THE SHORT-TERM EFFECTS OF FISCAL POLICY IN MEXICO: AN EMPIRICAL STUDY

Dr. Víctor M. Cuevas Ahumada*

Introduction

The purpose of this paper is to investigate the short-term effects of fiscal policy on the Mexican economy. To that end, we employ a Structural Vector Autoregression (SVAR) model reflecting some basic features of the Mexican economy, since it is consistent with a small open economy with a flexible exchange rate and free capital mobility. To improve the robustness of the findings, we also resort to the Generalized Vector Autoregression (GVAR) technique and make use of three different indicators of fiscal policy: government spending, government revenues and the budget deficit. These are the three basic indicators of fiscal policy proposed by Tanzi and Zee (1997) and every single one has been recently utilized in empirical macroeconomics. Indeed, previous empirical work does not provide conclusive support for the use of one particular indicator.[1]

To deal with the stationarity issue, we follow two complementary approaches: one is to estimate typical VAR models with stationary variables, whereas the other is to estimate atypical VAR models with nonstationary variables but ensuring the overall stability of the system as suggested by Sims (1980), Doan (2000, p. 283) and Lütkepohl (2006). In the latter case, we ensure model adequacy –among other things– by performing stability

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* Profesor-investigador del Departamento de Economía de la Universidad Autónoma Metropolitana-Azcapotzalco y miembro del Sistema Nacional de Investigadores. Correo electrónico: victorcuevasahumada@yahoo.com.mx.

[1] For instance, Easterly and Rebelo (1993), Barro and Sala-I-Martin (1995), and Ambler and Paquet (1996), resort to government spending to capture the stance of fiscal policy. Lucas (1990) and Stokely and Rebelo (1990), *inter alia*, use taxes for the same specific purpose. Finally, Martin and Fardmanesh (1990), and Catao and Terrones (2003), along with others, employ the government budget deficit.

tests, given that stability is a sufficient condition for the "overall stationarity of the system," notwithstanding the inclusion of individual nonstationary variables.[2] Altogether, the above gives rise to twelve different model specifications, as we are using two distinct methodologies for estimation purposes (*i.e.*, structural and nonstructural), two different approaches to deal with the stationarity issue (standard VARs in first or second differences, and nonstandard but stable VARs in levels), and three fiscal policy indices (spending, revenues and the deficit). Moreover, in order to evaluate the effects of fiscal policy shocks and their transmission channels, each specification is used to perform a battery of diagnostic tests and estimations. Our basic purpose is to start working with a benchmark specification and then test the robustness of the findings by means of alternative specifications.

As we shall see, a brief survey of the literature reveals that the economic effects of fiscal policy are still the subject of a heated controversy, which seems to be coupled with an increasing difficulty to attain clear-cut empirical results in recent years. The empirical evidence presented in this paper suggests that a fiscal expansion, resulting from a tax cut, produces the following effects: (i) the money supply increases along with the interest rate and the price level, (ii) the domestic currency depreciates in real terms despite the higher interest payments, and (iii) economic activity rises and the trade balance deteriorates. Along these lines, one of the most interesting findings emerging from this study is that fiscal expansion leads to real exchange rate depreciation in spite of an upward trend in interest rates, given that it is broadly consistent with the so-called

[2] We originally intended to estimate a multivariate Vector Error-Correction (VEC) model to capture not only the short-term dynamics but also the long-run equilibrium relationships among the variables. According to test results, however, every indicator of fiscal policy is weakly exogenous and, therefore, cannot be part of the sensitivity analysis. In view of this finding, we opted for the short-term VAR analysis.

country risk view of fiscal policy. According to this view, fiscal loosening in developing countries such as Mexico may induce risk-averse investors to transfer funds abroad in order to avoid domestic inflationary taxes, exchange rate risk and other potential hazards commonly associated with unsound public finances. Such capital outflows may, in turn, weaken the domestic currency in real terms even with a higher rate of return on the peso-denominated bonds.

The remaining of this paper is organized as follows. Section I offers a brief review of the recent literature. Section II develops the theoretical framework, with emphasis on a benchmark model specification. Section III describes the dataset and conducts the integration analysis. The estimation results are presented in Section IV. Finally, we conclude by summarizing the most relevant empirical findings and their policy implications.

I. Literature Review

With the advent of new econometric techniques, the short and long-term influence of fiscal policy on both aggregate demand and aggregate supply has been the subject of renewed attention. In this regard, there are four major strands of literature: (i) the traditional Keynesian view, (ii) the Ricardian Equivalence view, (iii) the New Keynesian view, which is partly based on a modern version of the Mundell-Fleming model, and (iv) the country risk view.[3]

[3] This is not an in-depth classification of fiscal policy theories, yet it provides the necessary background to proceed with the empirical analysis and interpret the results with reference to a theoretical framework.

Under the traditional Keynesian view, an expansionary fiscal policy tends to increase both aggregate demand and output in the short term.[4] In other words, an exogenous increase in government spending or a tax cut will affect aggregate demand by raising private consumption and investment. Under the static Keynesian model, with inflexible prices and slack in productive capacity, output responds rapidly to changes in aggregate demand while inflation remains low and stable. It must be emphasized that the effects on output and prices are highly dependent on the assumptions made about the economy in which fiscal expansion takes place. For example, Sutherland (1997) and Perotti (1999) find that fiscal policy can be effective in fostering economic activity only when government debt is relatively low.[5] More recently, an empirical research conducted by Perotti (2002), based on five prominent OECD countries, points to the conclusion that the economic effects of fiscal deficits have become increasingly subtle over the last two decades.

