Monetary policy rules in some mature emerging economies

Renato Filosa[1]

Introduction

The last decade has witnessed widespread changes in the monetary and exchange rate regimes of many emerging economies. The central banks of these economies have become more independent, inflation targeting regimes have gained momentum and exchange rate regimes are more flexible.

However, there is limited empirical work assessing the economic consequences of these regime changes, particularly in comparison with the extensive literature that focuses on the same topics for the industrial countries.

In an attempt to partially fill this gap, this paper uses small structural VAR models to explore three connected issues that are relevant to the pursuance of a stability-oriented monetary policy in the emerging markets.

First, is it possible to have model-based measures of core inflation capable of reflecting price level movements that are due to the activity of monetary authorities and for which these authorities are accountable? The first section of the paper explores this topic using a small SVAR not yet considered for this purpose by the existing literature.

Second, is it possible to estimate the reaction function of the central banks of mature emerging economies and compare the results with those obtained for industrial economies? Section 2 of the paper provides these estimates and illustrates the main difficulties in applying to emerging economies analytical tools that have been successfully used for the main industrial economies.

In the third section of the paper simulations of the effects of alternative monetary policy rules or the main macroeconomic variables of a selected number of economies are presented. These simulations are compared with those obtained for the euro area under similar assumptions.

The last section provides a summary of the results and some conclusions.

1. The quest for a robust monetary regime for mature emerging economies

In the past few years momentous changes have occurred in the monetary and exchange rate regimes of most emerging countries. In Latin America, after decades of extreme swings in inflation and in the exchange rate (due to overly accommodating monetary policy and unsustainable fiscal laxity), massive outflows of capital (despite widespread capital controls) and repeated systemic disruptions in the domestic financial systems, successful reforms radically changed the landscape in the second half of the 1990s. Inflation is now under the control of more independent central banks, fiscal deficits have been reduced to manageable proportions, capital mobility is generally very high, and exchange rates far more flexible but nonetheless far more stable than previously. In Asia, countries are recovering from devastating currency and banking crises that have interrupted years of price and exchange rate stability. As in Latin America, exchange rate regimes in the majority of Asian countries no longer exhibit the characteristics of the hard pegs of the 1980s and early 1990s.

[1] I am very grateful to Stephan Gerlach for valuable comments and also to Stephan Arthur, Anna Cobau and Marc Klau for their effective statistical assistance.

Following their exit from monetary arrangements based on exchange rate "fixity", the majority of these emerging economies have been confronted with the need to adopt a new monetary framework and are still facing issues similar to those encountered in the recent past by the industrial countries, namely: the inflationary outcomes of discretionary monetary policies, the difficulties of implementing direct monetary control strategies due to the instability of the intermediate targets stemming from the liberalisation of their financial systems, and the unsustainability of the hard pegs in a world of much increased capital mobility and not fully credible policies.

Economic events, however, do not fully explain the trend towards monetary policy frameworks centred on the basic tenet that the primary, if not exclusive, task of central banks is to achieve and maintain price stability. Important theoretical advances have also played a role in catalysing this global regime shift.

1.1 Monetary policy rules for closed economies

The theoretical work has concentrated on identifying a commitment mechanism capable of ensuring macroeconomic stability while leaving monetary authorities with some room for exercising discretion. Three main theoretical considerations explain these developments.

"First, after a long period of near exclusive focus on the role of nonmonetary factors in the business cycle, a stream of empirical work beginning in the late 1980s has made the case that monetary policy significantly influences the short-term course of the real economy."

"Second, there has been considerable improvement in the underlying theoretical frameworks used for policy analysis." [2]

And, third, *"there may be gains from enhancing credibility either by formal commitment to a policy rule or by introducing some kind of institutional arrangement that achieves roughly the same end"* [3].

Inflation targeting has emerged as a monetary framework that subsumes a complex institutional arrangement. In fact, as Mishkin and Savastano (2000, p 32) put it, inflation targeting involves several elements: *"(1) the public announcement of medium-term numerical targets for inflation; (2) an institutional commitment to price stability as the primary goal of monetary policy, to which other goals are subordinated; (3) an information-inclusive strategy in which many variables, and not just monetary aggregates or the exchange rate, are used for deciding the setting of policy instruments; (4) a transparent monetary policy strategy that ascribes a central role to communicating to the public and the markets the plans, objectives, and rationale for the decisions of the central bank; and (5) mechanisms that make the central bank accountable for attaining its inflation objectives. The list should clarify one crucial point about inflation targeting: it entails much more than a public announcement of numerical targets for inflation for the year ahead."* These elements describe a general *"framework for policy within which 'constrained discretion' can be exercised"*[4] in a world where rigid rules have ceased to have any effectiveness.

Several monetary "rules" have been proposed by the literature that are consistent with this approach. Following Taylor,[5] a very parsimonious representation of the framework for closed economies is provided by the following two expressions:

$$Y_t = A(L,g)Y_t + B(L,g)r_t + u_t \qquad (1)$$

$$r_t = g_\pi \pi_t + g_x x_t + g_r r_{t-1} + g_0 + \varepsilon_t . \qquad (2)$$

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2 Clarida et al (1999), p 1661.

3 Clarida et al (1999), p 1663.

4 Bernanke et al (1999), p 22.

5 Taylor (1999).

In equation (1), which represents the macroeconomic model of the economy, Y_t is the vector of endogenous variables, r_t is the short-term interest rate, $A(L,g)$ and $B(L,g)$ are vector polynomials in the lag operator L, and u_t and ε_t are serially uncorrelated vectors of random disturbances.

Equation (2) represents the reaction function of monetary authorities or the monetary policy rule. The above reaction function, a seemingly simple one, assumes that the policy variable responds to inflation (π_t) and the output gap (x_t) and its own past value, and it is consistent with several monetary rules proposed by the literature.

In fact, the above reaction function can be interpreted as a Taylor rule[6] according to which the monetary authorities react to *actual* inflation and the actual output gap. However, it can also be consistent with the *inflation forecast targeting* as shown by Svensson: *"The instrument depends on current inflation not because current inflation is targeted (current inflation is predetermined) but because current inflation together with output and the exogenous variable predict future inflation."* [7]

In an inflation targeting context, the "simple" rule subsumes, in reality, a complex set of economic behaviour and preferences. The rule is derived, in fact, from the minimisation of the loss function of the central bank expressing society's preferences about the short-term trade-off between inflation and the level of activity. More specifically, the arguments of the loss function are the discrepancy between actual inflation and the targeted inflation forecast (which monetary authorities are committed to achieve within a prespecified time horizon) and the deviation of the output gap from its targeted level (assumed to be zero).

The inflation forecast in turn depends on a number of relevant variables (wage settlements, changes in the exchange rate, import prices, etc) as summarised in a potentially complex model. In this sense, inflation forecast targeting is consistent with a more realistic representation of the central bank's behaviour than that of the Taylor rule as it reflects the fact of life that interest rate decisions are not based on the observation of two variables only. More fundamentally, in an inflation targeting framework the reaction function describes a definitive commitment on the part of the central bank to achieving the target that is not implicit in the Taylor rule.

In this framework, the most important issue facing policymakers concerns the effects on macroeconomic stability of different monetary policy rules. In fact, the dynamics of the main macroeconomic variables following a shock critically depend (for any given structural model of the economy) both on the variables that are included in the reaction function of the central bank and on the value of the parameters of the monetary policy rule.

Concerning the latter, Taylor[8] and Clarida et al[9] show that $g_\pi \leq 1$ leads to instability in the economy as the response of the central bank to inflation fails to increase the *real* interest rate and therefore to cool down the economy. A "low" response to inflation thus coincides with monetary accommodation. If the output gap is not an argument of the reaction function, the approach coincides with the *strict inflation targeting* regime where the inflation target is achieved – within the time horizon chosen by the central bank – irrespective of the consequence that this action may have on the variability of output and the instrument itself. Several contributions have shown that for the industrial countries a strict inflation targeting regime (ie when $g_x = 0$) leads to high variability of the main economic variable and potentially to instrument instability.[10] If instead $g_x > 0$, the achievement of the inflation target is more gradual, as stated by Svensson (who assumes that the central bank is committed to achieving the inflation forecast target in two years): *"The intuition for this is that always adjusting the two-year inflation forecast all the way to the long-run inflation target, regardless of the one-year inflation forecast, requires more output fluctuations. If there is a positive weight on output stabilisation, a gradual adjustment of the two-year inflation forecast towards the long-run inflation target reduces output*

6 Taylor (1993).

7 Svensson (1997), p 1119.

8 Taylor (1999).

9 Clarida et al (1998).

10 See, for example, Rudebusch and Svensson (1999).

fluctuations. The higher the weight on output stabilisation, the slower the adjustment of the inflation forecast towards the long-run inflation target (the larger the coefficient)." [11]

Finally, if the lagged interest rate is also present in the reaction function, there is another source of gradualism. In this case, the central bank achieves the "required" change in the interest rate through a succession of "small" steps (the central bank follows the so-called *interest smoothing* approach). From an empirical point of view, all estimated reaction functions of the main industrial countries find that the interest smoothing hypothesis is always validated by data and that g_r is very high (0.8 or 0.9).[12]

One final critical issue is whether central banks should respond differently to different disturbances. More precisely, should central banks use the same rule to respond to supply and demand shocks? From a theoretical point of view, the answer to this question is clear:

"The simple idea is that countering demand shocks pushes both output and inflation in the right direction. Demand shocks do not force a short run trade-off between output and inflation."

"Shocks to potential output also do not force a short run trade-off. But they require a quite different policy response. Thus, eg, a permanent rise in productivity raises potential output, but it also raises output demand in a perfectly offsetting manner, due to the impact on permanent income. As a consequence, the output gap does not change. In turn, there is no change in inflation. Thus, there is no reason to raise interest rates, despite the rise in output." [13]

1.2 A general representation of the Taylor rule

This paper estimates monetary policy rules of the Taylor type following the model proposed by Clarida, Galí and Gertler (CGG).[14]

The model postulates that the central bank aims at maintaining the inflation rate equal to a prespecified target level (for example zero) and keeping the economy as close as possible to a neutral cyclical position. To achieve these objectives, the central bank uses some operating instrument. It is assumed, consistently with the practice of most central banks, that the main operating instrument is a short-term interest rate.

It is therefore assumed that the central bank sets the target short-term interest rate r_t^* conditional on the state of the economy and that the short-term interest rate depends on the deviation of expected inflation and output from their respective targets, that is:

$$r_t^* = \bar{r} + \beta\left(E\left[\pi_{t+n} | I_t\right] - \pi^*\right) + \gamma E\left[x_t | I_t\right] \tag{3}$$

where $\bar{r}$ is the long-run equilibrium nominal rate, π_{t+n} is the inflation rate between time t and time t+n, x_t is the real output gap and π^* is the target level of inflation and output. The symbol E is the expectation operator and I_t is the set of information available at time t.

From Equation (3) one can derive the implied target for the ex ante real interest rate,

$rr_t \equiv r_t - E\left[\pi_{t+n} | I_t\right]$ as:

$$rr_t^* = \overline{rr} + (\beta - 1)\left(E\left[\pi_{t+n} | I_t\right] - \pi^*\right) + \gamma E\left[x_t | I_t\right] \tag{4}$$

where $\overline{rr}_t$ is the long-run equilibrium real rate of interest.

This equation explicitly shows the importance of the value of the coefficient β. If $\beta > 1$, changes in the *nominal* rate induce changes in the *real* interest rate that reduce inflation; if $\gamma > 0$, the *real* interest

11 Svensson (1997), p 1132.

12 See, for example, Clarida et al (1999).

13 Clarida et al (1999), pp 1674-75.

14 Clarida et al (1998).

rate is also changed to stabilise output. Conversely, if $\beta < 1$, changes in the nominal interest rate *accommodate* changes in inflation instead of *resisting* them. The reduction in the real interest rate derives from the fact that the monetary authorities increase the nominal interest rate by an amount that is *insufficient* to avoid the decline in the real interest rate.

An additional desirable feature of the model is that it allows the control of inflation and the stabilisation of output to be identified as *independent* objectives. In the traditional Taylor rule model, in fact, the central bank reacts to *actual inflation* and actual output gap. In the Taylor rule type of equation, it is not clear that the central bank can respond *independently* to inflation and the output gap. For example, if *actual inflation* and the actual output gap are linked by a linear Phillips curve, responding to inflation implies an automatic response to the output gap as well. If, instead, *expected inflation*, and not *actual inflation*, enters the reaction function of the central bank, this automatic link no longer exists and the equation can test whether there is an independent response to the two variables in the central bank reaction function. The model, then, encompasses the Taylor model.

In order to obtain an estimatable equation, the authors define $\alpha \equiv \bar{r} - \beta\pi^*$.

Equation (3) could then be rewritten as:

$$r_t^* = \alpha + \beta E\left[\pi_{t+n} | I_t\right] + \gamma E\left[x_t | I_t\right]. \tag{5}$$

The authors, in addition, assume that the actual rate adjusts only gradually to the target as follows:

$$r_t = (1-\rho) r_t^* + \rho r_{t-1} + v_t \tag{6}$$

where $\rho \in [0,1]$.

The parameter ρ captures the degree of interest rate smoothing. Several explanations of the interest smoothing hypothesis have been proposed in the literature: central banks move policy interest gradually for fear of disrupting capital markets, to avoid policy reversals, etc. The error term v_t is a random shock assumed to be i.i.d.

