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Macroeconomic effects of high interest rate policy: Mexico's experience

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> "In their confrontation before the Macmillan Committee, Montague Norman is usually depicted as hopelessly out-maneuvered and wrong, barely able to grasp what Keynes was saying. I now wonder whether it was not Montague Norman who was right, inarticulate though he was on that occasion; and whether the large impact on activity that Keynes attributed to changes in the short-term rate of interest (on which so much has since been built), though clever and ingenious, was not simply mistaken, and Norman right to be puzzled. The use of interest rates for domestic purposes rather than the exchange rate may come to seem one of the greatest aberrations of the half-century since" (Dow and Saville, 1990, pp. XX)

In the latter part of the last century, monetary policy all over the world was redesigned to a new scheme known as inflation targeting. Mexico joined this policy approach officially in 2002, setting a goal for inflation of 3% with a minus/plus 1% margin of error. However, even before Mexico's central bank became autonomous in 1993, it had a strategy to reduce inflation relatively similar to inflation targeting, relying to a large extent on interest rate management.

The inflation targeting scheme, according to the New Macroeconomic Consensus, is based on the following principles:

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a) the main, and in practice the only objective of the Central Bank is to keep inflation under control;

b) inflation control is achieved by ensuring that demand does not grow above the "natural rate of growth", whose trend is exogenously determined. If demand growth is too high, inflationary pressures are generated by excessive wage increases or increases in profit margins, or both. When demand grows below the "natural rate of growth", inflation declines;

c) demand control is achieved through interest rate management. The central bank controls its own interest rate, which impacts the complex of interest rates set by private banks, thus influencing private spending. Moreover, it is implicit in this approach that fiscal policy should not play a significant role.

In the Mexican case, there is a temporary coincidence between declining inflation and the application of the anti-inflation strategy based on interest rate management. This has led to an important discussion about how effective this strategy has been, by itself, in the reduction of the inflation rate, and about the additional impact that such a policy can generate on other relevant variables. For instance, there are some isolated studies that suggest that the reduction of the rate of inflation has been at the expense of output growth (see Loría, Ramírez and Galán, 2009; Galindo and Ros, 2006; 2008; Cuevas, 2008; Ibarra, 2008; 2011; and Mantey, 2009). There are also other points of view that assert that the impact of the interest rate on GDP is practically non-existent, so that, if the country has stagnated, this is due to reasons other than those associated with high rates of interest (Levy, 2009). Furthermore, other authors do not find evidence of an impact of such policies on the GDP or other relevant variables (e.g. Carrasco and Ferreiro, 2013).

The objective of this paper is to contribute to the debate on the subject, seeking to respond to the question: what have the effects of the monetary policy of a high interest rate on inflation and on Mexico's real economy been? Contrary to the nowadays-dominant fad, economic history and economic theory teach us that control of inflation need not be the only goal of monetary policy, and interest rate not the only, and not

always the best of its instruments. However, this is the only instrument that will be discussed in this paper.

The work is structured as follows: after this introduction, we outline our theoretical framework and specify our reference model; the third section discusses the methodology of the implicit function theorem, with which we develop some comparative statics exercises. In the fourth section, the results of the first comparative statics exercise, which refer to the impact of the interest rate on prices, are discussed; the fifth section develops the second comparative statics exercise showing the results of the interest rate on the GDP. This section has three subdivisions, where we discuss in detail the effects of the interest rate on each component of aggregate demand. Along with the discussion of the comparative statics results form the model, we put forward some stylized facts and econometric results that support our hypotheses.

1. A macroeconomic model

It is intuitively clear that the policy of a high interest rate impacts a large set of variables. It is also clear that these effects are difficult to determine without a complete macroeconomic model. Therefore, preliminarily we put forward a macroeconomic model, inspired by the theory of effective demand. We depart from the conventional strategy to economic model specification, whereby the macroeconomic behavior is modeled as the result of decisions taken by optimizing agents (usually representative agents). We discard this approach because it assumes agents possess a degree of knowledge that does not, and in fact cannot, exist.

The model has eight equations.[1] The signs of the partial derivatives indicate the expected signs of the changes induced by changes in the determining variables. However, we will check afterwards for the

[1] We have deliberately simplified the model, omitting variables that are difficult to include in the exercises of comparative statics or have no relevance to our theoretical discussion.

empirical adequacy of our a priori assumptions, considering both the existence of an association between the variables and the direction of such association.

$$Y \equiv C + I + J \tag{1}$$

$$J = J(\theta, Y^*, Y) \qquad J_\theta, J_{Y^*} > 0;\ J_Y < 0 \tag{2}$$

$$C = C(w, p, r) \qquad C_w > 0;\ C_r, C_p < 0 \tag{3}$$

$$I = I(w, r, \theta) \qquad I_w, I_\theta <> 0;\ I_r < 0 \tag{4}$$

$$e = e(r, r^*, p) \qquad e_r, e_p < 0;\ e_{r^*} \tag{5}$$

$$\theta = \theta(e, p^*, p) \qquad \theta_p < 0;\ \theta_{p^*}, \theta_e > 0 \tag{6}$$

$$\theta = e(p^*/p) \tag{6'}$$

$$p = p(e, w) \quad p_e, p_w > 0 \tag{7}$$

where:

$Y \equiv$ GDP
$C \equiv$ consumption
$I \equiv$ gross investment
$J \equiv$ trade balance
$Y^* \equiv$ external demand
$w \equiv$ nominal wage
$p \equiv$ national price index
$r \equiv$ nominal domestic interest rate
$e \equiv$ nominal exchange rate (pesos per dollar)
$\theta \equiv$ real exchange rate
$r^* \equiv$ foreign interest rate
$p^* \equiv$ world price index

Equation (1) is simply the aggregate demand equation. In equation (2) we specify the trade balance. This is a conventional specification in which we assume that the trade balance improves when the real exchange rate rises and when the level of world output increases, and it worsens when domestic GDP increases.

In equation (3) we specify the consumption function. We state it as a positive function of wages, as we assume that workers have a higher

propensity to consume than the capitalists. In addition, we assume an inverse relationship between consumption and the domestic interest rate because an increase in the latter entails higher credit costs, which may induce workers to reduce their credit-financed consumption. We also assume that higher prices reduce the purchasing power of workers, which may also affect their consumption.

In equation (4) we specify an investment function. Investment depends directly on wages, though with a partial derivative with ambiguous sign. Indeed, a greater share of GDP accruing to workers implies higher consumption (Kalecki, 1954), but higher wages also affect the profit margin, and can reduce total profits. Investment may be inversely affected by the interest rate. A hike in the real exchange rate may also affect investment decisions, though again the sign of the partial derivative is ambiguous.[2]

The nominal exchange rate *e*, as specified in (5), depends inversely on the domestic interest rate and directly on the foreign interest rate. Following a hike in domestic rates the peso will appreciate owing to capital inflows, and if foreign rates rise it will depreciate (Dornbusch, 1991). It also depends on the price index, because when the inflation rate changes, the central bank manipulates the exchange rate to maintain the competitiveness of domestic production; this has been in fact the behavior of Mexico's Central Bank in the last years.

In (6) and (6') we specify the real exchange rate. Note that from the definition of the real exchange rate in (6') two important consequences must inevitably occur in the short run, if we assume both labor and intermediate inputs productivity as given, as well as the markup charged by firms to their direct unit costs to set their prices. The first is that if the nominal wage does not change, an increase of the real exchange rate is

[2] For reasons previously mentioned, GDP does not appear as an argument of the investment function; this has to do with the limitations of the technique we will use. Indeed, to obtain the partial derivatives using the implicit function theorem (which will be discussed later), it is necessary to omit this variable to find a non-recursive model solution. Nevertheless, we include other variables as arguments in our function, whose behavior is close to the one that would be achieved if the GDP would have been part of the specification. Besides, below we present an estimated model where GDP appears among the arguments of the investment function.

necessarily associated with lower real wages. In particular, if a depreciation of the national currency (increase in e) occurs, the rising costs causes a growth in prices that brings down real wages. In other words, for peso depreciation to raise the real exchange rate, real wages must decrease. The second consequence is that an increase in the real exchange rate will also be accompanied by a fall in the share of wages in value added.[3]

Finally, equation (7) shows the determinants of the price index. Our central hypothesis is based on the notion that firms set prices under a system of oligopolistic competition. That is, firms set prices by considering first of all prime costs, which consist of wage costs plus external ones. Additionally, firms add a markup to their prime costs; the markup depends, among other factors, on the degree of competition. Following Kalecki, we may assume that the latter is reflected in the average price of the industry, and that the domestic price of competitive imports plays an important role (Kalecki, 1954; Sylos Labini, 1979; Malagamba, 2014).

2. Foundations of comparative statics analysis

Using as a basis the previously specified model, in this section we carry out some comparative statics exercises. We must clarify that with these exercises we do not aim at finding out the exact mathematical solutions for the consequences of the shocks we subject the model to. Rather, we want to illustrate the main interactions between the variables

[3] This follows from the Kaleckian equation for the share of wages in value added: $v = 1/[1 + (k - 1)(em/w + 1)]$, where (em/w) is the ratio between the unit cost of intermediate inputs (where e is the nominal exchange rate and m is the input-output ratio) and unit wage costs (to simplify we make labor productivity constant and equal to one), and (k) is the 'degree of monopoly' (i.e. the price-cost ratio). For simplicity we assume that all intermediate inputs are imported. Let us note in this context that if the degree of monopoly k is positively associated with the real exchange rate, which seems to be Mexico's case (Malagamba, 2014), the negative association between the exchange rate and the real wage, and of the exchange rate with the wage share, are magnified.

of our model, and predict the likely effects on our variables of interest induced by changes in the interest rate.