The Ricardian Equivalence (*RE*) approach contends that interest rates and output are unaffected by an enlargement of the budget deficit resulting from a tax cut. The argument behind is that economic agents realize that the government will take on more debt to finance a larger gap between public expenditures and public revenues. Since a growing federal debt will eventually force the government to raise taxes again, economic agents respond by increasing savings (and eventually bequests) in order to protect the future generations from the negative effects of fiscal expansion. Thus, according to this view, the tax alleviation will fail to stimulate private consumption and

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[4] Obviously, a necessary condition for this to happen is that there be slack in capacity utilization.

[5] A more relaxed fiscal policy can increase the risk of default if implemented in the context of elevated government debt ratios, disheartening economic agent's confidence in government policies and provoking contractionary effects on aggregate demand and economic activity through diminished consumption and investment spending.

economic growth because a higher government deficit (*i.e.*, a higher public dissaving) is fully offset by an increase in private savings. In this perspective, national savings remain unaltered as well as interest rates and economic activity. This contention was first made by Barro (1974) and then followed by other authors: Plosser (1982, 1987), Evans (1985, 1987a, 1987b), Bayoumi and Masson (1998), Giorgioni and Holden (2003), and De Mello *et al*. (2004).[6]

According to the New Keynesian view (often called the Mundell-Fleming view), an expansionary fiscal policy raises both prices and interest rates. Interest rates tend to rise because a higher budget deficit typically involves an enhanced demand for loans. As the government borrows more in the domestic financial market, the competition for scarce funds intensifies, interest rates escalate and this, in turn, may crowd out private investment.[7] Concerning the external sector of the economy, this notion maintains that high real interest rates frequently give rise to massive capital inflows and exchange rate appreciation. A real appreciation of the domestic currency erodes international competitiveness (that is, it makes domestic goods more expensive abroad and foreign goods cheaper at home), thereby widening the current account deficit.[8] Consequently,

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[6] Nonetheless, the empirical evidence concerning the RE theory is somewhat mixed. Ball and Mankiw (1995) and Doménech *et al*. (2000) are among the various empirical papers questioning its validity. Moreover, Stiglitz (1988) and Botman and Kumar (2006), *inter alia*, show that the theoretical assumptions for the RE to hold are extremely rigorous and difficult to meet in practice. Put differently, a full RE requires the following assumptions to be satisfied: (i) homogeneous consumers, (ii) perfect foresight, (iii) lump-sum taxation, (iv) completely free access to financial markets by all consumers and firms, and (v) a risk-free public debt. Under such a restrictive setting, changes in the budget deficit can be fully offset by variations in private savings and there will be no incidence on interest rates or output.

[7] An implicit assumption here is that the government borrows money domestically to finance its deficit.

[8] Similarly, a restrictive fiscal policy lessens inflationary pressures and reduces interest rates to the extent that the government borrows less and the competition for scarce funds becomes less stringent. The decline in domestic interest rates stimulates private

the net effect of fiscal policy on economic activity ultimately depends on factors such as the degree of openness of the economy, the output level compared to full capacity, and potential crowding-out effects arising from an increase in market interest rates, an exchange rate appreciation, or a price adjustment. It is worth mentioning that this approach is based on an amplified version of the Mundell-Fleming model (1987), which focuses on economic policymaking in small open economies with free capital mobility and flexible exchange rates. Among the most relevant works in this particular area are: Blanchard (1981, 1984, 1985), Blanchard and Dornbusch (1984), Feldstein (1984), Branson, Fraga and Johnson (1985), Dornbusch (1986), and Reinhart and Sack (2000: 175).

The country risk theory of fiscal policy brings the country risk premium into the picture. Within this analytical framework, even though fiscal expansion elevates interest rates, the domestic currency is likely to depreciate. This latter assertion clearly contradicts the New Keynesian notion which claims that, all else equal, higher interest rates lead to exchange rate appreciation. In fact, the central discrepancy between these two theories (the New Keynesian and the country risk) relates to the impact of fiscal developments on the exchange rate. As already noted, the effects of the budget deficit on the economy obviously depend on the underlying macroeconomic model and its array of intrinsic assumptions. In this respect, the country risk approach basically emphasizes the role played by the country risk factor in bringing about exchange rate depreciation following a fiscal expansion (or exchange rate appreciation after a fiscal retrenchment). The basic

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investment and economic growth but makes the peso-denominated bonds less attractive to investors, so that they shift funds away from Mexican securities and toward foreign securities. In such a circumstance, the Mexican peso is likely to depreciate (as capital flows leave the country), trimming down the current account deficit.

explanation lies in the fact that international rating agencies (such as *Moody's* and *Standard & Poor's*) regard the government budget deficit as a key variable in assessing economic performance and country risk. Therefore, increasing budget deficits, especially in developing countries, are usually deemed as an early warning indicator (that is, as a signal of deterioration in the so-called economic fundamentals) not only by such rating agencies but also by international investors. So, in the face of expansionary fiscal policies, risk-averse investors may respond by transferring funds abroad to avoid domestic inflationary taxes, exchange rate risk and other inherent vulnerabilities of unsound public finances.[9] The massive capital outflows originated in this manner may, in turn, be the source of exchange rate depreciation even with increased real interest rates.[10] Some of the main proponents of this theory are: McDermott and Wescott (1996), Eichengreen (2000: 67), and Cuevas and Chávez (2007).