Combining Equation (5) with the partial adjustment equation (6) gives:

$$r_t = (1-\rho)\left\{\alpha + \beta E\left[\pi_{t+n} | I_t\right] + \gamma E\left[x_t | I_t\right]\right\} + \rho r_{t-1} + v_{t.} \tag{7}$$

The authors eliminate the unobserved forecast variables from the expression by rewriting the policy rule in terms of the actual output gap and the inflation forecast as follows:

$$r_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma x_t + \rho r_{t-1} + \varepsilon_t \tag{8}$$

where: $\varepsilon_t \equiv -(1-\rho)\left\{\beta\left(\pi_{t+n} - E\left[\pi_{t+n} | I_t\right]\right) + \gamma\left(x_t - E\left[x_t | I_t\right]\right)\right\} + v_t$.

The error term is a linear combination of the forecasting errors of inflation and output and the shock v_t.

Finally, while it is assumed that the central bank can pursue an independent monetary policy, this does not imply, as mentioned before, that the central bank cannot have objectives other than inflation control and stabilisation of the business cycle. For example, it could aim at maintaining the real exchange rate within a predetermined range or it could flexibly pursue a monetary target. This implies that, in the equation describing how monetary authorities set the interest rate, it is possible to include other variables in addition to inflation and output. If z_t denotes one such variable, equation (5) can be replaced by the following equation:

$$r_t^* = \alpha + \beta E\left[\pi_{t+n} | I_t\right] + \gamma E\left[x_t | I_t\right] + \xi E\left[z_t | I_t\right]. \tag{9}$$

As noted in Section 1.1, theory suggests that central banks should respond to demand shocks but not to supply shocks. In addition, it was also noted that different monetary rules, for example the Taylor as compared with the strict Inflation Targeting rule, have different effects on the economy and on the instrument itself.

These considerations therefore suggest that it is important to empirically assess:

– the nature and the intensity of the shocks affecting emerging markets;

– whether there is empirical evidence that central banks in these economies react to variables other than just inflation and output;

– whether different monetary policy rules (and/or the parameters of the reaction functions themselves) produce different effects on the economy when demand or supply shocks hit a country.

2. Supply and demand shocks affecting emerging economies

Small open emerging economies have traditionally been exposed to significant shocks, both real and nominal. These disturbances may, in turn, be of domestic or foreign origin. They have conferred on the economies a much higher volatility than observed in industrial countries. The following paragraph tries to empirically identify the nature and the effects of these shocks on emerging economies.

2.1 A SVAR model for open economies

The importance of shocks and their nature (real and nominal) has often been invoked in the literature[15] to explain the greater volatility in emerging economies compared with the industrial countries.

One convenient way to assess the relative importance of real (supply and demand) and nominal disturbances for these economies and to estimate the effects they produce on the exchange rate and inflation is to estimate the structural VAR (SVAR) originally proposed by Clarida and Galí (1994). One particularly appealing feature of this model is that it has well established theoretical foundations as it represents a stochastic version of the two-country model developed by Obstfeld (1985).[16]

The model aims at identifying three structural disturbances that hit the economy. The first is called *supply shock* and is meant to capture all real disturbances that have a long-run effect on output. Supply shocks include, for example, terms-of-trade shocks or technological changes. The second type of shock considered in the model is the *real demand shock.* It can be originated by a fiscal disturbance or by a change in the propensity to spend or it can arise from an exogenous change in foreign demand for domestic production. The third shock is called *nominal (or monetary) shock*. It can be interpreted as an exogenous change in monetary policy – either domestic or foreign – or in wage claims or in price formation.

Assuming rational expectations and full price flexibility, Clarida and Galí show that the model is lower triangular in the long run and has the following form:

$$y_t^e = y_t^s$$

$$q_t^e = \left(y_t^s - d_t\right)/\,\eta + \left[\eta(\eta+\sigma)\right]^{-1}\sigma\gamma\delta_t$$

$$p_t^e = m_t - y_t^s + \lambda(1+\lambda)^{-1}(\eta+\sigma)^{-1}\gamma\delta_t$$

where y_t^e is the equilibrium level of the domestic product, d_t is the real demand shock, p_t^e is the equilibrium price level, m_t is the money supply, η and σ are the elasticity of output with respect to the real exchange rate (q_t) and to the real interest rate respectively, and λ is the elasticity of money demand to the nominal interest rate. As in the Clarida-Galí model, all variables, except the interest rate, represent domestic relative to foreign levels.

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15 See IMF, *International Capital Markets* (November 1997); IMF, *World Economic Outlook* (May 1998), pp 80-82; Hausmann and Gavin (1996), p 36; Bruno (1994), pp 71-74.

16 *"The model not only exhibits the standard Mundell-Fleming-Dornbusch results in the 'short run' when prices adjust sluggishly to demand, money, and supply shocks, but it also embodies the 'longer-run' properties that characterize macroeconomic equilibrium in the open economy once prices adjust fully to all shocks."* (Clarida and Galí (1994), p 24).

The stochastic behaviour of the model assumes that the supply and nominal shocks are permanent while a fraction γ of the demand shock δ_t is assumed to reverse itself within one period after the shock.

The model has the following *long-run properties:*

(a) the level of output is influenced only by supply shocks;

(b) the real exchange rate depreciates following a supply shock but appreciates as a consequence of a real demand shock (nominal shocks have no long-run effects on its level;

(c) the equilibrium level of prices is increased by real demand shocks and nominal shocks but is reduced by a supply shock.

If it is assumed that after a shock the price level adjusts only gradually to the new equilibrium level, the *short-run properties* of the economy are as follows:

(a) the level of output depends on all three shocks;

(b) the real exchange rate is also affected by nominal shocks. To the extent that the effect of such a shock on the real exchange rate is significant, the model is consistent with the Mussa conjecture. It should, in addition, be noted that the model is also consistent with the overshooting hypothesis.

The econometric strategy used to identify the structural shocks consists in the estimation of a structural VAR according to the methodology proposed by Blanchard and Quah (1989) that imposes the long-run restriction in the equations of the unrestricted VAR.

2.1.1 Estimation results

The model has been estimated using the 1980-99 quarterly data for six middle-income countries in Latin America and Asia (Argentina, Brazil, Mexico, Indonesia, Korea and Thailand). The data on the real GDP and the consumer price index have been scaled by the same variables for the United States. The real exchange rate is the bilateral real exchange rate vis-à-vis the US dollar.

The identification strategy used to estimate the structural shocks predicts the following general pattern for the impulse response.

A *positive supply shock* gradually increases output towards a new higher steady state level. The same shock reduces the price level, reflecting the greater efficiency of the productive process or lower production costs. This in turn, by increasing competitiveness, would induce a depreciation of the real exchange rate (given the definition of the exchange rate – quantity of foreign currency per unit of domestic currency – in the graphs an increase (decrease) of the exchange rate signals appreciation (depreciation)). Supply shocks, however, may lead to an appreciation of the real exchange rate if they reflect disturbances in the terms of trade. If the international trade of commodities represents an important component of the GDP, an improvement in the terms of trade would stimulate exports (and so output) and increase the international price of the output of the country (ie the real exchange rate).

A positive *real demand shock* is expected to temporarily increase output, increase prices, due to the creation of excess demand, and appreciate the real exchange rate, both because of the increase in prices and because the demand shock would tend to increase domestic interest rates relative to the foreign one and this would tend to induce a nominal appreciation of the exchange rate.

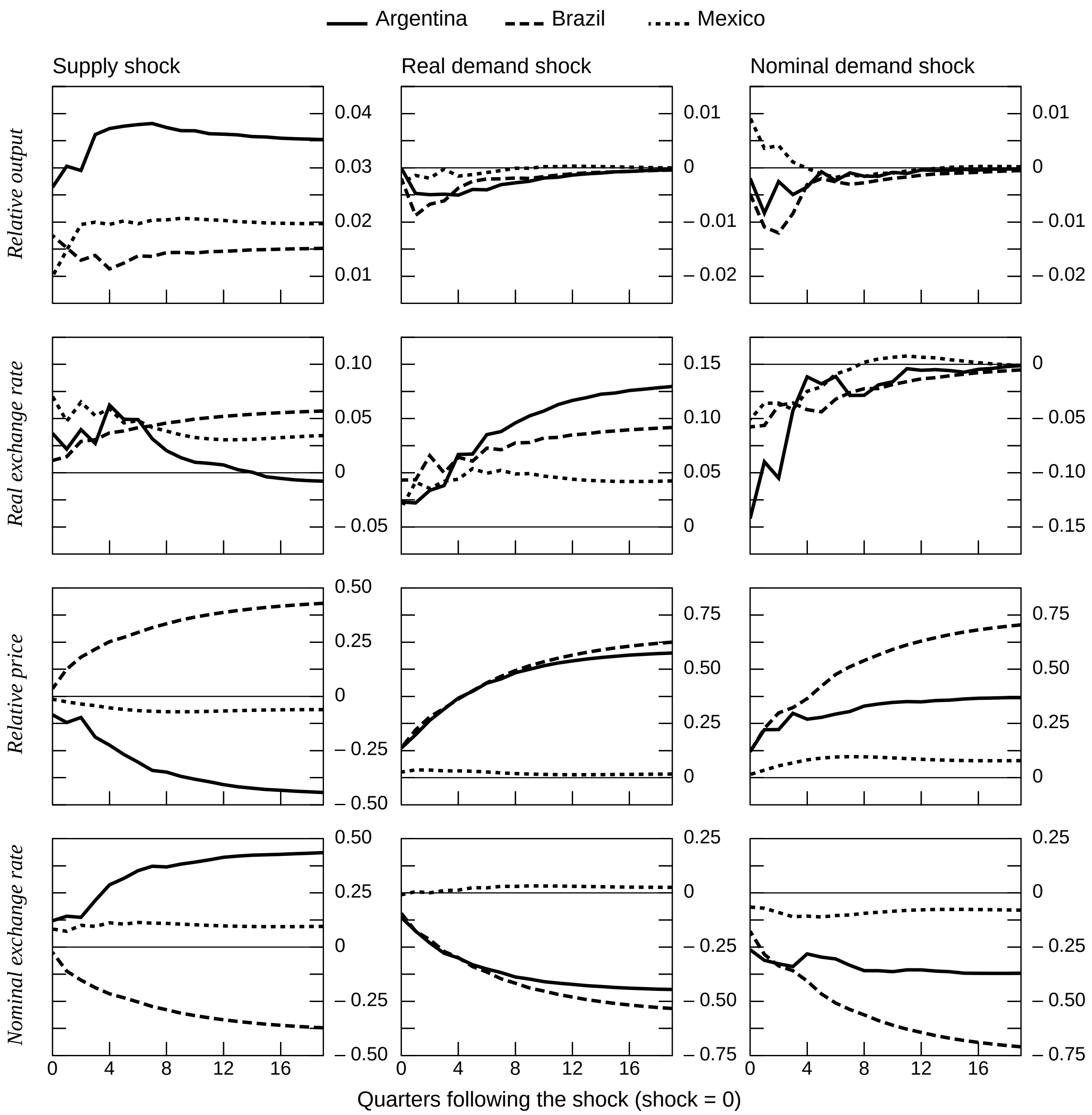
Finally, a *nominal or monetary shock* (such as an easing of monetary policy, a reduction in foreign interest rates or an increase in wage claims) is expected to temporarily increase output and prices and depreciate the real (and nominal) exchange rate. The impulse response can also show overshooting or undershooting of the exchange rate, as explained in the previous section.

The empirical results represented in Graphs 1-2 show that the impulse responses are consistent with the dynamics of the theoretical model with the exception that the real exchange rate appreciates for all countries following a supply shock.

For all countries, a positive *supply shock* increases output to a new higher steady state level, as expected. The shock, however, produces for all Latin American countries an appreciation of the exchange rate instead of the expected depreciation. This appreciation is permanent for all countries except Argentina. One interpretation of this finding is that a positive supply (terms-of-trade) shock has contributed to an improvement in the sustainability of the external position of these countries.

