0-1 dummy for the Russian crisis. Importantly, the speed of adjustment (or error correction) coefficient is negative and highly significant, and relatively large in absolute terms (-0.66 in Mexico and -0.60 in Chile); this supports the idea that there does exist a meaningful long-term relationship between the chosen variables.

There are important similarities between the two countries. One is the evidence of full transmission of changes in the US interest rate to the local interest rate, despite the different exchange rate regimes: the point estimate for the US interest rate coefficient is 1.46 in Chile and 1.20 in Mexico; in both countries, the hypothesis that the coefficient is equal to one cannot be rejected at conventional levels (p-value of 0.29 in Chile and 0.54 in Mexico). Another result is that the coefficients linking interest rates to the output gap have similar sizes: a one percentage point change in the output gap induced an interest rate change of 1.81 in Chile and 1.75 in Mexico.[6] Thus, in both countries the interest rate tended to behave in anti-cyclical fashion in the long run (although not necessarily so in the short term, as will be seen).

A final similarity is that in both countries the coefficients for the inflation rate and the real exchange rate are positive. However, the size of the estimated coefficients differs greatly between the countries. Thus, while the estimated inflation coefficient is 1.24 in Chile, it is only 0.66 in Mexico; moreover, the hypothesis that the coefficient is not significantly different from one has a p-value of 0.18 in Chile but 0.0002 in Mexico. Thus, while in Chile during the disinflation period the nominal interest rate tended to adjust fully to inflation, in Mexico this adjustment was partial. Therefore, as inflation tended to fall in Mexico, nominal interest rates followed the same trend but to a smaller degree. This introduced an upward bias in the real interest rate. This may explain partly why the pace of disinflation tended to be faster and the real exchange rate appreciation stronger in Mexico than in Chile.

[6] Corbo (2002), in contrast, found that the real interest rate did not react in a statistically significant way to variations in the output gap during the band period in Chile. Caputo (2004), using a longer estimation period, found a statistically significant output coefficient.

In the case of the real exchange rate, the situation is the opposite. In both countries the estimated real exchange rate coefficient is positive (reflecting a policy of leaning against the wind) but it is much higher in Mexico (74.5) than in Chile (19.4)[7]. Thus, it appears that interest rates were more sensitive to sustained variations in the real exchange rate in Mexico than in Chile during their respective disinflation periods, despite the fact that Mexico was in a float and Chile had an exchange rate band.

Now, it is important to recall that during this stage the real exchange rate in both countries followed a downward trend; thus the positive coefficient indicates that, controlling for the effect of inflation and the US interest rate (and recall that the model includes a linear trend), a fall in the real exchange rate (a currency appreciation) led to a fall in the local interest rate. This of course would have tended to reduce the extent of appreciation. Somewhat surprisingly, this effect was stronger in Mexico, where the extent of real currency appreciation was also greater.

To get a complete picture of interest rate behavior, let us now consider short-term dynamics. For this we will use the estimated coefficients of the variables in differences and calculate the dynamic effect of a change in each variable on the interest rate. In this calculation it is assumed that changes in the relevant variables are transitory but "persistent"; in particular, it is assumed that they last for three periods (months). The variables we focus on are the inflation rate, the real exchange rate and the output gap.

Beginning with inflation, it is possible to see a very strong response in Chile. A one-point change in the inflation rate elicited a more than proportional

[7] See Mohanty & Klau (2004) for a similar result. As is well known, the practice of leaning against the wind is fairly common among emerging market economies (see Ho & McCauley 2003).

rise in the nominal interest rate (of 2.5 points after two periods; see figure 14). In contrast, the corresponding response in Mexico was much smaller (of about 0.5 after one period; see figure 15). At first sight it is puzzling that Mexico had a milder response to changes in inflation and yet its pace of disinflation was faster than Chile's. As mentioned, though, one way to interpret these results is to consider that inflation changes in Mexico were mostly reductions; the fact that the interest rate responded less than fully to changes in inflation means that the real interest rate tended to increase as inflation fell, leading to faster disinflation.