We use for this purpose the theorem of the implicit function. This theorem states that, given a system of equations Y, if the F^i functions of this system have continuous partial derivatives with respect to all endogenous and exogenous variables and, in addition, if in the point ($z_{1,0}$, ..., $z_{n,0}$, $x_{1,0}$, ..., $x_{m,0}$) that satisfies the system the following determinant of the Jacobian matrix is not null, i.e.

$$|J| \equiv \left|\frac{\partial(F^1, \ \dots, F^n)}{\partial(z_1, \ \dots, z_n)}\right| \equiv \begin{vmatrix} \frac{\partial F^1}{\partial z_1} & \cdots & \frac{\partial F^1}{\partial z_n} \\ \vdots & \ddots & \vdots \\ \frac{\partial F^n}{\partial z_1} & \cdots & \frac{\partial F^n}{\partial z_n} \end{vmatrix} \neq 0$$

then there exists a m-dimensional space ($x_{1,0}$, ..., $x_{m,0}$), N, where the variables (z_1, ..., z_n) are functions of the variables (x_1, ..., x_m) in the form of the system expressed as Y (see Gandolfo, 1997).

We investigate here the consequences of restrictive monetary policy on some variables of interest; in particular on GDP, prices, consumption, investment and the trade balance. As noted above, following a shock to the interest rate, all the variables involved in the model incur into a shock.

As a first step, the seven equations in the preceding section will be equalized to zero, such that we can re-write:

$$\begin{aligned}
&F^1(Y, C, I, J, e, \theta, p; r): Y - C - I - J = 0 \\
&F^2(Y, C, I, J, e, \theta, p; r): C - C(w, p, r) = 0 \\
&F^3(Y, C, I, J, e, \theta, p; r): I - I(w, r, \theta) = 0 \\
&F^4(Y, C, I, J, e, \theta, p; r): J - J(\theta, Y^*, Y) = 0 \\
&F^5(Y, C, I, J, e, \theta, p; r): e - e(r, r^*, p) = 0 \\
&F^6(Y, C, I, J, e, \theta, p; r): \theta - \theta\,(e, p^*, p) = 0 \\
&F^7(Y, C, I, J, e, \theta, p; r): p - p(e, w) = 0
\end{aligned} \tag{8}$$

In (8), the dependent variables are: GDP (Y); consumption (C); investment (I); the trade balance (J); the nominal exchange rate (e), the real exchange rate (θ); and the price level (p). To know the sign of the impact of the domestic interest rate on the dependent variables, it is necessary to find the partial derivatives following a change in the interest rate, keeping the rest of the system constant. That is, we must calculate a Jacobian for each exercise, which can be expressed as follows:

$$\left(\frac{\partial p}{\partial r}\right) = \frac{|J_p|}{|J|}$$
$$\left(\frac{\partial Y}{\partial r}\right) = \frac{|J_Y|}{|J|}$$

The second step is to compute the aforementioned Jacobians. We begin by checking that the denominator is not zero as this is essential in order for the results to have an economic meaning:

$$Y = \begin{bmatrix} 1 & 0 & 0 & J_Y+1 & 0 & 0 & 0 \\ Y_C-1 & 1 & 0 & Y_C & 0 & 0 & 0 \\ Y_I-1 & 0 & 1 & Y_I & 0 & 0 & 0 \\ Y_J-1 & 0 & 0 & 1+Y_J & 0 & 0 & 0 \\ 0 & 0 & \theta_e & -\theta_e & 1 & \theta_e-1 & 0 \\ -I-J_\theta & 0 & 1+I & J_\theta-1 & 0 & 1 & 0 \\ -C_w-I_w & C_w-1 & I_w-1 & 0 & 0 & 0 & 1 \end{bmatrix} \quad (9)$$

In (9), we show the matrix of the partial derivatives of the system of equations, whose determinant is $2-(Y_J \cdot J_Y)+J_Y \neq 0$. Accordingly, it is valid to continue with the exercise.

3. Effects of changes in interest rates on the level of prices

We begin the analysis examining the effects on the price level of an interest rate shock. As mentioned, the conventional view holds that a rise in the interest rate entails a decline in inflation rate due to falling demand,

and vice versa. To analyze this, below we show the results of one exercise. For this purpose, the matrix expressed in (9) is assumed to be unchanged, except for row 7, the price equation; when we change this row, a series of movements on the variables ensue, which are shown in equation (10).

Our comparative static result is the following:

$$\frac{|J_p|}{|J_r|} = 2 + Y_J \cdot e_r \cdot e_p + Y_J^2 \cdot p_e + Y_J^2 \cdot p_e \cdot e_r + Y_J - Y_J^2 - Y_J \cdot p_e - Y_J \cdot p_e \cdot e_r - Y_J^2 \cdot e_p \cdot e_r + 2\, e_r \cdot e_p - 2\, p_e \cdot e_r - 2\, p_e \qquad (10)$$

In (10) we can see that price index is affected by the partial derivative of GDP with respect to the trade balance (Y_J), which means that when the trade balance changes, this may affect both GDP and prices. Indeed, according to (2), the real exchange rate is an argument of the trade balance equation, such that if the change of (10) has been the consequence of an interest rate shock this will entail also an appreciation of real exchange rate, and may cause two possible outcomes. On the one hand, this variation will cause a loss of competitiveness, such that the trade balance could deteriorate, which may lower the level of GDP. The second effect is that the currency appreciation and cheaper imported inputs reduce business costs and the price index.

In (10) we also see that the price index depends on the movements of the nominal exchange rate, which in turn may vary due to changes in the interest rate (e_r) and the price index itself (e_p). Depreciation triggers inflation due to the higher cost of imported inputs and final goods.