Graph 1

Impulse responses to supply and demand shocks

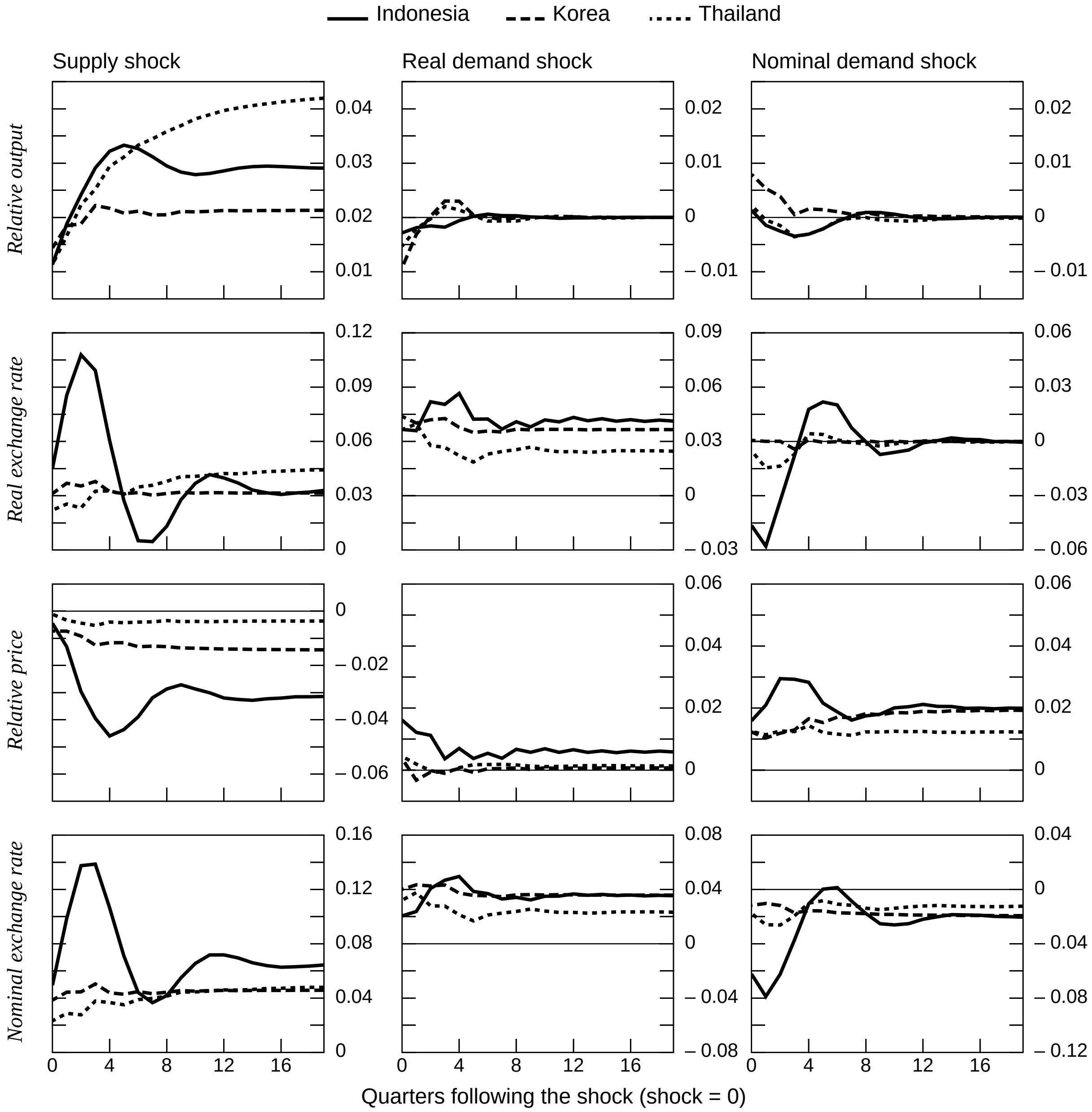


A *real demand shock* increases the relative price (significantly in Argentina and Brazil consistently with their record of being high-inflation countries) and induces an appreciation in the real exchange rate. One important observation is that in Argentina and Brazil the real appreciation due to a real demand shock is entirely attributable to the increase in the relative price as the *nominal exchange rate* (which has been mechanically derived from the log difference between the real exchange rate and the relative price) depreciates. This evidence is consistent with the conjecture that during the period under review fiscal authorities lacked credibility. A fiscal expansion, therefore, led to an immediate surge of inflation and depreciation of the exchange rate. Concerning the effects of a real demand shock on output, data reveal that such a shock does not have a significant impact on real activity, except in Mexico and Korea.

A *nominal shock* produces the expected effects on the real (and nominal) exchange rate along with inflationary pressures that, again, are particularly pronounced in Argentina and Brazil. Following a monetary shock, the real exchange rate depreciates on impact and remains persistently below the pre-shock level in Latin America and Indonesia. In the other two Asian countries the increase in the relative price is exactly matched by nominal depreciation, so that the real exchange rate is not affected at all.

Graph 2

Impulse responses to supply and demand shocks



Furthermore, in all countries there are distinct manifestations of a variability of the real and nominal exchange rate (in addition to the initial overshooting). Monetary shocks thus have persistent *short-term* effects on the real exchange rate in Latin America and Indonesia in accordance with the Mussa conjecture. Finally, monetary shocks do not have significant effects on output, except in Mexico and Korea. These results give empirical support to the proposition that demand management efforts, as captured by the model as the effects of real demand and nominal shocks, were misguided.

2.2 Estimating core inflation

Having established that the response of these economies to the main disturbances is consistent with the theoretical underpinnings of the model, it is possible to turn to the question of whether this methodology allows us to obtain a meaningful estimate of core inflation.

There are several reasons why it is useful, for monetary policy purposes, to have a measure of inflation that represents underlying monetary inflation better than the change of an official price index.

First, central banks need to distinguish between temporary or reversible price changes and trend inflation.[17] Second, it is important that core inflation functions as a leading indicator of future actual price changes. This has an implication for the choice of method to calculate core inflation as certain approaches provide a distorted measure of long-term inflation. Third, and perhaps most importantly, central banks need to have a measure of inflation that reflects monetary policy actions for which they are responsible and accountable. This too is of critical importance for the choice of methodology as certain methods produce a measure of core inflation that does not distinguish between the sources of inflationary shocks, in particular monetary shocks.

As a measure of core inflation, many central banks use a definition of CPI inflation that excludes certain categories of goods and services that are supposedly volatile. The most popular example of this type of definition is the "ex food and energy" price index. The risk of such an approach, however, is to exclude from the index components that, in fact, can contribute to trend inflation and not just to its short-term volatility. Therefore, this approach could lack credibility as it involves arbitrary decisions as to what constitutes the transitory component of inflation.

Because of these shortcomings, a second method of measuring core inflation has been developed. It consists in computing a price index that uses trimmed means of the distribution of price changes.[18] The basic motive for adopting such an approach is that the measure of core inflation obtained by excluding certain items is a distorted measure of the long-term price developments that matter for the decision-making process, as in most cases price changes have a leptokurtic distribution. Trimmed means measures are, instead, robust estimates of long-term inflation when price changes are skewed. While this approach may lead to a conceptually correct way of excluding transitory movements in prices that are not representative of general inflation, it nonetheless suffers from transparency and credibility problems as the general public may fail to understand the complex methodology with which such a measure is calculated.

More importantly, these methods, and their variants, suffer from the basic shortcoming of having no theoretical economic justification. More precisely, they fail to provide an analytical decomposition of the historical profile of inflation into the components that directly reflect the effect of the different sources of inflation, particularly the effects of monetary policy actions, ie monetary shocks.

Different approaches, all based on the estimation of small SVARs, have been developed for this purpose. A thorough review of these models is provided by Folkertsma and Hubrich (2000). It suffices here to recall their main features to clarify their basic differences and similarities in relation to the model used in this paper.

Quah and Vahey (1995) estimate a bivariate SVAR (the endogenous variables are the changes in both output and the inflation rate) to quantify core inflation, which they define as the component of inflation that is originated by shocks not having long-term effects on real output. A basic shortcoming of this approach is that the model assumes super-neutrality of money with the consequence that the level of core inflation is undetermined. *"If we accept that core inflation as measured by Quah and Vahey does in fact correspond to the component of inflation that is under the control of the monetary authority, and also that this component of inflation is in fact neutral with respect to output in the long run, it invites the question of why a central bank would ever want to be concerned about price stability. After all, if all the central bank controls is the price level in the long run, and if the rate at which the price level increases has no implications for the level of real economic activity, then one inflation rate*

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17 *"During periods of poor weather, for example, food prices may rise to reflect decreased supply, thereby producing transitory increases in the aggregate index. Because these price changes do not constitute underlying monetary inflation, the monetary authorities should avoid basing their decisions on them."* (Bryan and Cecchetti (1994), p 195.)

18 Bryan et al (1997).

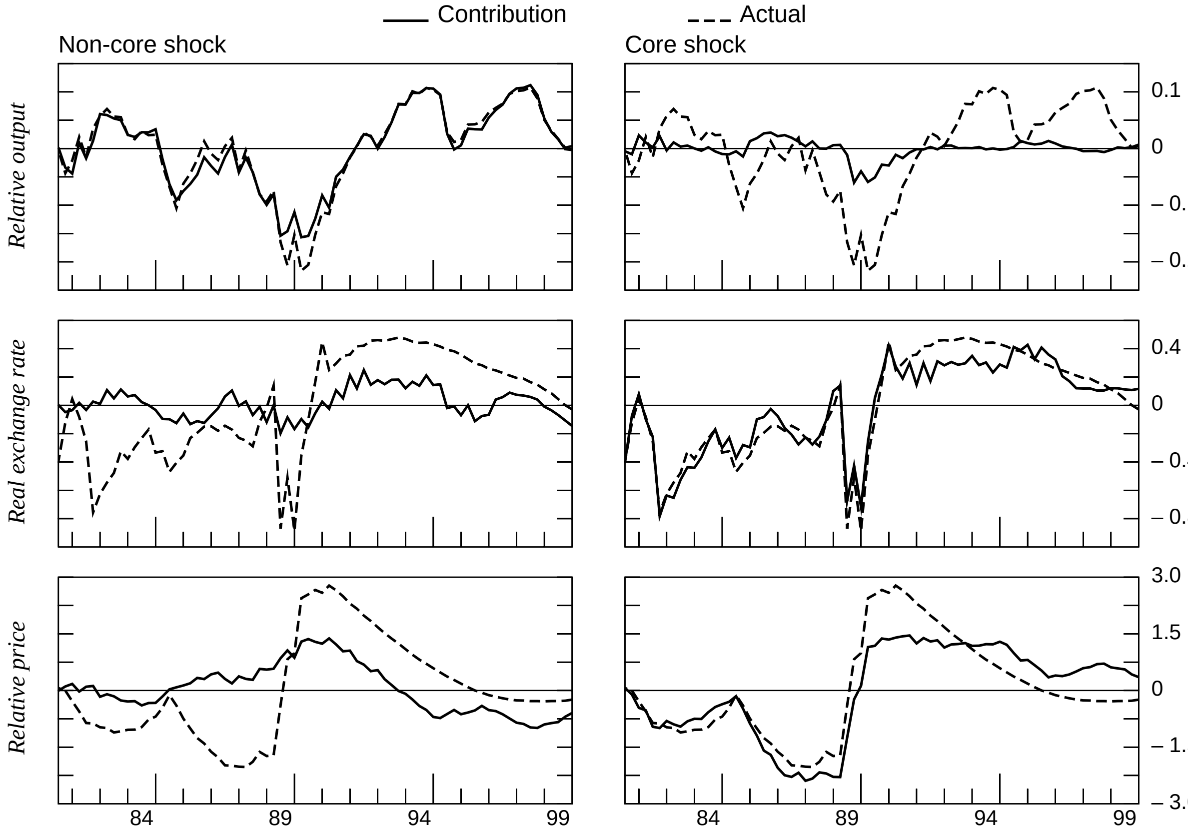
is just as good in welfare terms as another. There is no reason to prefer a steady state inflation rate of 2% over one of, say, 20%. Price stability or zero inflation ought not to play any particular role in the setting of objectives for monetary policy. Of course nobody seriously believes this.”[19] A similar problem affects the three-variable SVAR (the endogenous variables of the model are the changes in real output and in the nominal interest rate and the level of the real interest rate) proposed by Dewachter and Lustig (1997) and by Blix (1995) (the three endogenous variables considered by this last author are the changes in real output, inflation and the level of velocity of money). The two-variable SVAR (changes in both output and inflation) proposed by Álvarez and Matea (1999), who identify what they call “permanent inflation”, does not make any assumptions as regards the neutrality of money. Finally, money is neutral but not super-neutral in Gartner and Wehinger (1998). In their three-variable model (changes in output and in the nominal interest rate and the rate of inflation) they in fact identify the level of core inflation.

The model used in this paper to identify real (supply and demand) and nominal shocks seems to be better placed than bivariate models to measure core inflation, ie the component of inflation that is originated by shocks ”not having long-term effects on real output”. The bivariate models in fact cannot distinguish between the inflationary effects of real demand shocks (for example fiscal shocks) from nominal disturbances (typically monetary policy shocks). Both disturbances have no long-term effects on output. Money is therefore neutral in this model.

The model used here could provide two measures of core inflation. According to a narrow concept, core inflation can be computed as the change in the price due to nominal shocks only; a broader concept could estimate core inflation as the sum of the inflationary effects of real demand and nominal shocks.

Graphs 3-8 provide the historical decomposition of the *relative price changes* when core inflation is calculated on the basis of the broad concept to which we have just made reference.