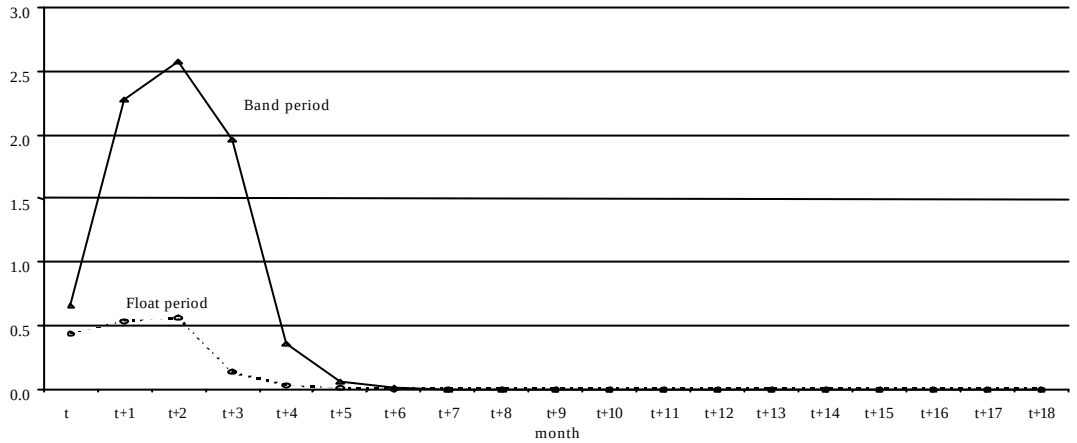
Consider next the real exchange rate. We find that the short-term interest rate response differed markedly between Mexico and Chile. In Mexico, a 10 percent change in the real exchange rate immediately led to a 5 point rise in the interest rate, which over time would die out. In Chile, in contrast, the dynamic effect comes close to a textbook case of uncovered interest parity, in the sense that the currency depreciation initially led to a fall in the interest rate, which after four periods would be more than fully reversed and finally die out (see figures 16 and 17).

Finally, in terms of output, in the case of Mexico there is no evidence of a statistically significant short-term effect on the interest rate. In Chile, instead, the evidence is consistent with a more active stabilization policy: a one-point rise in the output gap would lead to a 4.5 point rise in the interest rate after only one period (note that our measure of the output gap corresponds to the 12-month moving average, so the variable captures protracted changes), which would later be more than fully reversed and finally die out.

In synthesis, in Chile during its disinflation period there is evidence of a significant stabilization policy with respect to output and also a textbook case of negative short-term link between currency depreciation and the interest rate; at

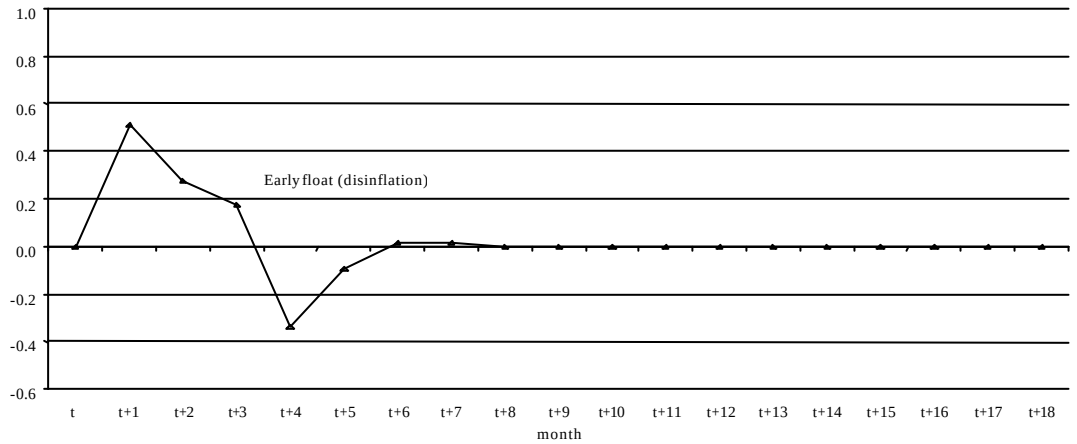
the same time, the response to changes in inflation was particularly strong. In Mexico, instead, the response to inflation changes during its disinflation period was much milder and the response to output was not significant, while the response to real exchange rate changes was particularly strong.