To give real content to the previous discussion, we report below the outcome of an estimated equation for inflation (Valencia, 2015). The author found the following results for a model estimated for the 2002-2014 period:[4]

[4] *t*-values are reported in brackets below each coefficient. The model includes yearly dummy variables for the 2008-2009 period. This and the subsequent models estimated for this paper were subject to a battery of misspecification tests to ensure that all the underlying probabilistic and statistical assumptions could not be rejected. Misspecification testing is the most rigorous procedure to ensure the statistical validity of

$$\Delta p = 0.48 + 0.12\,\Delta w + 0.3\,\Delta e + 0.002\,r + 0.008\,\Delta\mu \qquad (11)$$
$$(1.98)\quad (3.87)\quad (3.72)\quad (8.62)\quad (11.64)$$

Where Δ denotes the first difference of the variable and μ stands for the degree of utilization of productive capacity in the manufacturing industry. We note here the small positive value, at 0.002, for the interest rate r. This may be associated with the higher cost of credit, which firms probably transfer to final prices. We also note a positive, very small value for μ, the parameter associated with the rate of utilization of capacity, at 0.008. The model implies that if demand were to influence inflation, as the inflation target scheme assumes, this should come mostly from its effect on nominal wages, on the exchange rate, on the profit margin, or on all of them. In this connection we add three relevant stylized facts about Mexico's economy.

The first is that demand does not appear to have an effect on the exchange rate, a result reported in an estimated model in De Jesús (2015). This author found that the exchange rate is associated only with the wage-share, with the difference between the domestic and the US interest rate, and with labor productivity (in all these cases the sign of the association is negative). The second one is a model for nominal wages for Mexico estimated by López (1999), who found that in Mexico nominal wages depend only on labor productivity, on the minimum wage, and on prices; while the level of employment and of output (and hence the degree of utilization of capacity) do not seem to have an influence. The last one is a model for the manufacturing profit margin (Malagamba, 2015), which demonstrated that aggregate demand has some, but very little, impact on profit margins.

All of the above suggests that the theory of inflation underpinning the inflation targeting strategy does not appear to be a robust one, at least considering Mexico's experience. In other words, since the nominal wage, the profit margin, and the nominal exchange rate do not seem to

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an econometric model, and to guarantee that inferences (goodness of fit, t values and sign of the parameters etc.) are valid (see Spanos, 1986). All these tests are available from the authors upon request.

jump following a demand upswing, it is not the latter that has the most influence on inflation.

4. Effect on the GDP caused by a change in the interest rate

In this section we will identify the effects on GDP following a shock to the interest rate. For this purpose, the first row corresponding to the partial derivatives from the system calculated with respect to output will be replaced by a new vector incorporating the results of the partial derivatives after a change in the interest rate. The result is shown in the following matrix:

$$J_Y = \begin{vmatrix} -C_r - I_r & C_r + 1 & I_r + 1 & 0 & -e_r & e_r + 1 & -e_r \\ Y_C - 1 & 1 & 0 & Y_C & 0 & 0 & 0 \\ Y_I - 1 & 0 & 1 & Y_I & 0 & 0 & 0 \\ Y_J - 1 & 0 & 0 & 1 + Y_J & 0 & 0 & 0 \\ 0 & -1 & \theta_p & -\theta_p & 1 - e_p & e_p - 1 & \theta_p - e_p + 1 \\ 0 & p_e & \theta_e & -\theta_e & p_e - 1 & 1 - e_p & \theta_e - 1 + p_e \\ -I - J_\theta & 0 & 1 + I & J_\theta - 1 & 0 & 0 & 1 \end{vmatrix} \quad (12)$$

Before proceeding with the analysis, we must emphasize that to investigate the effects we are interested in, it was necessary to make some drastic assumptions. This is essential to obtain results that are not overly complicated in terms of the variables involved. For instance, investment and consumption depend on the GDP, but the GDP also depends on them both. To solve this from equations (3) and (4) of section 1 with the implicit function theorem would involve a never-ending loop solution to the model, so we decided to substitute wages for GDP. We must stress that even though this procedure suppresses some important effects of the shock we are investigating, it is useful for the purposes of this section, which is merely to illustrate and bring to light the main interactions among our variables.

Now, it can be seen that the determinant of (12) is logically the result of the algebraic summation of the effects of an interest rate shock on each of the components of the GDP, i.e. consumption, investment and the trade balance. Accordingly, the result can be sub-divided as follows:

$$\frac{\partial C}{\partial r} = 2\,Y_C \cdot p_e + 2\,Y_C \cdot p_e \cdot e_r + 2\,Y_C \cdot e_p + 2\,Y_C \cdot C_r \cdot p_e \cdot e_p + 2\,Y_C \cdot C_r \cdot e_p - 2\,Y_C - 2\,Y_C \cdot e_{p^2} - 2\,Y_C \cdot C_r \cdot e_{p^2} - 2\,Y_C \cdot C_r \cdot p_e - 2\,Y_C \cdot e_r \cdot e_p \quad (13.1)$$