Graph 3: **Historical decomposition of supply and demand shocks: Argentina**



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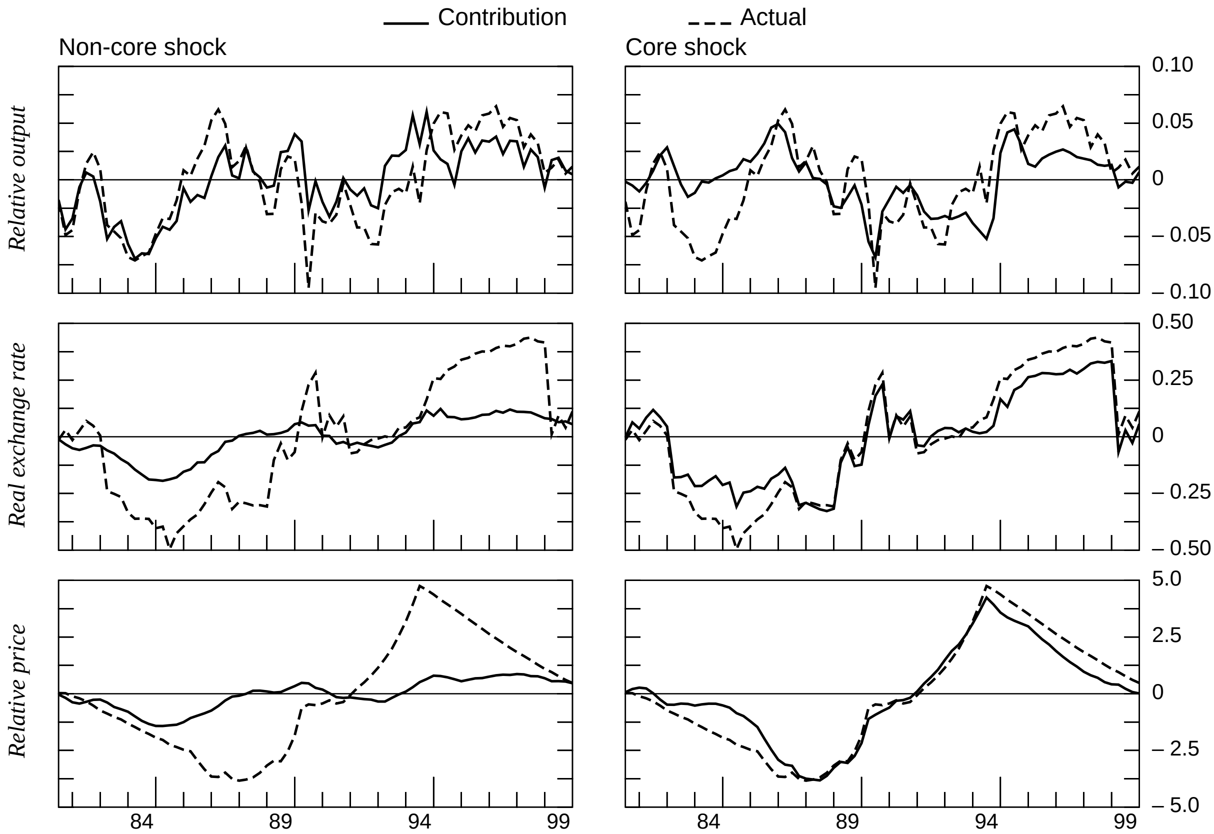
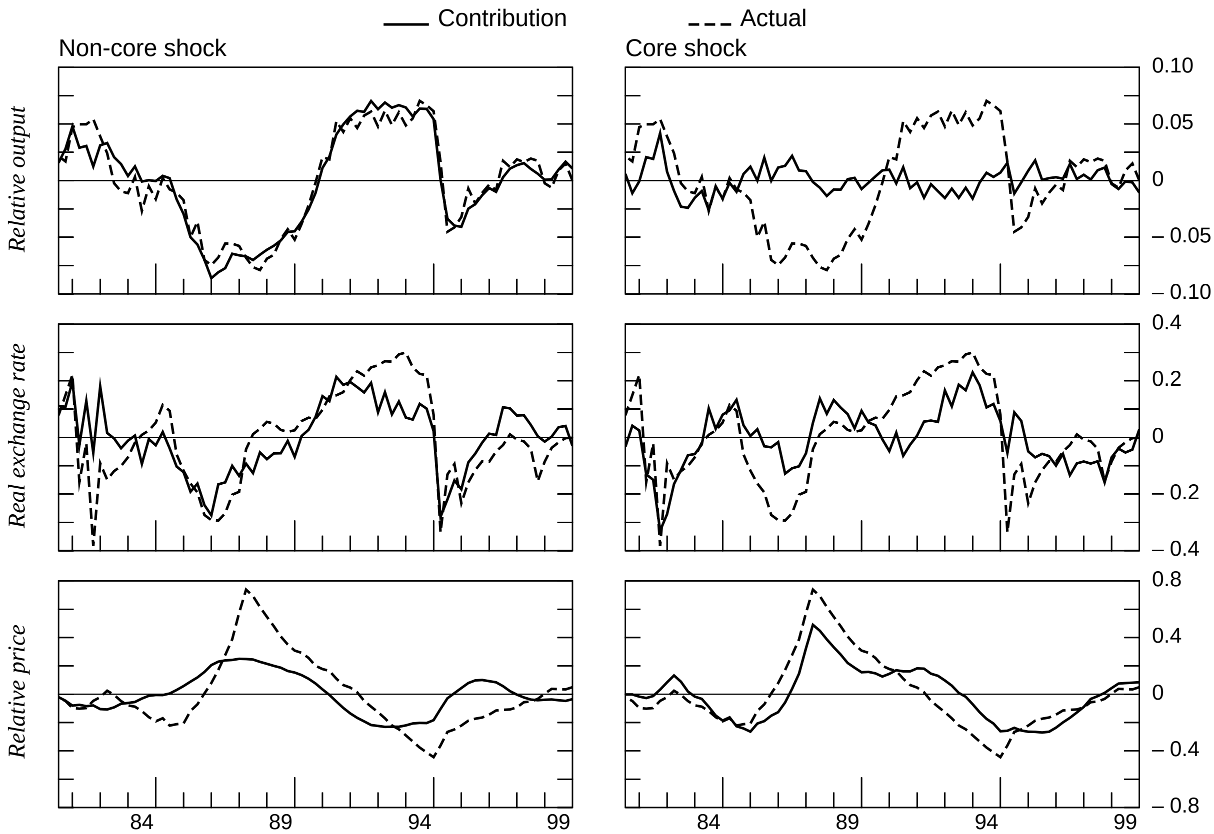
19 Wynne (1999), pp 12-13.

Graph 4: **Historical decomposition of supply and demand shocks: Brazil**



Graph 5: **Historical decomposition of supply and demand shocks: Mexico**



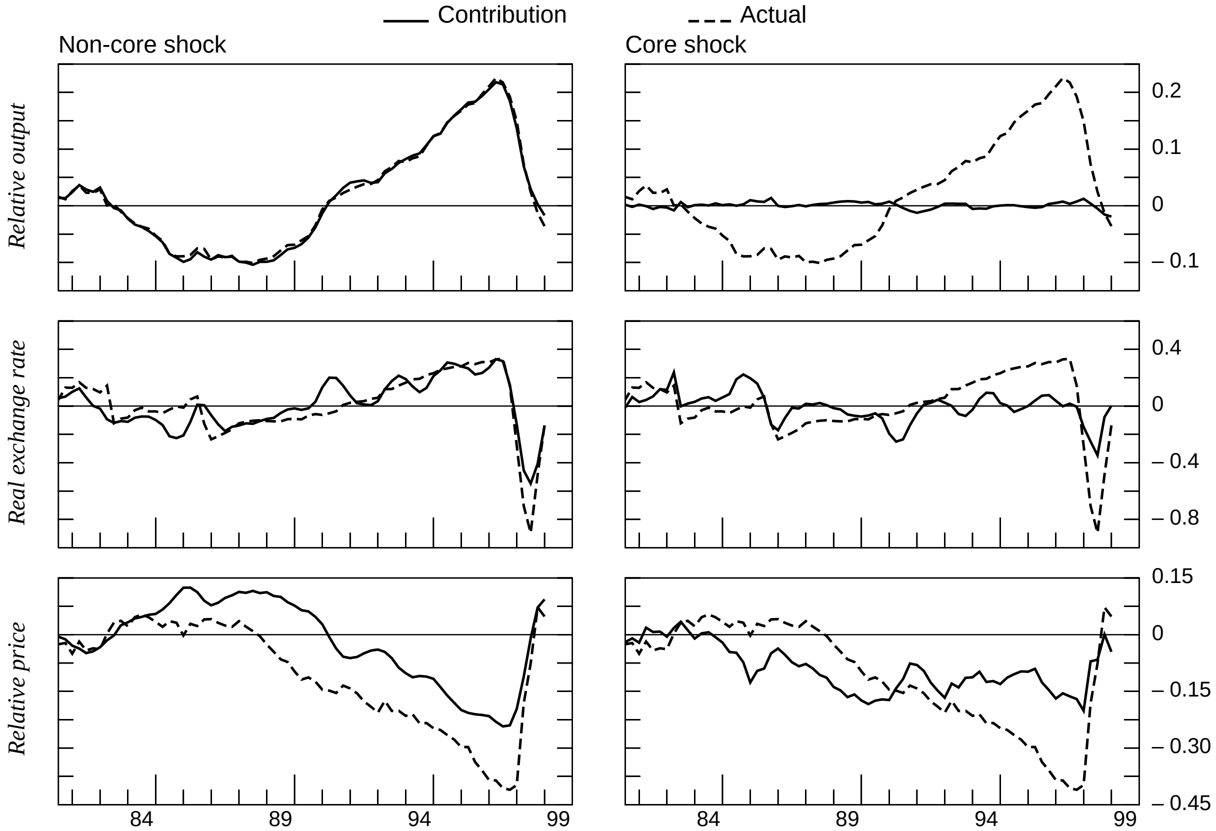
Two characteristics emerge from the graphs. First, the importance of “non-core” (supply) and “core” (demand plus nominal) shocks has changed over time. Second, policies, as captured by the core shocks, are more important than exogenous supply shocks in shaping the time profile of the relative price. This is true in Latin America, both in the first half of the 1980s (during which the relative price showed a falling trend) and subsequently (when the relative price increased). In Asia, this phenomenon is also apparent: from 1981 to 1996, the impulse coming from “core” shocks was more intense than that from non-core shocks, although this is not generally true for all the countries.

Concerning Latin America, these features are particularly evident in the case of Argentina and Brazil. In Argentina, the contribution of core shocks follows very closely the actual price dynamics. In addition, the graph shows that between 1990 and 1994 policies firmed the relative price at the level that prevailed after the 1989-90 crisis (the corollary of this is that the decline in the actual relative price after 1991 is almost entirely due to supply shocks). In Brazil, this evidence is even more pronounced as the cycle of the relative price follows very closely the contribution of core shocks. Furthermore, the coincidence of the contribution of non-core shocks with the actual behaviour of the price index is particularly striking for Venezuela (not shown here). Mexico is an intermediate case. In fact, while non-core shocks track actual data very closely, there is also evidence of a clear correlation of supply shocks contributing to the actual profile of the relative price.

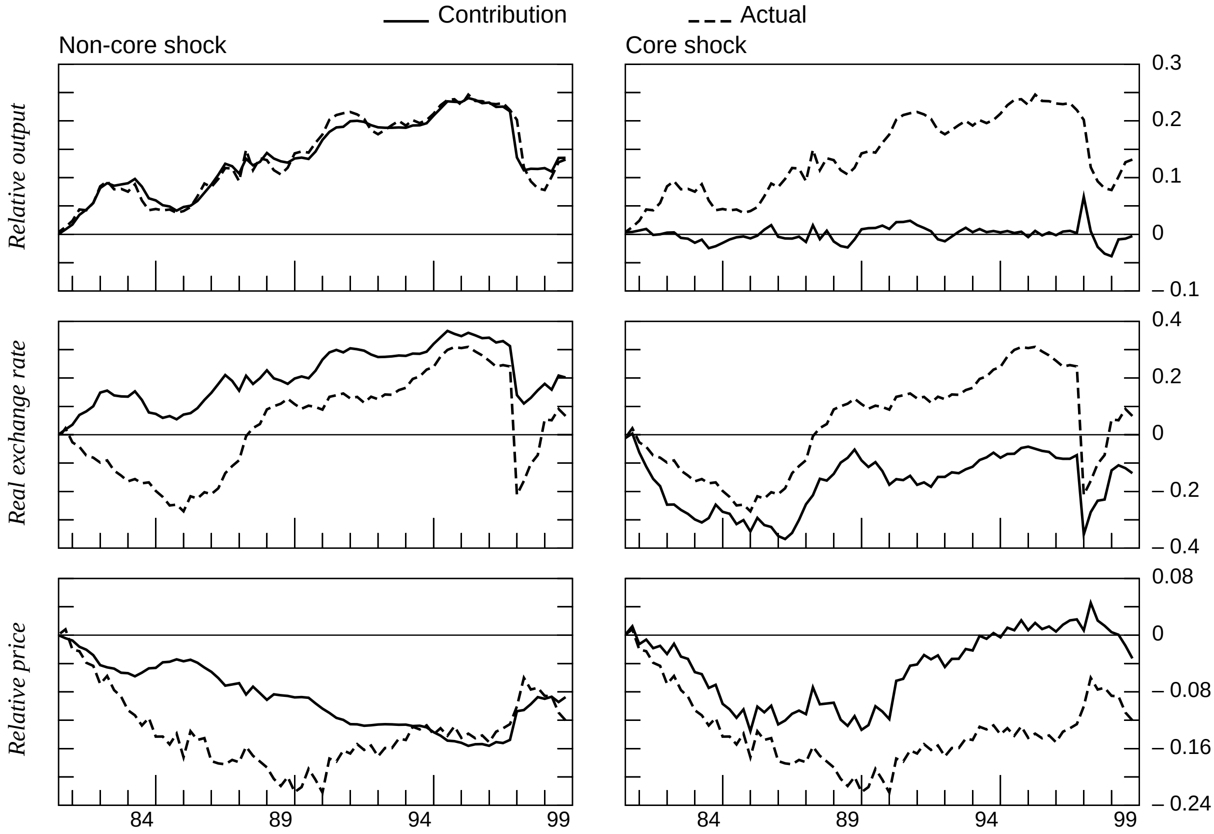
In the case of Asia, the pattern is more diversified. Core shocks almost fully explain the behaviour of the relative price in Thailand. The same can be said for Hong Kong and Singapore, although the results are not reported here. By contrast, in Korea, although the short-term changes and the cycle of the relative price reflect the impulses coming from core shocks, the role played by non-core shocks in determining the trend is very important. This is even more true in the case of Indonesia, where, on balance, non-core shocks appear to be dominant.