Figure 14. Chile: dynamic effect of inflation on the nominal interest rate



Note: the figure shows the effect of a one percentage point rise in the inflation rate that lasts for three periods.

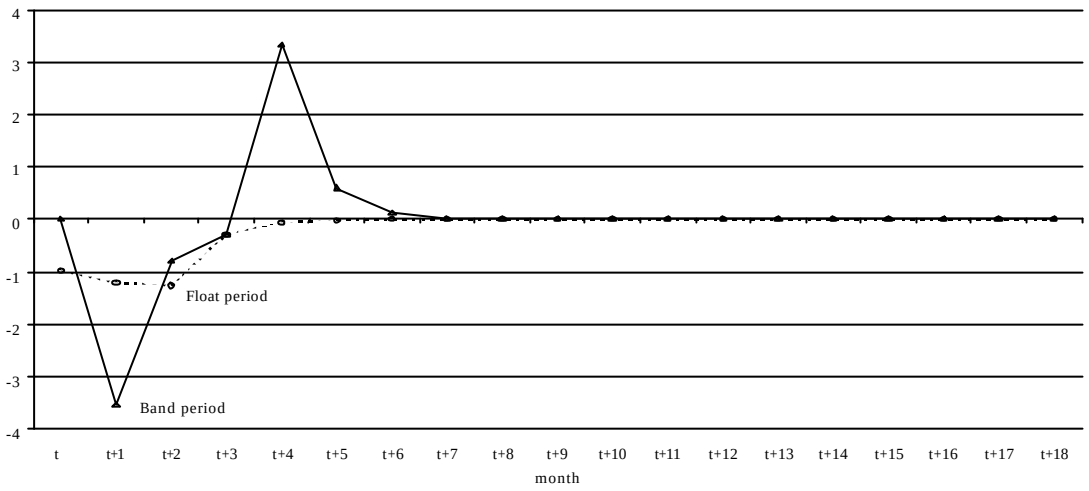
Figure 15. Mexico: dynamic effect of inflation on the nominal interest rate



Note: the figure shows the effect of a one percentage point rise in the inflation rate that lasts for three periods.

The observed responses to output help to explain why Chile had a more stable growth path than Mexico. The response to inflation –both in levels and in differences-- may also help to explain why Chile had higher growth than Mexico, given that the nominal interest rate reacted more forcefully to the ongoing falls in inflation. The response to the exchange rate --both in levels and in differences--, however, does not help to explain why the real exchange rate was more stable in

Figure 16. Chile: dynamic effect of the real exchange rate on the nominal interest rate



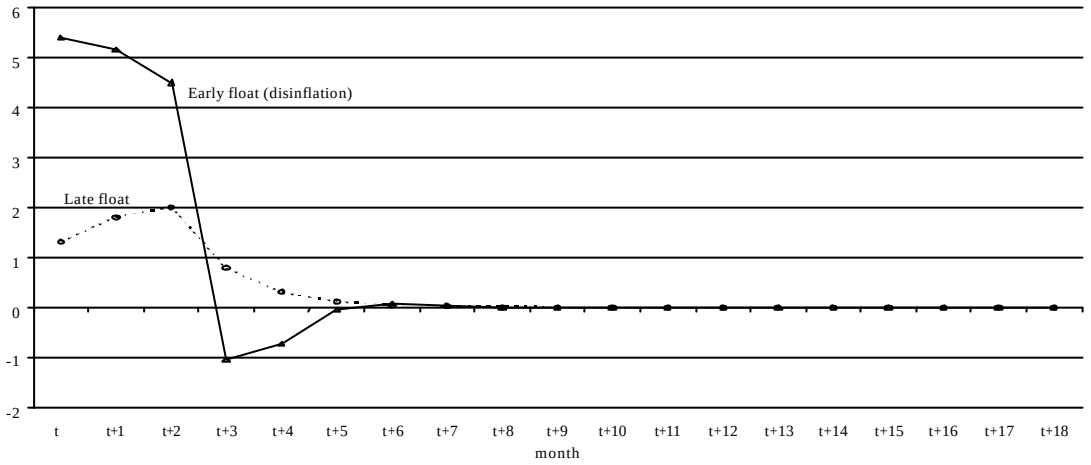
Note: the figure shows the effect of a ten percent rise in the real exchange rate that lasts for three periods.