$$\frac{\partial I}{\partial r} = 1 + 2\,I \cdot Y_I + 2\,Y_I \cdot e_{p^2} + 2\,Y_I \cdot e_p + 2\,Y_I \cdot I_r \cdot e_p + 2\,Y_I \cdot I_r \cdot p_e \cdot e_p + 2\,Y_I \cdot p_e \cdot e_p + 2\,I \cdot Y_I \cdot e_p \cdot \theta_e + 2\,I \cdot Y_I \cdot p_e \cdot \theta_p \cdot p_e \cdot e_r \cdot \theta_p - 2\,Y_I \cdot p_e - 2\,Y_I \cdot I_r \cdot p_e - 2\,Y_I \cdot I_r \cdot e_{p^2} - 2\,I \cdot Y_I \cdot e_r \cdot e_p \cdot \theta_p - 2\,I \cdot Y_I \cdot \theta_p - 2\,I \cdot Y_I \cdot \theta_e \quad (13.2)$$

$$\frac{\partial J}{\partial r} = Y_J + Y_J \cdot e_r \cdot e_p + 2\,Y_J \cdot e_{p^2} + 2\,Y_J \cdot J_\theta \cdot e_p \cdot \theta_e + 2\,Y_J \cdot J_\theta \cdot p_e \cdot \theta_p + 2\,Y_J \cdot J_\theta \cdot p_e \cdot e_r \cdot \theta_p - 2\,Y_J \cdot e_p - Y_J \cdot p_e \cdot e_p - Y_J \cdot p_e \cdot e_r - 2\,Y_J \cdot J_\theta \cdot \theta_p - 2\,Y_J \cdot J_\theta \cdot \theta_e - 2\,Y_J \cdot J_\theta \cdot e_r \cdot e_p \cdot \theta_p \quad (13.3)$$

In the following sections, we will study how the rise in the interest rate affects each individual GDP component. For the time being, we simply mention something that appears clearly in sub-results (13.1), (13.2) and (13.3), i.e. it is not at all evident that a rise in the interest rate must necessarily reduce GDP as assumed in the inflation targeting strategy; the result may bring a GDP rise.

5.1 Effects on GDP induced by changes in consumption

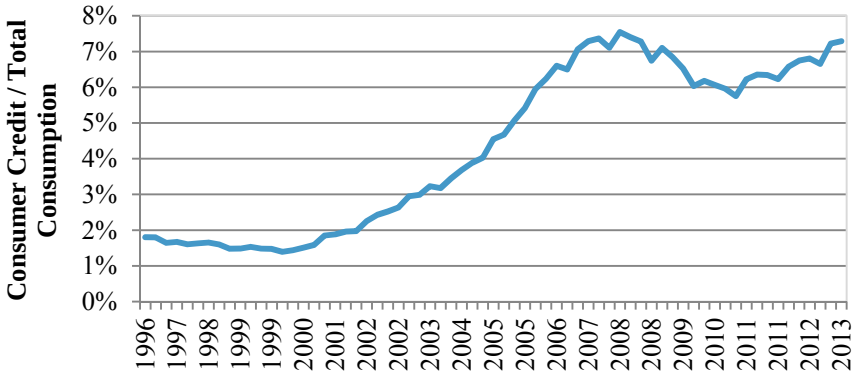
These effects appear in equation (13.1), which we rewrite below:

$$\frac{\partial C}{\partial r} = 2\,Y_C \cdot p_e + 2\,Y_C \cdot p_e \cdot e_r + 2\,Y_C \cdot e_p + 2\,Y_C \cdot C_r \cdot p_e \cdot e_p + 2\,Y_C \cdot C_r \cdot e_p - 2\,Y_C - 2\,Y_C \cdot e_{p^2} - 2\,Y_C \cdot C_r \cdot e_{p^2} - 2\,Y_C \cdot C_r \cdot p_e - 2\,Y_C \cdot e_r \cdot e_p \quad (13.1)$$

Equation (13.1) shows that the variables inducing changes in consumption are changes in the price index, in the nominal exchange rate, and in the interest rate itself. In general, we may infer that the interest rate seems to have an indeterminate effect on consumption.

We can give to this result, purely mathematical in its present guise, a more specific content taking into account some stylized facts of Mexico's economy. For instance, in this country it appears that although credit–financed consumption has grown significantly, its weight in total consumption is small. This is clearly seen in figure 1, where it is shown that presently credit-financed consumption barely exceeds 7% of the total.

Figure 1. *Relative weight of consumption credit in total consumption, current prices* (*1996-2013*)



Source: Banxico and INEGI.

A second important stylized fact comes from an econometric estimation of the determinants of consumption in Mexico we carried out for this work. We estimated a VAR model with quarterly data for the period 1988-2010, relying on the specification made in equation (3) but adding some additional variables: GDP, money supply (*M2*) and taxes (*T*). Moreover, instead of wages we include the share of wages in value added *v*. Money supply seems an appropriate proxy for measuring liquidity and credit availability in the economy and taxes are included because they tend to reduce the disposable income of households. Our results yield the following long-term equation:[5]

$$C = 1.48\ Y + 0.623\ v - 0.002\ r + 1.82\ M2 - 0.76\ T \qquad (14)$$

[5] All variables included in the specification were found significant at 95% confidence level or higher, while the price index was not significant in statistical terms (probably because we do not include nominal wages, but the share of wages in GDP). We also estimated the implied Error Correction Mechanism (ECM). The latter suggests that the right-hand side variables of the equation do indeed Granger-cause consumption.