To a very large extent these differences are not unexpected. In Latin America the empirical results confirm that erratic policies – both monetary and fiscal – have been the predominant source of inflation. In Asia, where by contrast more stability-oriented policies have been persistently pursued, changes in the low rate of inflation can be attributed to some extent to supply shocks as well.

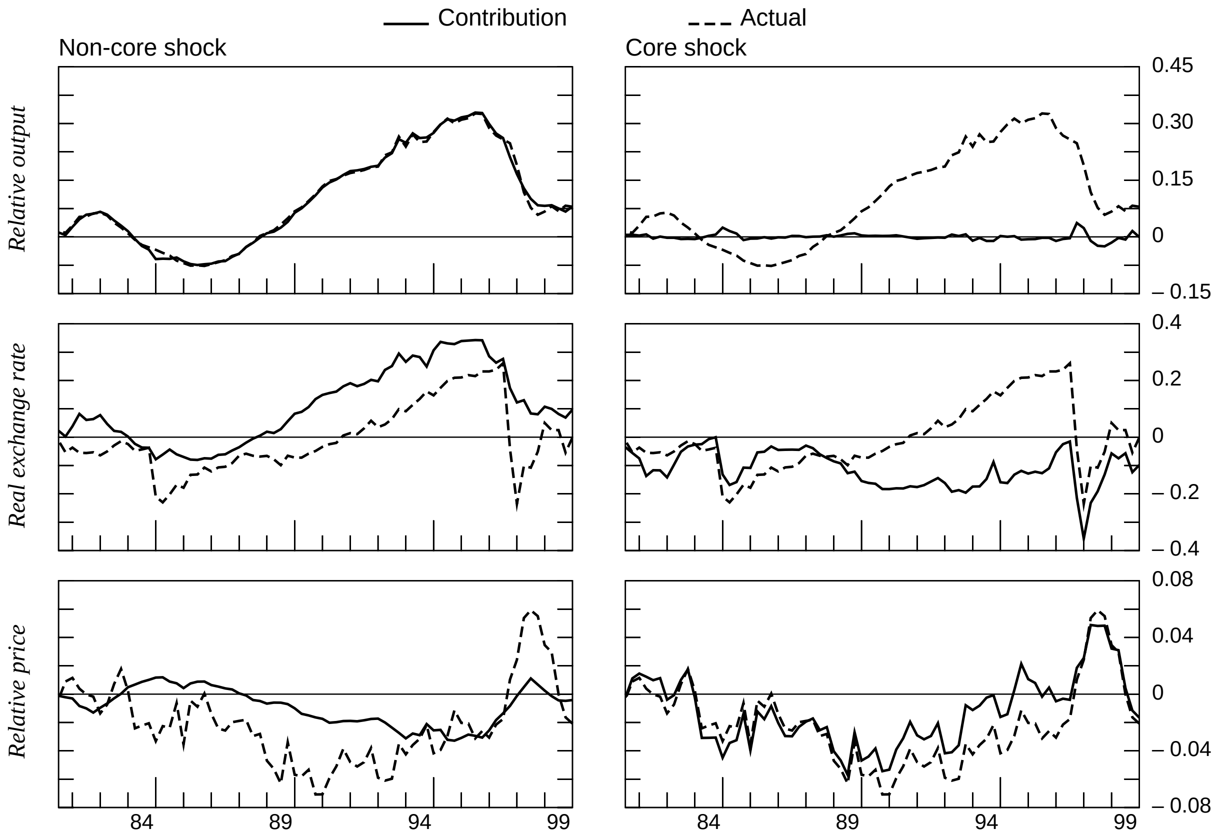
Graph 6: **Historical decomposition of supply and demand shocks: Indonesia**



Graph 7: **Historical decomposition of supply and demand shocks: Korea**



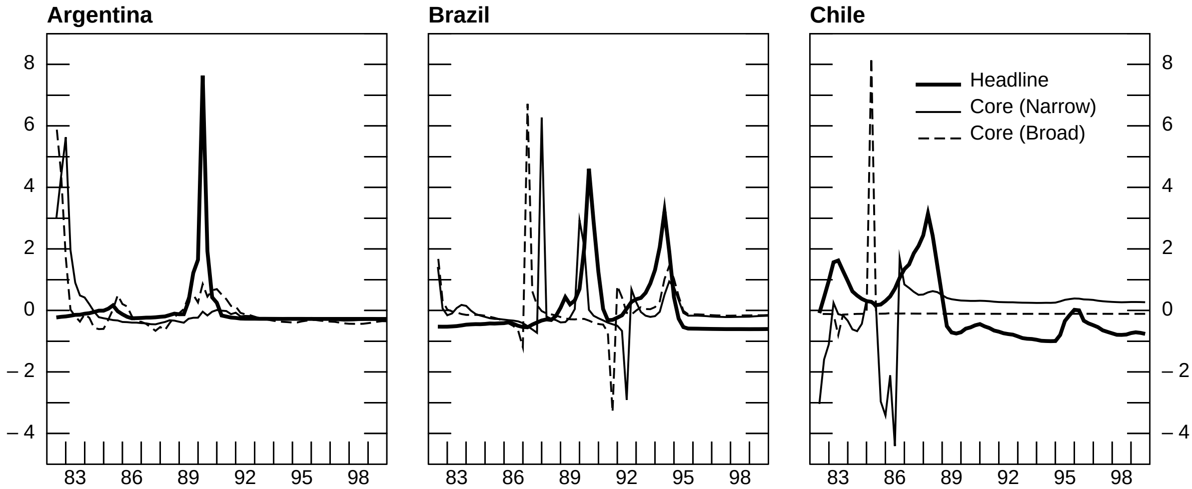
Graph 8: **Historical decomposition of supply and demand shocks: Thailand**



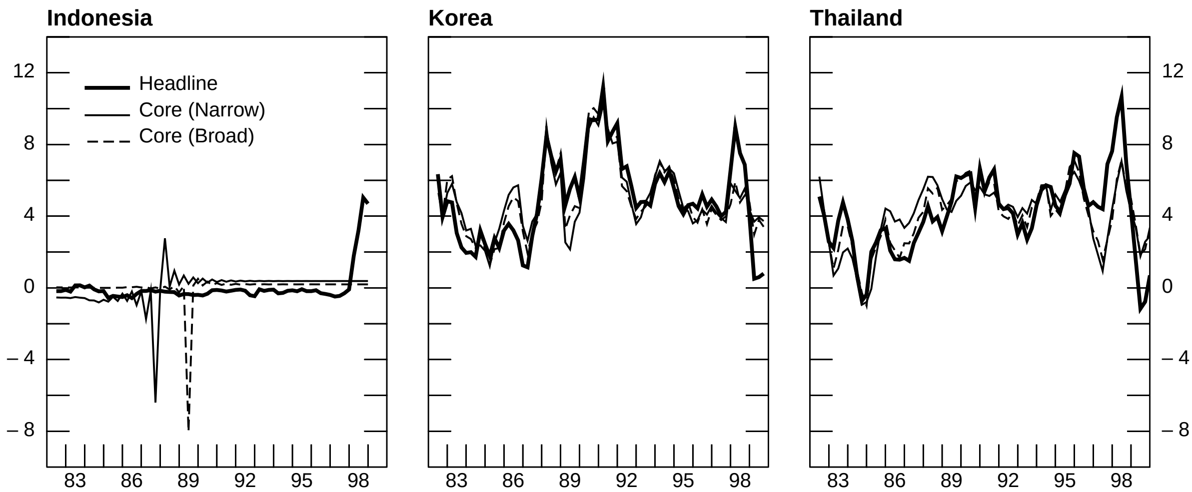
Despite these encouraging results, the graphs of core inflation refer to *relative inflation*, ie inflation in the country under review relative to US inflation. In order to calculate core inflation (narrow and broad), the model has been re-estimated without scaling the endogenous variables. In addition, by way of comparison, the model has been estimated for the three major industrial economies.

The estimated measures of headline and core inflation for the six emerging economies are reported in Graphs 9-10.

Graph 9



Graph 10



As observed above, one important motive for using the trimmed means is that the measures of core inflation obtained by such a statistical approach produce an unbiased estimate of the mean of the original series. In order to test whether model-based measures of core inflation have predictive power, statistical tests have been conducted (t-statistics of a VEC) to assess whether the measures of core inflation, obtained from the estimation of the SVAR model, are cointegrated with headline inflation. Table 1 reports the results of the tests.

From the table it is clear that:

- in the case of Argentina, Brazil, Mexico and Indonesia the mean of both measures of core inflation is way off the mark from the mean of the actual series;
- the test of cointegration indicates that among the emerging markets the measures of core inflation have a predictive power only in the case of Korea and Thailand, where inflation has been rather stable and low for most of the period;

Table 1

Headline inflation and core inflation: descriptive statistics and test for cointegration

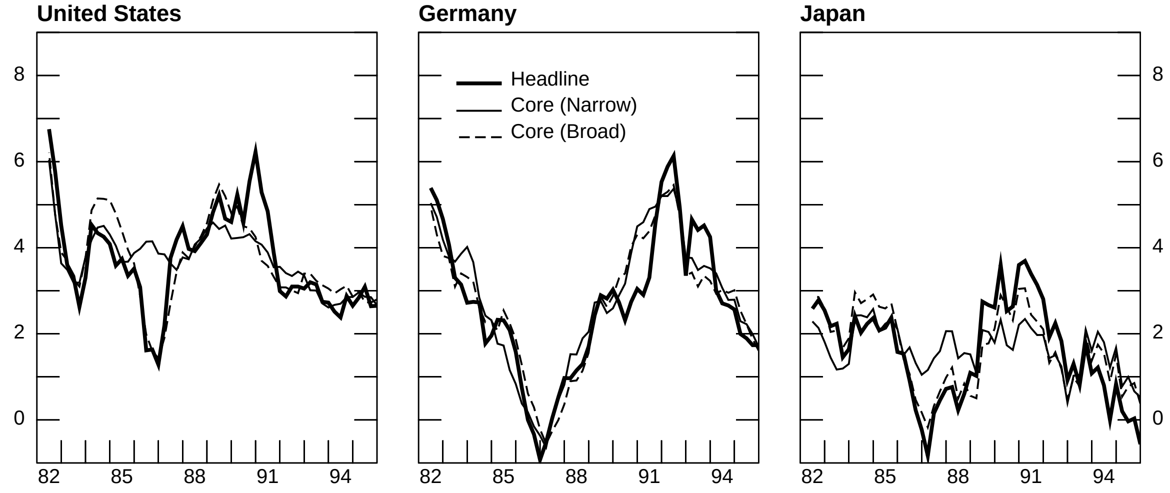
	Mean	Standard deviation	t-statistic on coefficient of VEC
United States (1980-95)			
Headline inflation	3.69	1.15	
Core (narrow)	3.73	0.67	–1.65
Core (broad)	3.69	1.02	–5.13
Japan (1980-95)			
Headline inflation	1.58	1.13	
Core (narrow)	1.67	0.53	–3.35
Core (broad)	1.64	0.91	–2.25
Germany (1980-95)			
Headline inflation	2.66	1.64	
Core (narrow)	2.76	1.58	–15.91
Core (broad)	2.69	1.49	–11.25
Argentina (1980-99)			
Headline inflation	705.87	2,560.41	
Core (narrow)	38.17	105.91	–6.06
Core (broad)	44.38	114.18	–8.31
Brazil (1980-99)			
Headline inflation	722.91	1,184.11	
Core (narrow)	111.39	516.46	–1.15
Core (broad)	72.64	417.88	1.36
Mexico (1980-99)			
Headline inflation	47.86	41.16	
Core (narrow)	–42.82	217.36	1.76
Core (broad)	1,410.99	12,683.57	–1.46
Korea (1980-99)			
Headline inflation	4.98	2.39	
Core (narrow)	5.01	1.93	–8.04
Core (broad)	5.01	2.10	–7.52
Indonesia (1980-98)			
Headline inflation	11.58	14.06	
Core (narrow)	101.15	173.81	–1.69
Core (broad)	–15.39	937.02	–0.35
Thailand (1980-99)			
Headline inflation	4.11	2.25	
Core (narrow)	4.05	1.79	–2.91
Core (broad)	4.00	1.74	–4.90

Note: Core (narrow) is measured as the baseline plus the nominal shock and Core (broad) as the baseline plus nominal and real demand shock.

– for the three Latin American countries, as well as for Indonesia, the presence of episodes of hyperinflation biases the estimation of the model and the measures of core inflation show a dynamics that is significantly different from that of headline inflation (Graphs 9 and 10). The model, in fact, generates arbitrary peaks for some countries because for some countries it fails to correctly identify the nature of the shock that generates extreme inflation values;

– in the case of the G3 (Graph 11), estimated measures of core inflation show statistical properties (particularly in the case of the broad measure of core inflation) that may warrant their use as an operational target for monetary policy purposes. In fact, both core inflation measures have almost the same mean of, and appear to be cointegrated with, headline inflation.

Graph 11



In conclusion, the use of small-scale SVAR to compute measures of core inflation for emerging markets is not appropriate in all cases where episodes of hyperinflation have punctuated the history of the country. In these cases in fact the measures of core inflation produce a biased estimate of the mean of actual inflation and core inflation measures do not have predictive power for future inflation.

3. The Taylor rule for open economies

A large number of emerging economies in both Latin America and Asia have recently moved away from rigid exchange rate regimes. According to the official classification, they are defined as "floaters"; this tends to establish the presumption that the behaviour of the exchange rate has little or no influence on the setting of interest rates.