Chile. This may be related instead to the observed reaction of interest rates to inflation: since the reaction in Mexico was relatively mild (less than proportional), this introduced an upward bias in real interest rate that tended to reinforce the ongoing process of real currency appreciation.

Stable inflation period There are interesting changes in both countries as we move to the period of low and stable inflation (see again table 3). A common change is that the estimated transmission of US interest rate to the local rates becomes much smaller. In Chile, the point estimated for the US real interest rate fell from 1.46 to 0.55 in the low inflation period. This perhaps is not surprising as

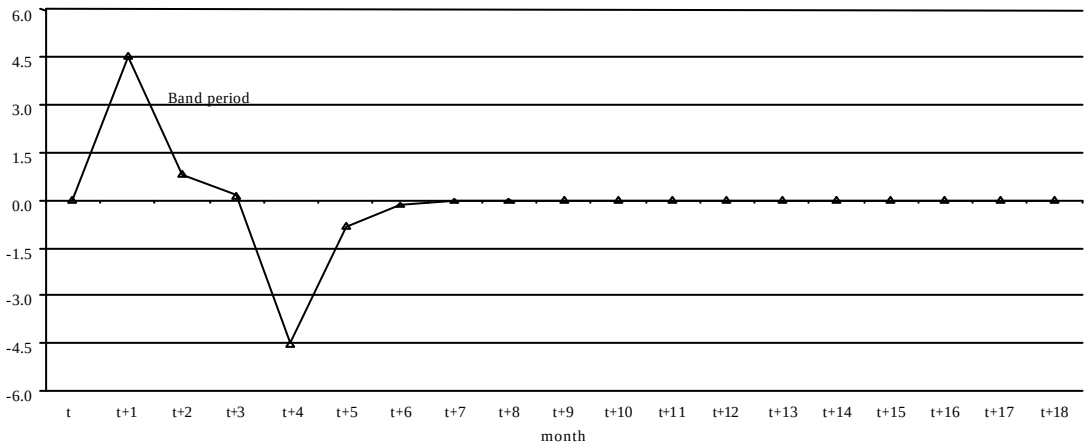
it coincides with a shift to a floating exchange rate regime, which in principle should enhance local monetary autonomy. However, something similar happened in Mexico although no change in exchange regime took place there. In particular, the estimated coefficient fell from 1.20 in the disinflation period to 0.48. In both countries, the hypothesis that the coefficient equals one (full transmission) is amply rejected.

Figure 17. Mexico: dynamic effect of the real exchange rate on the nominal interest rate



Note: the figure shows the effect of a ten percent rise in the real exchange rate that lasts for three periods.

Figure 18. Chile: dynamic effect of the output gap on the nominal interest rate



Note: the figure shows the effect of a one percentage point rise in the output gap that lasts for three periods.

An important observation (pointing perhaps in the same direction of greater monetary autonomy) is that in Mexico the real exchange rate coefficient became non-significant, while it had been highly significant (and large) in the disinflation period. In terms of short-term dynamics, the effect remains significant but much smaller than during the disinflation period (with a peak change of 2 points in the interest rate for a 10-percent change in the real exchange rate, rather than the 5.5 peak of the previous period[8]). In Chile the story is similar. The real exchange rate coefficient in the long-term relationship in fact becomes negative, while the short-term effect on the interest rate remains negative as in the disinflation period.

It is important to mention, however, that this greater monetary autonomy has not been reflected in a stronger response to the output gap. In Mexico, the long-term coefficient has been stable (the point estimate increased from 1.8 --for a one-point change in the gap-- during disinflation to 2.1 in the more recent period). However, the short-term effect has in fact become non-significant. In Chile, not only the short-term effect became non-significant, but the output gap coefficient in the long term relationship fell (from 1.8 to 0.7).