To sum up, it is worth mentioning that the effects of fiscal policy very much depend on factors such as the consumer's planning horizon, the labor supply elasticity, the degree of openness of the economy and the structure of financial markets.[11] We can argue further that the effects of fiscal expansion (or fiscal reduction) are also a function of: (i) the specific tax and spending policies behind it, and (ii) the economic and political circumstances under which fiscal policy measures are implemented.

II. Theoretical Framework

[9] The sensitivity of investors may vary depending not only on their attitude toward risk but also on factors such as the initial state of public finances, the magnitude and composition of the fiscal relaxation, and the pace of the implementation process.

[10] By the same token, contractionary fiscal policies may result in exchange rate appreciation in spite of the fall in real interest rates induced by a lower public demand for loans.

[11] See Botman and Kumar (2006) for a more detailed discussion on this subject.

Although the empirical analysis is confined to the VAR framework, we employ two different estimation techniques to enhance the robustness of the findings: the generalized and the structural technique. The Generalized VAR (GVAR) method was developed by Pesaran and Shin (1998) in order to improve the so-called "recursive" VAR method introduced by Sims (1980). Even though the generalized and the recursive methodologies are both "nonstructural" by definition, the former has the advantage of producing empirical evidence that does not depend on the VAR ordering.[12] Nonstructural VARs have become widely used in econometric analysis because economic theory plays no role in identifying and estimating the model (i.e., they allow the data to speak freely). Two circumstances were responsible for making the lack of theoretical restrictions a critical advantage: (i) the persistent dispute among equally plausible theories with regard to the basic structure of the economy, and (ii) the Lucas critique, which argues that the impact of government policies cannot be predicted since those policies continuously alter the structure of the economy and the way people form their expectations about the future.[13] By the same token, nonstructural VARs basically rely on "pure" multiple time series analysis, so that the role played by economic theory is restricted to selecting the variables of the system. That is why these models are also referred to as atheoretical models.

On the other hand, Structural VAR (SVAR) models represent a further development in econometric theory and applied work. Under the SVAR methodology, economic theory does play an important role in identifying and estimating the model. Along these lines,

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[12] By contrast, impulse responses and variance decompositions from recursive VARs may be sensitive to changes in the ordering of the equations, increasing the difficulty of obtaining clear-cut empirical results.

[13] As a matter of fact, the growing popularity of nonstructural VARs can be ascribed to the implausible assumptions and theoretical biases behind the large-scale simultaneous equation models of the early years.

SVAR models can be characterized as an intermediate approach, that is, as an approach lying somewhere in between the pure multiple time series models and the structured large-scale simultaneous equations models. To identify and estimate our SVAR model we shall draw heavily on the method proposed by Amisano and Giannini (1997).

Even though we use three different indicators (government spending, government revenues and the budget deficit) to study the effects of fiscal policy shocks, for expositional convenience we rely on the budget deficit to explain the theoretical underpinnings of our SVAR model. So, we start by saying that the model is made up of seven endogenous variables: budget deficit (BD_t), money supply (M_t), nominal interest rate (R_t), real exchange rate (Q_t), prices (P_t), output ($GEAI_t$) and trade balance (TB_t).[14] We shall see that this model is broadly consistent with a small open economy with a flexible exchange rate and free capital mobility.

Equation (1) represents a SVAR model in its primary form:

$$AY_t = A_1 Y_{t-1} + A_2 Y_{t-2} +,...,+ A_p Y_{t-p} + B\varepsilon_t \qquad (1)$$

where $Y_t = [BD_t, M_t, R_t, Q_t, P_t, GEAI_t, TB_t]'$ is a (7x1) vector of endogenous variables, A, B, and A_i are (7x7) coefficient matrices, with $i = 1,2,..., p$, and $\varepsilon_t = [\varepsilon_t^{BD}, \varepsilon_t^{M}, \varepsilon_t^{R}, \varepsilon_t^{Q}, \varepsilon_t^{P}, \varepsilon_t^{GEAI}, \varepsilon_t^{TB}]'$ is a (7x1) vector of structural shocks. The elements of ε_t are shocks to the different variables of the system. For instance, ε_t^{BD} denotes fiscal shocks, whereas ε_t^{M} and ε_t^{Q} stand for monetary and exchange rate shocks, respectively. We assume that the elements of vector ε_t are orthonormal, that is, they are

[14] Since monthly GDP-data is not available in the case of Mexico, we make use of the Global Economic Activity Index (Indicador Global de Actividad Económica) as a proxy for output.

uncorrelated with unit-variance and zero expected value. Therefore, the covariance matrix of structural shocks, $E(\varepsilon_t \varepsilon_t^{'}) = \Lambda$, is an identity matrix.