Recent research has, however, shown that the main features of the exchange rate dynamic of these countries differ from those of true floaters. Calvo and Reinhart (2000) document that the dynamics of some critical variables of emerging economies reveal that they try to voluntarily minimise exchange rate volatility. In their words these countries exhibit *fear of floating*.

There are at least three basic reasons why emerging economies may wish to avoid "excessive" exchange rate fluctuations.

One consists in the fact that emerging economies are characterised by a large pass-through of devaluation into inflation.[20] High indexation de jure or de facto implies that even temporary devaluations are translated into persistent higher inflation: in the extreme case of full indexation, an inflationary shock may determine a shift to a significantly higher and permanent inflation rate.[21]

A second reason, clear evidence of which has been provided by the recent wave of crises in both Latin America and Asia, is that devaluation may significantly weaken the balance sheets of both banks and firms. Thus, significant swings in the exchange rate may lead to systemic financial crises and deep recessions, in addition to inflation.

Third, for countries with a large external debt denominated in foreign currency, devaluation may seriously undermine the fiscal position besides negatively impacting on the fragile balance sheet of the private sector. Again, this may induce a recession and/or a higher rate of inflation.

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[20] For an indication of this in the case of Mexico, see Ortiz (2000).

[21] On this point, see Bruno (1994).

From an empirical standpoint, in their review of the functioning of the exchange rate regime of a large number of emerging countries, Calvo and Reinhart (2000) find that:

- the variability of the exchange rate of these economies is lower than that of the true floaters;
- the variability of foreign reserves is high, which the authors take as evidence of attempts to lean against the wind through interventions in the foreign exchange markets;
- the volatility of short-term interest rates is high, indicating that monetary policy systematically responds to exchange rate changes;
- the correlation between the exchange and interest rates is positive, while that between foreign currency reserves and the exchange rate is negative. The authors interpret this empirical regularity as additional evidence that monetary authorities both intervene and use monetary policy to limit exchange rate fluctuations.

In sum, the primary conclusion reached by the authors is that countries that have exited from a rigid exchange rate regime have nonetheless tried to avoid clean floating. Their behaviour, rather, seems to be closer to that of countries managing non-credible pegs.

A parallel study that compares the post-crisis dynamics of the exchange rate of Asian countries[22] comes to broadly similar conclusions. The authors find sufficient empirical evidence to support the hypothesis that, despite the greater post-crisis flexibility of the exchange rate regime, Asian countries have not gone as far as allowing the exchange rate to float freely. Countries, in fact, have tried to stabilise high-frequency exchange rate variability, to slow the pace of appreciation after the sharp devaluation due to the crisis, and finally they have accumulated ample precautionary foreign currency reserves. As in the case of the Calvo-Reinhart findings, the evidence is that these countries have deliberately tried to remain in the middle of the continuum of exchange rate regimes and away from either corner solutions.

In the case of the countries studied in this paper, the evidence of fear of floating is however mixed. Table 2 reports the variability (measured by the standard deviation of monthly data) of various measures of the exchange rate, inflation and the short-term interest rate together with simple correlation coefficients between the short-term interest rate and the other variables. These statistics have been computed for different subperiods (except for Chile) to reflect the behaviour prevailing at different points in time before and after the crises that hit these countries.

Concerning the pre- and post-crisis variability of exchange rates, there is distinct evidence that volatility has increased since countries decided to abandon peg arrangements. The only exception to this pattern seems to be Mexico and Brazil. But here it is evident that the enormous volatility of any measure of the exchange rate in these two countries during the 1980s likely reflects the lack of discipline of macroeconomic policies rather than serving as evidence of the inherent variability of floating exchange rate regimes. In the case of Asian countries, the shift from the hard pegs of the 1990s to the more flexible post-crisis exchange rate framework is, instead, clear-cut (with the exception, of course, of Malaysia, which in 1999 adopted a hard peg to the dollar).

By contrast, there is not much evidence of any positive link between devaluation and changes in the interest rates. In the majority of cases the correlations are low, not significant and/or have the wrong sign. Evidence of fear of floating is only significant for Brazil and Mexico, particularly for the latter country.

Simple statistics are, however, a weak tool to establish whether central banks systematically react to exchange rate movements through change in interest rates. The assumption that this may indeed be the case seems to be validated by the findings presented in Section 2.1.1, namely that nominal and real shocks have a significant impact on inflation, output and exchange rates (both nominal and real).

Thus, it seems reasonable to assume that the Taylor rule that is appropriate for large countries with limited exposure to foreign shocks has to be modified to properly fit small open economy circumstances.

[22] Hernandez and Montiel (2001).

Table 2

Short-term interest and exchange rates

Country			Variability[1]					Correlation of changes in interest rate			
			ΔUS$	ΔNER	ΔRER	ΔR	INF	ΔUS$	ΔNER	ΔRER	INF
Brazil	80:01	94:07	10.5	10.8	4.4	11,894.6	44.3	0.012	0.023	0.182	–0.051
	96:01	98:09	0.1	1.0	1.1	5.0	1.8	0.257	0.386	0.418	–0.341
	99:01	00:12	7.6	7.7	7.5	3.3	2.2	0.498	0.465	0.444	0.392
Chile	82:10	00:12	2.1	2.5	2.6	9.0	6.3	–0.035	0.043	–0.040	0.221
Mexico	80:01	94:07	5.9	6.0	5.0	7.4	10.5	0.165	0.163	0.097	0.178
	96:01	00:12	2.2	2.4	2.5	3.0	3.0	0.762	0.748	0.772	–0.231
Indonesia	80:01	97:06	2.9	3.2	3.1	1.3	3.2	–0.011	0.037	0.053	–0.055
	99:01	00:12	6.8	7.1	6.9	2.1	4.0	–0.001	–0.023	–0.033	0.120
Korea	80:01	97:06	0.9	1.5	1.6	1.1	2.9	0.004	–0.147	–0.176	0.074
	99:01	00:12	1.7	1.8	1.8	0.2	2.0	–0.101	–0.054	–0.014	–0.078
Malaysia	80:01	97:06	1.2	1.2	1.3	0.4	1.7	0.139	0.067	0.046	0.156
	99:01	00:12	0.0	0.9	1.0	0.3	1.2	na	–0.091	–0.138	–0.046
Thailand	80:01	97:06	1.2	1.6	1.7	1.7	2.4	–0.028	–0.069	–0.040	–0.054
	99:01	00:12	1.8	2.1	2.1	0.4	1.2	0.137	0.217	0.184	0.328

[1] Standard deviation of change of the US dollar exchange rate, nominal and real effective rate (NER and RER), short-term interest rate (R) and inflation (INF).

Ball (2000) argues in favour of the inclusion of a measure of the real exchange rate in the reaction function of monetary authorities of countries exposed to foreign shocks on the basis of the following simple model:

$$x_t = \mathbf{a}x_{t-1} + \mathbf{b}r_{t-1} + \mathbf{d}e_{t-1} + \varepsilon_t$$

$$\pi_t = \pi_{t-1} + \mathbf{f}x_{t-1} + \mathbf{g}(\Delta e_{t-1}) + \eta_t$$

$$e_t = -\mathbf{h}r_t + v_t \,.$$

The first equation is a standard IS curve for open economies according to which output (x_t) is boosted (reduced) by the devaluation (appreciation) of the lagged real exchange rate (e_{t-1}) .

The second equation is a standard Phillips curve where changes in the exchange rate affect inflation (π_t) according to a pass-through coefficient **g**.

The third equation reflects the hypothesis that increases in the real interest rate (r_t) attract capital flows and lead to an appreciation of the exchange rate (in the notation used here the exchange rate is defined as national currency per unit of foreign currency).

From this model the author derives the following modified Taylor rule that minimises a weighted sum of inflation and output:

$$r_t = \beta\pi_t^* + \gamma x_t + \delta\Delta e_t \,.$$

The modified Taylor rule has a number of interesting features.

The first is that $\pi^{*} = \pi_t - \mathbf{g}\Delta e_{t-1}$, ie the target rate of inflation now represents *"a measure of inflation that excludes the transitory effects of exchange rate fluctuations"*.[23] One can think of this definition in terms of the central bank targeting a measure of *domestic inflation*. In so doing, the central bank is reacting to exchange rate changes not because of movements in the currency per se but because changes in the external value of the currency generate long-term inflation. Implicitly, the modified rule says that the central bank should not react to transitory movements in the exchange rate. This behaviour, in addition, would prevent the central bank from tightening aggressively in response to changes in the exchange rate. In fact, *"by construction, π^{*} is unaffected by temporary exchange rate movements, so π^{*} targeters have no incentive to move exchange rates aggressively"*.[24]

Accordingly, an equation similar to that obtained by Ball has been estimated to empirically verify whether, and to what extent, the countries under review have reacted to exchange rate changes.

3.1 Estimation results

Equation (8) is analytically derived by making three important assumptions, namely that the central bank can independently change its operating instruments (normally short-term interest rates), that price stability is the primary objective of monetary policy, and that no significant change in the monetary and/or exchange rate regime has taken place within the estimation period. It is fair to say that in most of the countries under review these implicit assumptions are not verified. In addition, in some countries, the data set includes serious outliers because countries experienced either repeated periods of hyperinflation or serious crises. For all these reasons the estimation results that are presented in Table 3 have to be viewed with caution as the violation of any of the assumptions on which the theoretical model is based or the presence of extreme data may distort the estimates.

To deal with the outliers, the specification of the equations for Brazil and Peru has been changed. The dependent variable of the equation is the *logarithm* of the short-term interest rate as this variable exhibits a strong correlation with both inflation and changes in the exchange rate (the US dollar). The logarithm of the short-term rate, in other words, seems to capture much better than the short-term rate itself the intensity with which both countries have responded to hyperinflation and the sharp devaluation of the currency. On these occasions, in fact, both countries show a disproportionate increase in the real interest rate that has no equivalent in any other country and the timing of changes in the interest rate coincides with the timing of major devaluation episodes.

According to this specification it then appears that the reaction of the central bank to rapidly changing circumstances is highly non-linear as the interest rate, in response to the same increase in inflation or the same devaluation, is increased by an amount that is higher, the higher the prevailing interest rate.

In the case of Brazil, the long-term semi-elasticity of inflation is equal to 1.45 in the first equation. This result seems consistent with the experience where between 1989 and 1990 and prior to 1994 the real short-term interest rate increased enormously. The second equation for Brazil (estimated using instrumental variables) shows two interesting features. First, the interest rate is increased with no lag when inflation rises or when the currency is devalued (the lagged dependent variable is not significant). Second, short-term rates seem to respond with a much greater intensity to currency devaluation than to surges in inflation. It is possible, however, that this result, rather than being reflective of a precise policy strategy, critically depends on the fact that, for example in 1994 and in 1990, when the currency devaluation stops, the short-term interest rate has declined sharply.

The two equations for Peru exhibit features similar to those of Brazil as far as the response of interest rates to inflation is concerned. In the case of Peru, in addition, there is evidence that interest rates respond to the development of monetary aggregates, a feature that has been observed for industrial countries as well. An (excessive) increase in money demand is countered by an increase in interest rates.

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[23] Ball (2000), p 3.

[24] Ball (2000), p 5.

Table 3

Estimated elasticities of Taylor rule type equations for selected emerging economies

Countries	Equation number	Long-run elasticities		ξ^2	ρ	R^2
		π	x^1			
Brazil[3]						
TSLS	1	0.83	1.84	–0.03	0.00	0.916
OLS	2	1.45	1.96	0.00	0.33	0.880
Chile						
TSLS	3	1.02	0.80	0.00	0.20	0.869
OLS	4	1.19	1.96	–0.53	0.37	0.796
Mexico						
TSLS	5	0.95	1.86	0.00	0.62	0.838
OLS	6	0.72	0.00	–0.43	0.53	0.894
Peru[3]						
TSLS	7	1.72	11.50	0.01[4]	0.77	0.886
OLS	8	1.20	2.02	0.00	0.60	0.925
Korea						
TSLS	9	0.76	1.42	–0.17	0.75	0.780
OLS	10	0.35	0.52	–0.19	0.72	0.850
Malaysia						
TSLS	11	1.11	0.37	–0.07[5]	0.87	0.846
OLS	12	0.63	0.37	–0.06[5]	0.87	0.860

[1] Output gap in the case of Chile and Korea. For all other countries, change in real output. [2] Short-term elasticity of the change in the dollar exchange rate. [3] The dependent variable is the log of the short-term interest rate. [4] $\Delta US\$_{-1}$. [5] $\Delta US\$_{-2}$.

The equation that includes among the explanatory variables the change in money demand, however, exhibits a puzzling result regarding the response to changes in the dollar value of the currency. The equation indicates that, after controlling for inflation and changes in money demand, the central bank leans with the wind rather than against. This result requires further investigation.

For the other countries (Mexico, Chile, Korea and Malaysia) the Taylor rule type of equation has been estimated.

From the estimated equations, it emerges that the change in the nominal interest rate in response to inflation is greater (in the longer run) than the change in inflation itself (ie the central bank induces an increase in the real interest rate) only in Chile and Malaysia. In both these countries, in addition, there is clear evidence that interest rates had been increased in response to currency devaluation and to a weakening of the cyclical position. The response to an increase in the output gap is particularly pronounced in the case of Chile.