5. Preliminary conclusions

The recent macroeconomic histories of Chile and Mexico show some similarities, particularly with respect to inflation. The two countries began gradual disinflation processes, taking off from practically equal inflation rates, in the early 1990s. Both had at the time an explicit exchange rate band. But eventually the paths diverged. Chile concluded its disinflation process in 1999 and shifted to a float. Mexico, instead, had a partial reversal because of a

[8] Martínez et al (2001), relying on a shorter estimation period, had found no statistically significant effects.

currency and financial crisis in 1995. Disinflation began again in 1996, after the country moved to a floating exchange rate regime. The divergence of paths is also evident in terms of economic growth, which has been consistently higher and more stable in Chile. This can in part be explained by the behavior of the real exchange rate, which has shown wider swings and a stronger tendency to appreciation in Mexico.

This paper has studied the role of monetary policy in these different macroeconomic performances. A qualitative analysis of shifts in the stance of monetary policy shows a more balanced approach in Chile, with clearly defined periods of increments and reductions in the central bank's policy rate. Some of the episodes characterized by rate reductions can be linked to situations of low economic growth. In Mexico, in contrast, all clearly defined shifts in the policy stance correspond to cases of monetary tightening. There are no corresponding episodes of purposeful loosening linked to low economic growth. A quantitative analysis of interest rates suggests that in Chile, at least during the band period, interest rates reacted counter-cyclically in the short run to variations in output; no such evidence is found for Mexico. This weak response to output has occurred despite the greater monetary autonomy afforded by the floating regimes in a context of low inflation. In particular, in the two countries there has been a notable fall in the extent of transmission of US interest rate changes to local interest rates.

In both countries the inflation rate and the real exchange rate have been key influences on monetary policy. Roughly speaking, disinflation has implied a tendency for the currency to appreciate in real terms, in both countries, irrespective of their specific exchange rate regime. It is only after disinflation ends that the process of appreciation begins to revert.

However, a difference between the two countries is that Chile in fact was willing to adopt a looser policy stance some time before disinflation concluded. As a result, the rate of nominal currency depreciation increased. Thus, while in Chile the process of real appreciation stopped in 1998, in Mexico it continued strong until 2001. The importance of this was evident in the early 2000s, as Chile was better prepared to face the effects of the US economic deceleration. The quantitative analysis of the behavior of interest rates provides further details on these different policy approaches. During disinflation, the interest rate in Chile tended to fully adjust to the reductions in the inflation rate. In Mexico, in contrast, the adjustment was partial. This introduced an upward bias in the real interest rate that may have contributed to the stronger appreciation tendencies seen in this country.

References

TBA

Appendix: data definitions and sources

Nominal interest rate:
Chile: average of deposit and lending rates, 90 to 365-day operations, in percentage. Source: central bank.
Mexico: interest rate on 28-day Treasury bills (Cetes), in percentage. Source: central bank.
US: 3-month Treasury bill rate calculated at constant maturity, in percentage. Source: Federal Reserve.

Real interest rate:
In all countries it corresponds to the difference between the nominal interest rate and the current inflation rate. The inflation rate was calculated as the percentage 12-month (or, in some cases, 4-quarter) variation in the consumer price index.

Real exchange rate:
The (multilateral) real exchange rate indexes were taken directly from the respective central banks. A rise in the index indicates a real currency depreciation.

Output:
Chile: Monthly index of general economic activity (imacec). The series from January 1989 to December 2001 corresponds to the index based on 1986. A second series starting in January 1996 corresponds to the 1996-based index. Source: central bank.
Mexico: Monthly index of global economic activity (igae), 1993=100. Source: National Institute of Statistics.
US: Industrial production index, 1997=100. Source: Federal Reserve.

The *output gap* is the log difference between output and its Hodrick-Prescott trend. Monthly fixed effects were removed from the resulting series. The regression analysis uses the left-sided, 12-month moving average.