The reduced-form or secondary SVAR model is given by equation (2):

$$Y_t = \Gamma_1 Y_{t-1} + \Gamma_2 Y_{t-2} +,...,+ \Gamma_p Y_{t-p} + e_t \tag{2}$$

where $\Gamma_i = A^{-1} A_i$ are reduced-form coefficient matrices with $i = 1,2,..., p$, and $e_t = A^{-1} B \varepsilon_t$ is the vector of reduced-form innovations. Estimation of equation (2) through the OLS method yields estimates of the reduced-form coefficient matrices, Γ_i, the reduced-form innovations, e_t, and their covariance matrix, $\Sigma = E(e_t e_t^{'})$. The AB-method of Amisano and Giannini (1997) is used here to identify and estimate our SVAR model [see also Lütkepohl (2006, Chapter 9)]. Equations (3) and (4) are useful in explaining such a method:

$$A e_t = B \varepsilon_t \tag{3}$$

$$\Sigma = E(e_t e_t^{'}) = E(A^{-1} B \varepsilon_t \varepsilon_t^{'} B' A^{-1'}) = A^{-1} B E(\varepsilon_t \varepsilon_t^{'}) B' A^{-1'} = A^{-1} B \Lambda B' A^{-1'} = A^{-1} B I_n B' A^{-1'}$$

$$= A^{-1} B B' A^{-1'} \tag{4}$$

Equation (3) arises from the fact that $e_t = A^{-1} B \varepsilon_t$ and draws attention to the relationship between structural shocks and reduced-form innovations. Equation (4), on the other hand, provides a means of explaining the identification procedure in an efficient way. In general, the elements of the vector of reduced-form innovations, e_t, will be correlated. Therefore, its covariance matrix, Σ, will be a non-diagonal symmetric matrix containing $n(n+1)/2$ independent parameters, where "n" denotes the number of endogenous variables of the model. [15]

Given that the covariance matrix of structural shocks is an identity matrix, no elements in Λ need to be estimated. In light of this assumption and the relationship between Σ and the coefficient matrices (namely, $\Sigma = A^{-1}BB'A^{-1'}$), the whole $n(n+1)/2$ distinct parameter estimates in Σ can used to estimate A and B. Thus, restricting B to be a diagonal matrix (with only n elements to estimate) will leave us with $n(n+1)/2 - n = n(n-1)/2$ elements of free information, which is precisely the maximum number of parameters in the A matrix that can be estimated. Since only a portion of the n^2 unknown elements in A can be estimated (*i.e.*, $n^2 > n(n-1)/2$), we have no choice but to impose a set of zero exclusion restrictions on A to identify the model.[16] The restrictions placed on A will be dictated by economic theory and a unique relation for $Ae_t = B\varepsilon_t$ will necessarily emerge. Such a unique relation, moreover,

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[15] Broadly speaking, Σ is the variance/covariance matrix of the vector of reduced-form innovations, e_t. The main-diagonal elements are variances and will be denoted σ_i^2, while the rest of the elements are covariances and will be denoted σ_{ij}. The Σ matrix can be represented as follows:

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \cdots & \sigma_{1n} \\ \sigma_{21} & \sigma_2^2 & \cdots & \sigma_{2n} \\ \cdot & \cdot & \cdot & \cdot \\ \sigma_{n1} & \sigma_{n2} & \cdots & \sigma_n^2 \end{bmatrix}$$

where each covariance term is given by $\sigma_{ij} = \frac{1}{T}\sum_{t=1}^{T} e_{it}e_{jt}$. The above matrix is symmetric in the sense that $\sigma_{21} = \sigma_{12}$, $\sigma_{31} = \sigma_{13}$, and so forth. Therefore, Σ must contain exactly $n(n+1)/2$ free-information elements to be used in estimating the A and B matrices.

[16] Because A contains n^2 unknown elements, we have to impose $n^2 - n(n-1)/2 = n(n+1)/2$ zero exclusion restrictions in order to (exactly) identify and estimate the system.

embodies a structure of contemporaneous correlations among the reduced-form residuals, which is consistent with economic theory.

The next step is to identify and estimate equation (3). In order to accomplish this task in a theoretically plausible manner, we place a set of zero exclusion restrictions on coefficient matrix "A" in such a way that the following two conditions are satisfied: one, the model is exactly identified and, two, the structure of contemporaneous correlations in equation (3) is consistent with a small open economy with a floating exchange rate system and free capital mobility. Equation (8) shows the result of this exercise:

$$Ae_t = \begin{bmatrix} 1 & 0 & a_{13} & a_{14} & 0 & a_{16} & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{32} & 1 & 0 & a_{35} & a_{36} & 0 \\ 0 & 0 & a_{43} & 1 & a_{45} & 0 & a_{47} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & a_{56} & 0 \\ a_{61} & 0 & a_{63} & a_{64} & 0 & 1 & a_{67} \\ a_{71} & 0 & 0 & a_{74} & 0 & a_{76} & 1 \end{bmatrix} \begin{bmatrix} e_t^{BD} \\ e_t^{M} \\ e_t^{R} \\ e_t^{Q} \\ e_t^{P} \\ e_t^{GEAI} \\ e_t^{TB} \end{bmatrix} = \begin{bmatrix} b_{11}\varepsilon_t^{BD} \\ b_{22}\varepsilon_t^{M} \\ b_{33}\varepsilon_t^{R} \\ b_{44}\varepsilon_t^{Q} \\ b_{55}\varepsilon_t^{P} \\ b_{66}\varepsilon_t^{GEAI} \\ b_{77}\varepsilon_t^{TB} \end{bmatrix} = B\varepsilon_t \qquad (8)$$

The estimation of system (8) is performed by Maximum Likelihood (*ML*) under the assumption that innovations follow a multivariate normal distribution.[17] The model under consideration must be thought of as the structure of contemporaneous correlations among the "orthogonalized innovations" and is expected to produce more theoretically meaningful impulse responses and variance decompositions. The elements of vector ε_t can be viewed as the structural shocks influencing each variable of the system (*i.e.*, the so-called own shocks). Since the model allows for interpreting the empirical results with reference to a theoretical framework, impulse responses and variance decompositions

[17] As noted earlier, the identifying restrictions are based upon two assumptions: (i) the vector of structural shocks (ε_t) is orthonormal, and (ii) the B matrix is diagonal.

can be useful in determining whether, and to what extent, shocks influence each variable as the underlying economic theory would suggest.