Concerning the sensitivity of interest rates to changes in inflation in Mexico and Korea, the estimates indicate that interest rates were increased on average by less than the increase in inflation. By contrast, both countries exhibit a strong response of monetary policy to exchange rate changes in accordance with the importance they have traditionally assigned to exchange rate stability. However, the changes in the exchange rate regime that have occurred in Mexico and Korea (as in all economies considered in this study) make it difficult to precisely quantify the extent to which the central bank responds to domestically induced price changes and to deviation of the exchange rate from "target". In other words, the changes in the monetary regime may bias the empirical assessment of the relative importance assigned by the central bank to domestic equilibrium (price stability) and to external equilibrium (exchange rate stability).

One general characteristic emerges from the estimates. In all countries short-term rates respond with the correct sign to exchange rate changes. Prima facie this can be taken as evidence that central banks react to the inflationary effects of devaluations and not necessarily to the fear that devaluations may generate serious balance sheet problems. This is because the results of the SVAR estimates indicate clearly that nominal and real demand shocks have powerful effects on inflation but not on output.

4. The effects of supply and demand shocks under alternative monetary rules

For the industrial countries – indeed mostly for the United States – there is an extensive empirical literature that provides estimates of monetary policy rules and model simulations that quantify the effects that the adoption of such rules produces on the main macroeconomic variables. There is, on the other hand, very limited empirical evidence on the same topic for the developing countries. This is obviously a consequence of the fact that developing countries have in general not followed such monetary rules and that, as already observed, emerging economies have experienced several changes in their monetary regime. To start filling this gap, the focus of this section is to empirically assess the consequences for inflation, output and the interest rate itself of the use of alternative monetary "rules" in response to shocks. To this end, a small macroeconomic VAR model has been estimated for two of the countries that have adopted either inflation targeting (Korea) or a monetary standard that, while based on money supply control (Mexico), is equivalent to an inflation targeting regime. Implicitly, the estimation of the SVAR would provide an empirical measure of the extent to which the transmission mechanism in these countries would permit an effective implementation of inflation targeting. By way of comparison, the same simulation exercise is also conducted for the euro area.

The model used here is that employed by Gerlach and Smets (1995) in their study of the transmission mechanism in the G7 countries. The model has three endogenous variables: real output, the consumer price and the nominal short-term rate.[25] The three-equation model is a highly stylised representation of the economy. The output equation is to be understood as the IS curve, the price equation is a Phillips curve and the interest rate equation is the reaction function of monetary authorities. The identification strategy uses a combination of long-run and contemporaneous restrictions. Only supply shocks determine in the long run the level of real output, as in the SVAR used in the previous section. The model used for this exercise, however, is also based on the assumption that monetary policy shocks do not have contemporaneous effects on output but can instantaneously affect prices. Concerning the reaction function of the central bank (the interest rate equation of the SVAR), the assumption is that monetary authorities respond to movements in output and prices only. This equation is therefore consistent with most of the Taylor-type equations proposed in the literature. One weakness of applying such an approach to small open economies is that such a reaction function postulates that the central bank does not respond to exchange rate movements that are not due to supply or demand shocks.

After having estimated the model, the analysis of the effects of both supply and demand shocks on the economy under alternative monetary policy rules has been conducted by replacing the interest rate equation of the SVAR with alternative policy rules whose basic parameters have been independently estimated as in the case of the euro area and Mexico or imposed a priori. The arbitrary values of the parameters of the monetary rules have been set as follows:

- the "Taylor" rule, according to which the interest rate is increased by 1.5 percentage points in response to a 1% increase in inflation and by 1% in response to a 1% increase in output. Using the symbols of the parsimonious model briefly described in Section 1.1, it is assumed that $g_\pi = 1.5$ and $g_x = 1$;
- the "Strict I.T." rule, where $g_\pi = 1.5$ and $g_x = 0$;
- the "Very Strict I.T." rule, where $g_\pi = 3$ and $g_x = 0$;

[25] It should be noted that the variable representing the volume of activity is real GDP and not the output gap, as in most empirical work on this topic. This is due to the fact that no reliable measure of the output gap exists for the emerging economies.

– the "Slow Adjustment" Taylor rule, which assumes that the monetary authorities adopt an "interest smoothing" approach. This is accomplished by adding to the Taylor rule the lagged value of the short-term interest rate with a coefficient equal to 0.9 and modifying accordingly the short-term coefficients of inflation and the change in output in order to have their long-run values equal to 1.5 and 1, respectively.

The nature of the exercise conducted here is different from the typical approach of the research on the optimal monetary policy rules. In the latter line of research, the purpose is to identify the optimal rule – as well as those that better proxy it – as the rule that minimises the variability of certain macroeconomic magnitudes (normally output and inflation) given the macroeconomic model and the preferences of the central banks. Here, instead, the purpose is to squarely focus on two issues:

– whether, given the macroeconomic model, the central bank's response should depend on the nature of the shock;

– whether alternative rules yield different economic outcomes mainly, but not exclusively, evaluated in terms of the stabilisation of the price level after a shock that the rules themselves make it possible to attain. As far as price stability is concerned, a rule can be regarded as being better than an alternative only if it permits greater long-term price reduction after a positive supply shock and a lower price level increase after a demand shock.

Before entering into the details of the results, it seems appropriate to note that in general there is a distinct instability in the estimates of the SVAR. This is no surprise as it is well known that the countries in question, perhaps with the partial exception of Korea, have changed their monetary regime several times in the sample period considered here. Furthermore, crises have characterised these economies and it is well known that VAR models are particularly sensitive to the presence of outliers in the value of the endogenous variables.

4.1 Euro area

The first experiment consists in comparing the impulse response function using the "Taylor" and "Strict I.T." rules with the results obtained using the "Model" interest rate equation (see Graph 12).[26]

In the euro area, both a "Taylor" and a "Strict I.T." rule produce higher (but more variable) output levels than the "Model" in the case of positive supply shocks before approaching new, common, equilibrium levels. However, the same rules yield suboptimal results as far as inflation is concerned, as the long-term price reduction due to the supply shock is far less than in the estimated "Model" response. The same rules, however, perform better than the "Model" rule as they contain inflation more successfully than the "Model" in the case of a demand shock. This implies, however, that interest rates have to be increased far more than in the "Model".

Graph 12 also illustrates a different experiment. The "Model" reaction function is replaced by two other *estimated* equations. The two equations are estimated with the GMM – using the Clarida-Galí-Gertler (1998) approach from two different periods, the "pre-ERM" period (1980-86) and the "post-ERM" period (1997-98).

The estimated results – not reported here – show a significant difference, particularly as far as the magnitude of the response of interest rates to inflation (g_π) is concerned. In the "pre-ERM" equation, the long-run response to inflation in the reaction function is well below unity ($g_\pi = 0.72$), signalling that on average the then non-existent euro area was following an accommodating monetary policy. This result is reversed in the "post-ERM" equation, where $g_\pi = 2.18$.

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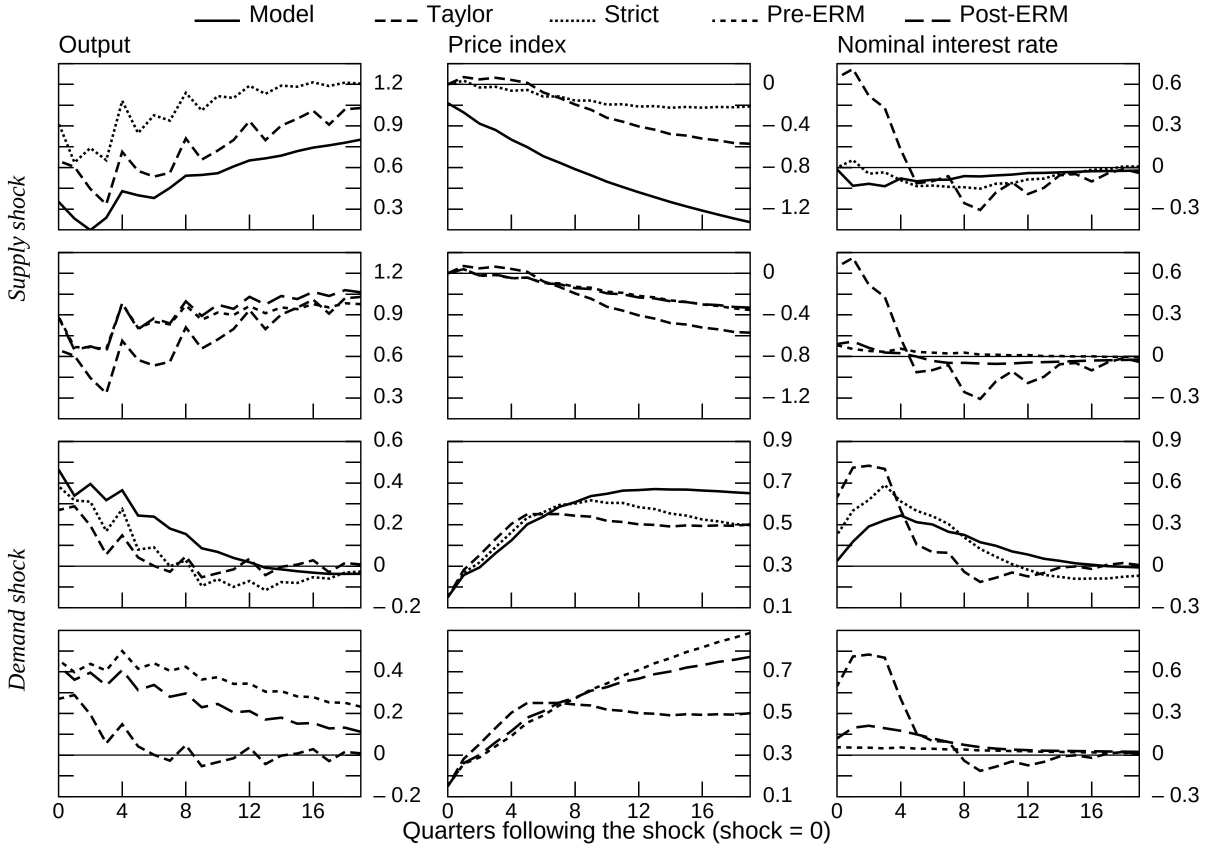
[26] In the case of Mexico and Korea, the attempt at estimating a reaction function à la Taylor has not produced meaningful results.

When these two equations are used in the SVAR, the impulse responses confirm the Taylor/Clarida-Galí-Gertler assertions that $g_\pi < 1$ leads to instability after an inflationary demand shock. The "pre-ERM" path of the price level, in fact, tends to diverge and the increase in output declines more gradually relative to the path of the "post-ERM" simulation. By contrast, the "post-ERM" rule stabilises the price level after the shock (at a level that is lower than "Model") and better contains output because of the more pronounced increase in the interest rate.

Graph 12: **Supply and demand shocks under different policy rules: European Union**



The "post-ERM" rule, however, is outperformed by the "Taylor" rule. By following the "Taylor" rule, there would be a faster reduction in excess demand and the steady state price level increase would be half that obtained with the "post-ERM" rule as the increase in the interest rate in the "post-ERM" case is almost three times that of the "pre-ERM" regime.

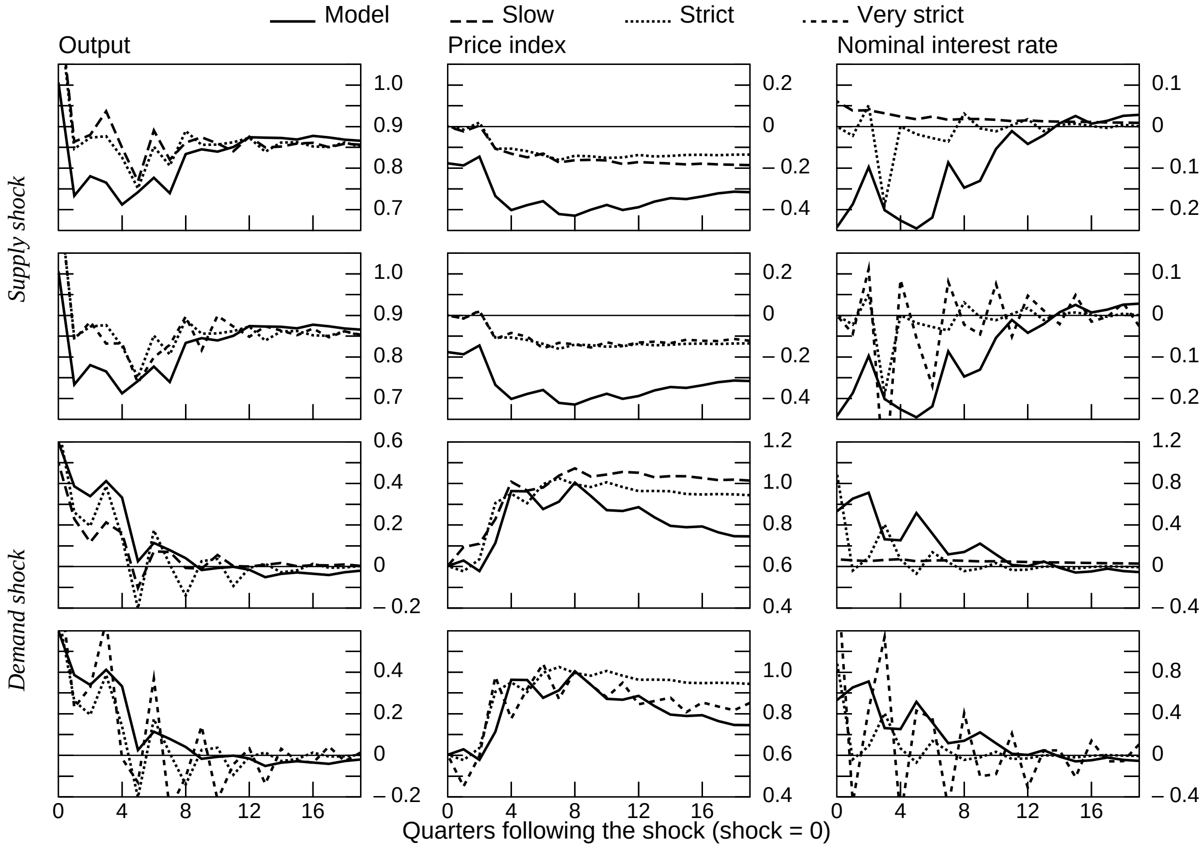
4.2 Korea

In the case of Korea (see Graph 13), the sample period has been shortened to eliminate the 1997-98 outliers.