Note that the coefficient of the interest rate on consumption, at 0.002, is negative for a given wage share, but it is very small, whereas the parameter associated with the wage share, at 0.62, is quite high. Accordingly, if a higher interest rate also affects the wage share (see below), then its total effect (including both the direct and indirect effects) may not be negative at all. To see why, it is useful to reproduce here the equation recalled in footnote 3:

$$v = \frac{1}{\left[1 + (k-1)\left(\frac{em}{w} + 1\right)\right]}$$

It can be seen that if the higher interest rate appreciates the domestic currency (e falls), the wage share rises.[6] This rise may offset, or more than offset, any negative direct effects of the interest rate on consumption.

5.2 Effects on GDP induced by changes in investment

We reproduce below the corresponding comparative statics result for investment:

$$\frac{\partial I}{\partial r} = 1 + 2\,I \cdot Y_I + 2\,Y_I \cdot e_{p^2} + 2\,Y_I \cdot e_p + 2\,Y_I \cdot I_r \cdot e_p + 2\,Y_I \cdot I_r \cdot p_e \cdot e_p + 2\,Y_I \cdot p_e \cdot e_p + 2\,I \cdot Y_I \cdot e_p \cdot \theta_e + 2\,I \cdot Y_I \cdot p_e \cdot \theta_p \cdot p_e \cdot e_r \cdot \theta_p - 2\,Y_I \cdot p_e - 2\,Y_I \cdot I_r \cdot p_e - 2\,Y_I \cdot I_r \cdot e_{p^2} - 2\,I \cdot Y_I \cdot e_r \cdot e_p \cdot \theta_p - 2\,I \cdot Y_I \cdot \theta_p - 2\,I \cdot Y_I \cdot \theta_e \qquad (13.2)$$

In (13.2) we can see all variables that affect investment, namely the nominal exchange rate, the price index, the interest rate and the real exchange rate. We can see that there are elements that may have a positive sign and elements that may have a negative sign for the partial derivative of investment relative to the interest rate, hence a possible indeterminate effect of the interest rate on investment can be postulated.

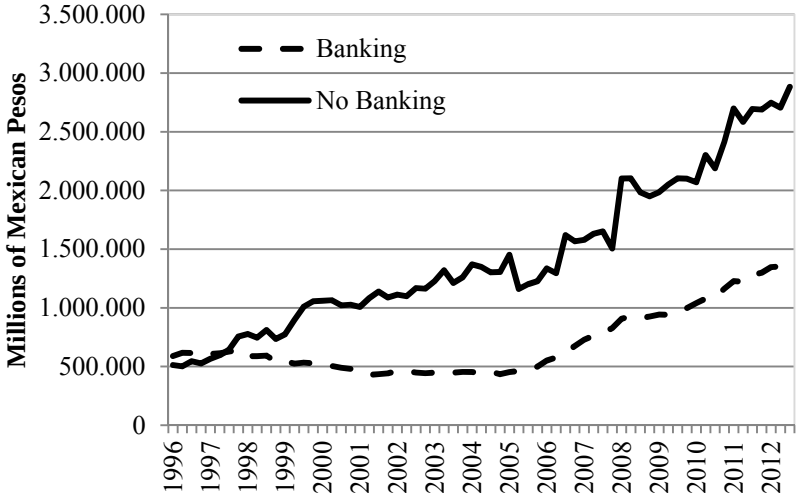
Let us therefore look at the facts. A first important empirical evidence to consider in the present context is that most of investment in

[6] The negative association between the wage share and the interest rate was found to be valid in the econometric model estimated by De Jesús (2015).

Mexico is not financed with domestic bank credit or with share issuance, but with other sources such as firms' savings, or with suppliers and dollar debt. In figure 2 we observe the sources of investment financing, split between bank and non-bank finance.

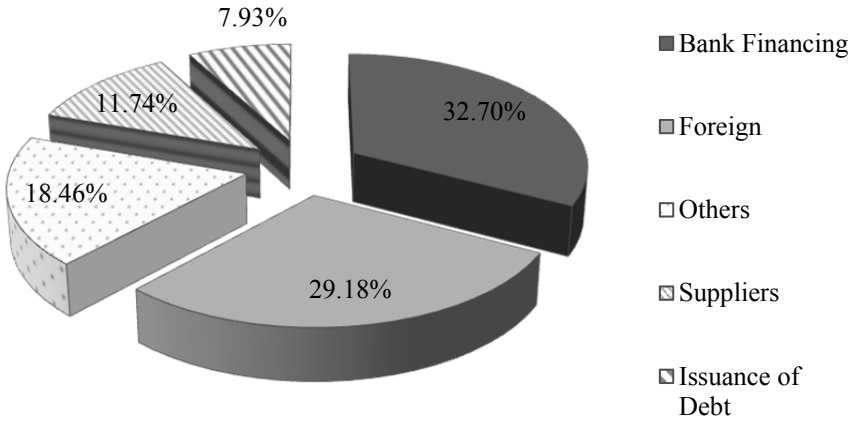
It is apparent that investment in Mexico is financed mostly by non-bank sources. We can report here that the structure of corporate debt in Mexico is composed of 32.7% bank credit and 67.3% non-bank credit. Of this last item, 29% corresponds to debt contracted in foreign currency, 18.46% come from other sources, 11.74% come from suppliers, and only 7.93% is by issuance of debt. This is shown in figure 3.