In a straightforward AB-model including seven variables (*i.e.*, $n = 7$) we can estimate a total of “twenty one” parameters in the A matrix [*i.e.*, $n(n-1)/2 = 21$ provided that $n = 7$], which amounts to imposing a total of twenty eight zero identifying restrictions on A. Under the restrictions specified in (8), the relation $Ae_t = B\varepsilon_t$ can be written as:

$$e_t^{BD} = -a_{13}e_t^R - a_{14}e_t^Q - a_{16}e_t^{GEAI} + b_{11}\varepsilon_t^{BD} \quad (9.1)$$

$$e_t^M = b_{22}\varepsilon_t^M \quad (9.2)$$

$$e_t^R = -a_{32}e_t^M - a_{35}e_t^P - a_{36}e_t^{GEAI} + b_{33}\varepsilon_t^R \quad (9.3)$$

$$e_t^Q = -a_{43}e_t^R - a_{45}e_t^P - a_{47}e_t^{TB} + b_{44}\varepsilon_t^Q \quad (9.4)$$

$$e_t^P = -a_{51}e_t^{BD} - a_{52}e_t^M - a_{53}e_t^R - a_{54}e_t^Q - a_{56}e_t^{GEAI} + b_{55}\varepsilon_t^P \quad (9.5)$$

$$e_t^{GEAI} = -a_{61}e_t^{BD} - a_{63}e_t^R - a_{64}e_t^Q - a_{67}e_t^{TB} + b_{66}\varepsilon_t^{GEAI} \quad (9.6)$$

$$e_t^{TB} = -a_{71}e_t^{BD} - a_{74}e_t^Q - a_{76}e_t^{GEAI} + b_{77}\varepsilon_t^{TB} \quad (9.7)$$

According to the budget deficit equation (9.1), fiscal innovations are affected by innovations in the interest rate, the real exchange and the output level. As is well known, an interest rate hike tends to widen the budget deficit by increasing the cost of domestic government debt (i.e., $a_{13} < 0$ or $-a_{13} > 0$). The weighted average maturity of the peso-denominated government bonds plays a key role in determining the time required for a change in market interest rates to have a full impact on interest payments. The real exchange rate, on the other hand, is intended to capture the so-called Cardoso effect on government spending and the oil-export effect on government revenues. On the one hand, Cardoso (1992) argues that real currency depreciation increases the local currency value of external debt servicing which, in turn, puts more pressure on the fiscal deficit. On the other hand, real exchange rate depreciation raises the domestic currency value of crude oil export revenues which, in turn, alleviates the pressure on the deficit. Therefore, the sign of parameter a_{14} is somewhat ambiguous. Economic activity, by contrast, is positively related to tax revenues and negatively related to the budget deficit (*i.e.*, $a_{16} < 0$ or $-a_{16} > 0$). In summary, the specification of (9.1) is intended to reflect the vulnerability of public finances to sudden changes in economic conditions.

The money supply function (9.2) assumes that the supply of money is essentially determined by the central bank. This specification is consistent with the notion that, under a flexible exchange rate system, the central bank is able to influence the supply of money to a certain degree. Therefore, in (9.2) innovations in money supply are only affected by their own shocks (ε_t^M).

Equation (9.3) is a money demand or *LM* function. Note that interest rate innovations depend on innovations in money supply, prices and output. Holding the money supply constant, an increase in economic activity or prices raises the demand for money and, therefore, the interest rate (*i.e.*, $a_{35} < 0$ and $a_{36} < 0$). Since the interest rate determines the opportunity cost of holding money, it must rise in order to restore the equilibrium in the money market.[18] By the same token, given real economic activity and prices, a monetary expansion lowers the interest rate (*i.e.*, $a_{32} > 0$). Lastly, under this view, an expansionary monetary policy not fully accommodated through an increase in output

[18] It is standard to assume that the demand for money is a decreasing function of the interest rate and an increasing function of prices and real economic activity. Thus, innovations in real economic activity and prices are used here as a broad measure of unexpected changes in money demand.

may result in inflationary pressure. In this manner, it is also possible to re-establish equilibrium by means of a higher price level.

Equation (9.4) simply reflects the dependence of real exchange rate innovations on innovations in interest rates, prices, and the trade balance. The real exchange rate, Q_t, is the relative price of imports in terms of domestic goods. Formally, $Q_t = \frac{S_t P_t^*}{P_t}$, where S_t is the nominal exchange rate, P_t^* is the foreign price level, and P_t was previously defined as the domestic price level. Therefore, an unexpected increase in the domestic price level, *everything else being constant*, produces a real exchange rate appreciation and vice versa. Moreover, an increase (decrease) in the domestic interest rate, *all else being equal*, produces massive capital inflows (outflows) and appreciates (depreciates) the currency in real terms.[19] Lastly, (9.4) reflects that innovations in the trade balance, like a sudden variation in international oil prices, can eventually alter the real exchange rate. For instance, an exogenous increase in the value of oil exports (resulting from a