If the estimated reaction function is replaced by alternative rules, the following results are obtained. "Strict I.T." and "Slow Adjustment" Taylor rules invariably produce worse results than the "Model" as far as inflation is concerned. In the case of supply shock the decline in prices is much more contained than in the "Model" and, following a demand shock, neither rule succeeds in reducing the price level after the initial increase as the estimated reaction function does. Two years after the shock, in fact, the price level stabilised at approximately the peak level, while the "Model" response shows a significant reduction after the initial sharp rise.

A "Very Strict I.T." rule approximates, as far as inflation is concerned, more closely the "Model" response in the case of a demand shock, but this happens at the expense of much increased variability in all three variables of the model. In the case of supply shocks, this rule is even less efficient than the other two, as it increases instrument instability without producing any additional benefit in terms of output or inflation.

Graph 13: **Supply and demand shocks under different policy rules: Korea**



4.3 Mexico

The simulation exercise differs, for Mexico, from that carried out in the case of Korea and the euro area.

In addition to the comparison of the "Model" with the Taylor rule, the effects of supply and real demand shocks have been simulated using the reaction function estimated with TSLS (Equation 5 in Table 3).

To further explore the issue of whether a stronger interest rate response to inflation would be effective in reducing inflation and increase the volatility of the economy, the estimated parameters of the monetary rule have been modified as follows:

(a) in the Variant to TSLS (1) the short-term elasticity of inflation has been kept constant but the *speed of adjustment has been halved*. This amounts to *halving the long-run inflation elasticity*;

(b) in the Variant to TSLS (2) the *short-term* elasticity of inflation has been *doubled*, leaving unchanged the speed of adjustment (this amounts to doubling the *long-term* elasticity of inflation).

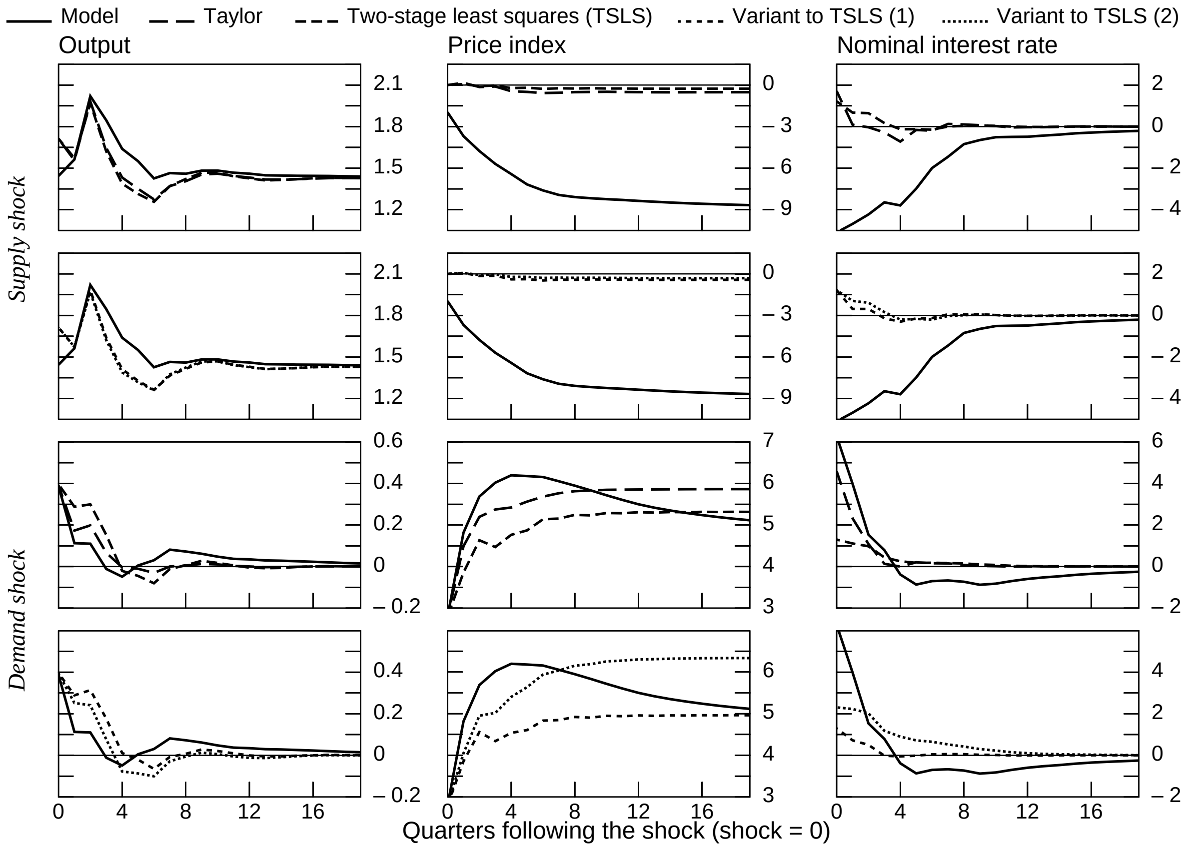
The results of these experiments are illustrated in Graph 14.

After a supply shock, the model yields a significant increase in output and a parallel reduction in the interest rate (nominal and real) and in the price level. If the interest rate equation of the model is replaced either by the Taylor rule or by the independently estimated reaction function, the price level does not fall in any significant way.

In the case of a demand shock, by contrast, the Taylor rule (but not the TSLS estimated reaction function) yields a better (lower) profile for the price level than the "Model" for most of the simulation period.

To test whether a stronger response of the nominal interest rate to inflation would allow a better containment of inflation following a demand shock, the *short-run price elasticity* of the estimated TSLS reaction function was *doubled* (leaving unchanged the parameters of the speed of adjustment). In doing so, the long-run elasticity of the policy instrument is *doubled*. Surprisingly, this change would worsen the inflationary effects of demand shocks (see response TSLS (2) in the graph). The result is counterintuitive, as the interest rate in the short term increases less than in the model.

Graph 14: **Supply and demand shocks under different policy rules: Mexico**



Vice versa, by *halving the speed of adjustment* of interest rates and leaving unchanged the response of the interest rate to inflation (which amounts to *halving the long-run* elasticity of the policy instrument to inflation and output), the inflation performance is better. The price level increase under this policy rule is less than under any other rule (see response TSLS (1) in the graph). The puzzling result is due to the dynamic structure of the model, particularly to the strong autoregressive component of inflation in the Phillips curve and in the positive coefficient of the lagged interest rate in this equation.

One (preliminary) conclusion that can be drawn from this result is that, in an economy characterised by significant inflation inertia, mere monetary tightening would not prove to be sufficient to effectively contain inflationary shocks. A more aggressive monetary policy, in this case, may lead to suboptimal results when the process generating inflation is strongly influenced by the past accommodative stance of policies.

Two main conclusions can be inferred from the simulation results obtained:

- the central bank should not follow the same rule irrespective of the nature of the shocks. In the case of a supply shock, in particular, the central bank should not contrast the increase in output by increasing the interest rate (at most, it should aim to decrease it to facilitate both the growth of output and the decline in prices);
- the conclusion reached in empirical studies on the industrial countries concerning the potentially higher variability that the "Strict I.T." rule may induce is confirmed, but this approach is not necessarily more effective than other "milder" rules in containing inflation as the simulations for Korea and Mexico indicate.

Summary and conclusions

The main motivation of this paper has been to ascertain whether the use of small macroeconomic models helps to answer three critical questions for the conduct of monetary policy in those emerging markets that have assigned to monetary policy the primary objective of attaining and maintaining price stability and that have abandoned a rigid exchange rate regime.

The first question is whether a model-based approach would allow the estimation of a measure of inflation that recovers the core inflation process and provides a reasonable means of extracting price changes that are due to monetary policy actions. There are several methods of measuring core inflation. Among them, univariate time series methodologies (such as moving average or Kalman filters) and techniques that exclude temporary or volatile changes in certain prices (the ex-food and energy price measures or the trimmed mean estimators) are the most popular approaches. At the same time, however, they all fail to distinguish price developments that are due to changes in the monetary policy stance – ie price developments for which monetary authorities are held accountable – from price changes that depend on factors, such as terms-of-trade changes, that are beyond the control of those authorities.

Small SVARs have been used by several authors to identify the effects on prices of monetary policy for several industrial countries. Following such an approach, the paper estimates core inflation for a selected number of mature emerging markets using a model that exhibits the theoretical properties of a two-country macro model of the Mundell-Fleming type. To ascertain the validity of the approach, the paper tests whether on average the measure of core inflation so obtained is an unbiased estimate of headline inflation and whether core inflation is cointegrated with actual inflation.

Both tests are passed only in two cases: Korea and Thailand, where inflation has been relatively low and stable for most of the past two decades. For all the other countries under review, the presence of episodes of hyperinflation biases the estimation of the model. In addition, the model creates a measure of core inflation affected by arbitrary outliers, presumably due to the inability of the model to correctly identify the exact nature of the shocks that in the past have determined the occurrence of hyperinflation. This contrasts with the case of the G3 where tests are passed.

The second question consists in assessing empirically whether the reaction function of monetary authorities can be described by the Taylor rule type of equation and in ascertaining to what extent the inflationary process has been accommodated or resisted by central banks.

Despite the changes in the monetary regimes, the estimates show that monetary policy in Chile, Mexico, Korea and Malaysia can be explained by reaction functions similar to the Taylor rule. In the case of Mexico and Malaysia these reaction functions indicate that central banks have been forward-looking. In the case of Chile and Malaysia, the empirical evidence shows that monetary policy has not accommodated inflation, while this does not seem to be the case for Mexico and Korea. For all the countries under review, however, there is also evidence that monetary authorities strongly reacted to changes in the exchange rate (consistently with the importance attached by these economies to its stability during part of the sample period). Of course, the change in monetary regimes makes it difficult to assess precisely the relative importance that these countries attached to price stability or to external equilibrium.

For Brazil and Peru, by contrast, the Taylor rule is not capable of explaining the behaviour of the short-term interest rate. To capture the high non-linear response of the interest rate to the sharp devaluation and extreme inflation that have characterised these countries during the 1980s and the 1990s, the equation has been estimated using the logarithm of the dependent variable. With this modification, the equation seems to capture relatively well the fact that interest rates in Brazil and Peru have been increased during periods of extreme tension by an amount that was higher, the higher the level of the interest rate preceding monetary policy actions.

Finally, a small SVAR has been estimated to describe the monetary policy transmission in these countries and to deal with the third issue, which concerns the macroeconomic effect of the adoption of alternative monetary policy rules.

Despite data problems and the regime changes, the small SVAR suggests that the transmission mechanism in the small number of economies studied here is very similar to that of industrial economies. Supply shocks increase output and decrease the price level and the real interest rate very much in the same way as in the major industrial economies. Demand shocks increase output temporarily and produce significant inflationary pressures, particularly in Latin American countries.

More importantly, these estimates confirm the theoretical proposition that monetary authorities should not respond to (or even accommodate) supply shocks but instead resist the inflationary pressures of demand shocks.

According to the theoretical results obtained by several authors – and validated empirically for some industrial countries – a stronger response of interest rates to inflation – or an exclusive focus on inflation by the central bank – yields a better inflation performance after a shock, at the price, however, of greater variability in both real output and interest rates.

The simulation of alternative rules for Korea and Mexico do not conform to these theoretical propositions. In the case of Korea an exclusive focus on inflation (and/or a stronger response of interest rates than prescribed by the Taylor rule) yields an inflation performance that is not better than that of other rules while generating a much higher variability in output and, endogenously, in the interest rate itself.

In the case of Mexico a better inflation containment following a demand shock is obtained not by increasing the response to inflation, but rather by accelerating the speed of adjustment of the interest rate to inflation. These results for Mexico are likely to be determined by the estimation of the model over a time span that includes periods of accommodative policy and episodes of sharp devaluation. But they may be taken as illustrative of the fact that changes in the monetary regimes may produce effects only to the extent to which the endurance of a stability-oriented monetary policy would progressively change the inflationary process.

The final conclusion that can be drawn from the simulation results is that the central bank should not follow the same rule irrespective of the nature of the shocks. In the case of a supply shock, in particular, the central bank should not contrast the increase in output by increasing the interest rate (at most, it should aim to decrease it to facilitate both the growth of output and the decline in prices).

An important caveat is, however, in order. The estimations of both the model and the reaction function are very sensitive to the choice of the sample period, to the estimation method and to the variables used as instruments. This is particularly the case where data contain extreme values of the type that have occurred on the occasion of the recent (and less recent) currency and banking crises and when important regime shifts have taken place.

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