Figure 2. Sources of financing investment in Mexico, current pesos (1996-2013)



Source: Banxico.

Figure 3 – Structure of financing investment in Mexico (2013)



Source: Banxico.

What these data suggest is that the interest rate probably would not have a significant direct influence on investment decisions. However, it may have an indirect influence, since a change in the interest rate may greatly affect the balance sheet of companies that are indebted in dollars. In fact, a decline in the interest rate results in a depreciation of the local currency and therefore an increase in the nominal and real exchange rate. The latter affects the amount and cost of dollar-denominated debt, expressed in national currency. In addition, the cost of imported machinery and inputs from abroad will suffer an increase. Owing to the above, the result may be a contraction in investment.

The results reached by Caballero and Lopez (2011), who estimated an investment function for the period 1990-2008, support such hypothesis. We report their estimated equation for investment below:

$$I = 1.09\ Y + 0.44\ g - 1.63\ \theta - 0.29\ \lambda - 0.0005\ \sigma + 0.18\ \eta$$

Where g is public investment spending, λ the income tax, σ the value added tax, and η foreign direct investment.[7] Thus, the authors find that increasing the real exchange rate by 1% depresses investments by 1.6% in the long term. But also, and importantly, the authors report that they found no evidence of a direct effect of the interest rate on investment. As mentioned, there may be an indirect influence association between the two variables, whereby the rise in the interest rate causes a decline in the real exchange rate, which stimulates investments.

5.3 Effects on GDP induced by changes in the trade balance

To identify the effects that interest rate changes may cause on the trade balance we will use the result of (13.3) which is replicated below:

$$\frac{\partial J}{\partial r} = Y_J + Y_J \cdot e_r \cdot e_p + 2\,Y_J \cdot e_{p^2} + 2\,Y_J \cdot J_\theta \cdot e_p \cdot \theta_e + 2\,Y_J \cdot J_\theta \cdot p_e \cdot \theta_p + 2\,Y_J \cdot J_\theta \cdot p_e \cdot e_r \cdot \theta_p - 2\,Y_J \cdot e_p - Y_J \cdot p_e \cdot e_p - Y_J \cdot p_e \cdot e_r - 2\,Y_J \cdot J_\theta \cdot \theta_p - 2\,Y_J \cdot J_\theta \cdot \theta_e - 2\,Y_J \cdot J_\theta \cdot e_r \cdot e_p \cdot \theta_p \qquad (13.3)$$

In (13.3), we see that the variables involved are the nominal exchange rate (e), the interest rate (r), the price index (p) and the real exchange rate (θ). Again, the result is ambiguous since there are terms with positive and temrs with negative signs. However, it appears that a rise in the rate of interest will contain inflation, but this will bring with it an appreciation of the nominal and the real exchange rate. If the Marshall-Lerner condition holds, the appreciation of the exchange rate will stimulate imports and reduce exports, worsening the trade balance. Incidentally, this is an adverse effect on the economy, which supporters of the inflation targeting strategy rarely, if at all, mention.

To give some flesh to the point we are discussing, we estimated a model for the trade balance, modeling the ratio of exports to imports, denoted by (χ). We include as arguments Mexico's GDP (Y) and US GDP (Y^*), the ratio of manufacturing exports to total exports, (X_m/X), the

[7] All variables reported were statistically significant at 95% confidence level or higher.

real exchange rate (θ), and the ratio of investments to output (I/Y). We obtained the following long-term equation:[8]

$$\chi = -196.56\ Y + 202.83\ Y^* + 12.233\ X_m/X + 4.6058\ \theta + 191.19\ I/Y \qquad (15)$$

We need not discuss in detail the results from the estimated equation. Let us only remark that the real exchange rate has a relatively high value; in fact, for each percentage point that the currency depreciates, the ratio of exports to imports increases by 4.6 percent. This result allows us to conclude that the current policy of high interest rate, which supports an overvalued currency, has had a significant negative effect on the trade balance. It is worth noting that this result is consistent with the conclusion of our comparative statics exercise.

To the above, we may add that the worsening of the balance, brought about by the interest rate hike and the induced currency appreciation, deteriorates what may be called 'external equilibrium level of output', i.e. the output level consistent with equilibrium of the trade balance (Thirlwall, 1979). The latter can force the economic authorities to apply a recessive policy, or otherwise can cause an external crisis, such as the one Mexico suffered in 1994-1995.