[19] To formalize this statement, we can assume that the following amplified version of the interest-parity condition holds:

$$i_t = i_t^* + \Delta S_t^e + \delta$$

where i_t^* is the foreign nominal interest rate, ΔS_t^e is the expected rate of depreciation (or appreciation) of the nominal exchange rate, and δ is the country risk premium, which for simplicity is to be treated as a positive constant term. Given that domestic and foreign debt instruments are near substitutes to investors (who are risk-averse and will seek the highest risk-adjusted expected rate of return), any deviation from this condition will result in substantial capital flows from one country to another. To visualize this, suppose that an increase in the domestic interest rate leads to the following deviation from parity: $i_t > i_t^* + \Delta S_t^e + \delta$. In this case, the domestic bond market will offer a higher expected rate of return, attracting sizable capital flows into the country. This flood of foreign funds is likely to produce a real exchange rate appreciation until the equilibrium condition is restored; that is, until the domestic rate of interest, i_t, falls and incentives to transfer funds across national borders are arbitraged away.

higher price and/or volume exported) may improve the trade balance and appreciate the peso in real terms.

Equation (9.5) is an inflation or price equation. In this case, we have allowed price innovations to be influenced by innovations in the following variables: budget deficit, money supply, interest rate, real exchange rate, and economic activity. A number of empirical papers identify these variables as key determinants of inflation in the Mexican economy. In a pioneer VAR analysis of the Mexican inflationary phenomenon, Arias and Guerrero (1982) show, among other things, that exchange rate shocks are a prominent source of price instability. More recently, Agénor and Hoffmaister (1997) confirm this finding by proving that inflation in Mexico is not only driven by nominal money growth but also by exchange rate depreciation.[20] The work of Wang and Rogers (1994), by contrast, concludes that fiscal and monetary disturbances have more influence on prices that do exchange rate depreciations. Indeed, unlike previous research, Wang and Rogers (*op. cit.*) do not consider the exchange rate as a key inflationary factor. The resulting dispute is to some extent solved by Baqueiro, Díaz de León, and Torres (2003), who provide robust empirical evidence indicating that the responsiveness of prices to exchange rate fluctuations decreases as the economy moves from a high- to low-inflation scenario. In this perspective, (9.5) includes the government budget deficit, the money supply and the real exchange rate as potential sources of inflation. Furthermore, we assume that interest rates and output may have an incidence on prices. Interest rates may work on prices through the cost of loans, whereas economic activity may serve (together with the budget deficit) as a proxy for aggregate demand.

[20] Other empirical papers devoted to this topic are: Dornbusch *et al.* (1990), Pérez-López (1996), and Galindo and Catalán (2004).

Equation (9.6) is an amplified *IS* function. To represent the equilibrium in the goods market, we make output innovations dependant upon innovations in the government budget deficit,[21] the interest rate, the real exchange rate and the trade balance. In this manner, an expansionary fiscal policy (*i.e.*, an increase in the deficit), or an improvement in the trade balance associated with a higher external demand for domestically produced goods and services, will stimulate aggregate demand and, therefore, economic activity. In contrast, an interest rate increase is likely to slow down economic growth by discouraging interest-sensitive consumption spending and private investment. Real exchange rate depreciation, on the other hand, gives rise to both expansionary and contractionary effects in developing countries such as Mexico. The expansionary effect stems from enhanced international competitiveness and increased net exports, whereas the recessionary effect derives from the fact that real currency depreciation raises the local-currency price of imported intermediate goods (*i.e.*, it provokes cost-push inflation). Lastly, the trade balance has been included in the *IS* function to capture the effects of external shocks to the home-country's demand for goods.[22] Indeed, the theory of international business cycles suggests that economic activity can be transmitted from one country to another through the trade (or the current account) balance, provided that international trade links are strong. In this fashion, the U.S. and the Mexican business cycles are positively correlated, so that a greater economic activity in the U.S. is likely to stimulate domestic output by way of an

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[21] In addition to government spending, an *IS* equation can incorporate other fiscal policy indices such as the budget deficit (See Blanchard and Fischer (1990, p. 530)).

[22] It is useful to recall that foreign output, denoted Y^*, is one of the basic determinants of the current account balance. Indeed, it is standard to express the current account balance as a function of the real exchange rate, domestic output, and foreign output.

improved trade balance.[23] In summary, the expected parameter signs in this case are: $a_{61} < 0$, $a_{63} > 0$, $a_{64} > 0$, and $a_{67} < 0$.

Equation (9.7) is an empirical equation for the external sector of the economy. In this case, innovations in the trade balance[24] rely on fiscal, exchange rate and output innovations. First, from the national income identity for an open economy we can infer that, *other things equal*, an increase in the government budget deficit deteriorates the trade balance (and, therefore, the current account balance) while a decrease in the government budget deficit improves it.[25] If the data are consistent with such a relationship, then there will be grounds for studying the twin-deficit problem in the case of Mexico (given that the trade balance is part of the current account balance and the latter has been reporting a deficit for several years). Secondly, real currency depreciation enhances international competitiveness and improves the trade balance, whereas real currency appreciation renders the opposite effect. Finally, a salient feature of developing countries such as Mexico is the strong positive relationship between

[23] See Backus and Kehoe (1992) and Gregory *et al.* (1995) for a detailed discussion on international business cycles.
[24] Monthly data for the current account balance is not available, so that we use the trade balance to capture the external sector of the economy.
[25] Let NI be the symbol for national income, C for consumption, I for investment, G for government spending, and CAB for current account balance (as previously noted, due to data-related problems, the current account balance is proxied here by the trade balance). In this manner, the national income identity for an open economy can be represented as: NI = C + I + G + CAB. In order to finance the current account deficit, the Mexican economy must borrow from the rest of the world. Thus, the CAB measures the amount of funds that Mexico needs to borrow every year from the rest of the world. If we rearrange terms and introduce taxes, the national income identity becomes: (NI–T)–C–(G–T) = I+CAB. Given that private savings, S_P, equal (NI–T)–C while government savings, S_G, equal –(G–T), we can obtain: $S_P + S_G$ =I +CAB. Next, considering that S_G is the negative of the government budget deficit [*i.e.*, S_G = (T–G) = –(G–T)=–BD], we can rewrite the previous expression as: CAB= S_P–I–BD. According to this model, *all else equal*, an increase in the BD worsens the CAB while a fall in the BD improves the CAB.

economic activity and the volume of imports, especially of capital and intermediate goods. As a result, faster economic growth is commonly associated with trade balance deterioration.

III. Data Issues

On the basis of the previously depicted model, we have selected seven variables. All such variables are treated as endogenous and are used in conducting our empirical analysis. Thus, we gathered monthly data for each variable from January 1996 to January 2008 (145 observations in total).[26]

Before presenting the empirical evidence, some data-related issues have to be discussed:

1. As stated before, we shall use three fiscal policy indicators: (i) the public sector budget deficit, (ii) total public sector spending, and (iii) total public sector revenues. As is well known, the public sector comprises the federal government, the state-owned enterprises under budgetary control, and the non-budgetary sector.
2. Money supply is measured by the monetary base, given that it only includes the currency in the hands of the non-bank public and bank reserves. Thus, the central bank controls this variable better than any broader measure of money, such as M1 or M2. In consequence, the monetary base is probably the operational definition of money that best captures the stance of monetary policy.
3. In view of the fact that treasury bills (Certificados de la Tesorería) are the most important debt instrument of the Mexican money market, we resort to the 28-day treasury-bill rate to measure the nominal interest rate.

[26] Source: INEGI and Bank of Mexico.

4. The real *effective* exchange rate index is used to reflect changes in international competitiveness. Such an index is based on consumer prices and measures changes in international competitiveness with respect to more than a hundred countries.
5. To measure changes in the price level, we utilized the National Consumer Price Index.
6. The Global Economic Activity Index (GEAI) is used as a proxy for output, due to the lack of monthly GDP-data for the Mexican economy.
7. Similarly, the trade balance is used here as a proxy for the current account balance, as monthly data is not available for the latter variable.

It is also worth mentioning that the *X12* procedure was used to seasonally adjust all variables, except for the budget deficit and the trade balance. Since these variables involve negative values, we had to employ the so-called Tramo/Seats method for seasonal adjustment. Moreover, all series were transformed into natural logarithms with the exception of interest rates, the budget deficit and the trade balance.

Integration Analysis

In view of the growing variety of unit root and stationarity tests and the fact that each test entails a different combination of *pros* and *cons*, we have deemed appropriate to perform three different types of standard tests: *Augmented Dickey-Fuller* (*ADF*, 1979), *Phillips-Perron* (*PP,*1988), and *Kwiatkowski, Phillips, Schmidt, and Shin* (*KPSS*, 1992). A critical issue in testing for the presence of unit roots (or for the presence of stationarity) in a time series concerns the specification of the test equation. The basic choice here relates to whether we must include a constant and a linear trend or only a constant, given that the KPSS test does not allow removing the constant term from the test equation.[27] To make such a determination we relied on Hamilton's methodology (1994, p. 501), which means that on a case-by-case basis we selected the specification conveying the most plausible description of the data, both under the null hypothesis and the alternative hypotheses. Moreover, a battery of *F* type tests was performed in an attempt to prove that the test equations were correctly specified. These tests, as opposed to the conventional *F* tests, are based on the critical values developed by Dickey and Fuller (1981) and Dickey *et al.* (1986) through simulation processes involving nonstationary variables. The results of the unit root and stationarity tests are summarized in Table 1:

Table 1. Unit root and stationarity tests

Variable	Specification of the test equation	ADF test statistic (Ho: unit root)	PP test statistic (Ho: unit root)	KPSS test statistic (Ho: stationarity)	Order of Integration
BD_t	C and LT	-0.58	-0.79	0.33**	≥ 1
ΔBD_t	C	-16.60**	-15.81**	0.57*	Inconclusive
$\Delta^2 BD_t$	C	-11.59**	-102.13**	0.13	0
$\Delta^2 BD_t$	None	-11.63**	-102.53**	Not available	0
G_t	C and LT	-2.89	-2.90	0.35**	≥ 1
ΔG_t	C	-12.83**	-12.88**	0.57*	Inconclusive
$\Delta^2 G_t$	C	-12.59**	-59.07**	0.18	0
$\Delta^2 G_t$	None	-12.64**	-59.02**	Not available	0
T_t	C and LT	-3.21	-3.27	0.29**	≥ 1
ΔT_t	C	-11.20**	-11.21**	0.49*	Inconclusive
$\Delta^2 T_t$	C	-10.89**	-81.85**	0.30	0
$\Delta^2 T_t$	None	-10.92**	-80.05**	Not available	0
MB_t	C and LT	-2.33	-2.24	0.34**	≥ 1
ΔMB_t	C	-11.91**	-19.18**	1.17**	Inconclusive
$\Delta^2 MB_t$	C	-10.95**	-123.34**	0.33	0
$\Delta^2 MB_t$	None	-10.97**	-122.21**	Not available	0
R_t	C	-2.92*	-2.94*	1.26**	Inconclusive
ΔR_t	C	-13.09**	-13.09**	0.23	0

[27] In some cases, however, we omitted both the constant and the linear trend and performed only unit root tests.