5.4. Summary of the impact on GDP of a rise in the interest rate

From the previous discussion it follows that a rise in the interest rate has an ambiguous effect on GDP. This rise may, by itself, dampen private demand, though this is far from definite; but what is certain is that it also tends to appreciate the nominal and real exchange rate. The latter reduces the cost of servicing the foreign debt of companies indebted in dollars and redistributes income in favor of workers, all of which may stimulate investment and consumption. In fact, for example López Sánchez and Spanos (2011) estimated an econometric model for Mexico and found that the exchange rate has a negative influence on demand and on GDP.

[8] We also estimated an Error Correction Model for the above model, where we found that the signs of the included variables coincided with the long-run equation. The ECM confirms that the right-hand side variables Granger-cause the trade balance.

Their conclusion is also similar to the results of Ivrendi and Yildirim (2013) for India, South Africa, Russia and China; likewise, Rafiq and Mallick (2008) reach analogous results in a study for Germany and France.

In the previous sections we have given some arguments for our previous statement. But to further support our claim, we report below the results of an estimated VAR model to identify the determinants of GDP. With a statistically well-specified VAR model, we found a cointegrating vector for GDP whose results are:[9]

$$Y = -6.1 + 0.75\ Y^* + 0.03\ v + 0.77\ g + 0.01\ r - 0.16\ t$$

Where t is the income tax (all variables except the interest rate in logarithms). It is not necessary to discuss here the model in detail. We only call attention to the small, though positive, sign we find for the interest rate. That is, a higher interest rate seems to stimulate GDP. How to explain this effect, completely contradictory to the expectations of the proponents of the inflation targeting strategy and to much of macroeconomic theory?

In our opinion, this result is not surprising from the perspective we have put forward in the course of our work. In particular, we note that a higher interest rate tends to appreciate the exchange rate, which tends to stimulate demand in two ways. One is the wage share (which has a positive effect on GDP), which contributes to higher consumption. The others are to reduce the weight of debt service of firms with debt in dollars, and the lower price of imported capital goods, which may stimulate investment (Caballero and Lopez, 2012).

Everything being considered, we may conclude that a higher interest rate does indeed allow controlling inflation; not because it depresses the GDP, but because it brings about currency appreciation. The latter, in turn, raises the wage share stimulating consumption out of wages, even as it reduces the debt service of firms, which encourages investment. Effective demand thus receives a positive shock. Notice also, and this is

[9] All variables reported were statistically significant at 95% confidence level or higher.

an important remark, that while currency appreciation stimulates effective demand and effective output, it also depresses the level of output compatible with external equilibrium. Accordingly, it gives rise to an unsustainable situation, which must entail the adoption of austerity measures, or it develops into a situation of increasing external disequilibrium that can result in a foreign exchange crisis.

5. Conclusions

In this paper we have attempted to identify the effects of a high interest rate policy on prices, output, and the three private aggregate demand components. To achieve this objective we made use of a theoretical framework inspired by the theory of effective demand. We have argued that the key variable to achieve inflation control has been the exchange rate and not the interest rate, although the latter exerts indirect effects on the price level and output, mostly by affecting the exchange rate.

We specified a macroeconomic model, with which we carried out comparative statics exercises that we solved using the implicit function theorem. The first exercise is in relation to the effect of the interest rate on the price level. We did not find a direct effect of the interest rate on prices, but we showed that the exchange rate has a strong impact on prices.

The second exercise was built with the aim of investigating the effects of the interest rate on GDP. To study this issue we considered the three aggregate demand variables, namely consumption, investment and the trade balance.We found an ambiguous effect of the interest rate on consumption, which we contrasted with some stylized facts of the Mexican economy, and which we confirmed with an econometric estimate where the elasticity of consumption with respect to the interest rate is not statistically different from zero.

Regarding investment, the stylized facts show that Mexican firms satisfy only a reduced share of their financing needs through bank credit, implying that the direct effect of the interest rate may be small. However, we reported empirical results, including for Mexico, showing a negative

relationship between the real exchange rate and investment. This suggests that in fact there may be a positive, or no association at all, between the interest rate and investment.

We also argued that a hike of the interest rate may have an ambiguous impact on the trade balance. Indeed, the balance depends on the income and the exchange rate elasticities, and both income and the exchange rate vary with the interest rate. In this context we argued that the current policy of a high interest rate, which tends to overvalue the domestic currency, is likely to have harmful consequences for the level of output compatible with external balance.

Finally, we specified and estimated a model for output. With such model we found a positive relationship between the interest rate and output. We argued that the sign of this association, though startling at first sight, is not so surprising after all, because a higher interest rate appreciates the peso. In turn, this stimulates demand in two ways: by reducing the burden of the service of debt denominated in a foreign currency, and by redistributing income in favor of workers.

We wish to conclude with an observation of a more general nature. In recent years, economic policy has lost relevance for policymakers. In fact, the notion that the only and the best thing the government can do is to ensure the credibility of its policy statements, maintain price stability with an adequate management of the interest rate, and keep government expenditure at the lowest possible level has become almost commonplace. We differ radically from this vision and have argued, and have hopefully demonstrated in this work, that shocks to the interest rate have a number of effects on a broad set of variables, not just on prices and inflation. This suggests that management of the interest rate should be used very cautiously, trying to keep it stable most of the time. This also indicates that economic authorities should have in stock other policy instruments, complementary or alternative, to control and tame inflationary pressures.

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