Q_t	C	-2.77	-2.96*	0.61*	Inconclusive
ΔQ_t	C	-9.08**	-9.07**	0.59*	Inconclusive
$\Delta^2 Q_t$	C	-9.29**	-89.85**	0.14	0
$\Delta^2 Q_t$	None	-9.31**	-88.84**	Not available	0
P_t	C and LT	-5.04**	-7.04**	0.34**	Inconclusive
ΔP_t	C	-3.85**	-3.09*	1.27**	Inconclusive
$\Delta^2 P_t$	C	-9.21**	-22.34**	0.35	0
$\Delta^2 P_t$	None	-12.88**	-19.45**	Not available	0
$GEAI_t$	C and LT	-2.66	-2.10	0.20*	1
$\Delta GEAI_t$	C	-15.60**	-15.96**	0.19	0
TB_t	C	-3.75**	-3.28**	0.83**	Inconclusive
ΔTB_t	C	-12.64**	-17.69**	0.12	0
ΔTB_t	None	-12.57**	-17.47**	Not available	0

Notes:

1. C = Constant and LT = Linear Trend.
2. Asterisks '*' and '**' denote rejection of the null hypothesis at the 5% and 1% significance levels, respectively.
3. The symbols Δ and Δ^2 are the first and second difference operators, respectively.
4. The ADF and PP test results are based on Mackinnon (1996) critical values and their associated one-sided *p*-values. In the ADF tests, the Schwarz Information Criterion is used to determine the lag length of each test equation. In the PP tests we control the bandwidth by way of the Newey-West bandwidth selection method and the Bartlett Kernel.
5. The KPSS test results are based on the critical values proposed by Kwiatkowski, Phillips, Schmidt and Shin (1992). To control the bandwidth, we use the Newey-West bandwidth selection method and the Bartlett Kernel.

The ADF and PP tests contrast the null hypothesis of a unit root against the alternative hypothesis of stationarity, whereas the KPSS test contrasts the null hypothesis of stationarity against the alternative of non-stationarity. The rationale for including a stationarity test, such as the KPSS test, lies in the lack of power of the unit root tests. Hence, to conclude that a given variable is stationary we must not only reject the unit root hypothesis in the ADF and PP tests, but also fail to reject the stationarity hypothesis in the KPSS test.

As we can see in Table 1, the use of different types of tests often leads to indeterminate or inconclusive results, but appropriate differentiation eventually produces clear-cut empirical conclusions. According to test results, the following series may involve more than one unit root: BD_t, G_t, T_t, MB_t, Q_t y P_t. All of these series may be integrated of order two, or I(2) series, because they are stationary in second differences with an unclear outcome in first differences. On the other hand, there are two variables, R_t and TB_t, which are probably I(1). In each case, when working in levels the two unit root hypotheses (*i.e.*, the hypotheses under the ADF and PP tests) are rejected but the stationarity hypothesis (*i.e.*, the hypothesis under the KPSS test) is also rejected, leaving the order of integration open to doubt. First differencing of R_t and TB_t, however, would consistently produce a stationarity result. Lastly, economic activity, $GEAI_t$, is an I(1) series as it is non-stationary in levels and stationary in first differences.

IV. Estimation Results

As noted earlier, we are resorting to two complementary estimation techniques (structural and non-structural VAR estimation), two approaches to deal with the stationarity issue (typical VARs in differences and atypical but stable VARs in levels), and three fiscal policy indicators (government spending, government revenues, and the budget deficit). Table 2 shows that, in light of these considerations, we have twelve different model specifications in all: one benchmark specification and eleven alternative specifications.

Table 2. Model Specifications for Empirical Analysis

Estimation Technique	Levels versus Differences	Fiscal Policy Indicator
1. SVAR	Stable Model in Levels	T
2. GVAR	Stable Model in Levels	T
3. SVAR	Stationary Model in Differences	T
4. GVAR	Stationary Model in Differences	T
5. SVAR	Stable Model in Levels	G
6. GVAR	Stable Model in Levels	G
7. SVAR	Stationary Model in Differences	G
8. GVAR	Stationary Model in Differences	G

9. SVAR	Stable Model in Levels	BD
10. GVAR	Stable Model in Levels	BD
11. SVAR	Stationary Model in Differences	BD
12. GVAR	Stationary Model in Differences	BD

Notes:
1. T=Government Revenues, G=Government Spending, BD=Budget Deficit.
2. Specification 1 is to be used as a benchmark.

First of all, we are interested in estimating our benchmark specification, which is represented by a stable SVAR model in levels with government revenues as a fiscal policy indicator (specification 1 in Table 2). The rationale for selecting such a model is twofold:

1. A SVAR model in levels allows for a richer empirical analysis while ensuring the robustness of the findings by means of stability checks. In fact, Sims (1980) and Doan (2000), *inter alia*, have argued against differencing when dealing with VAR models, even if the series involved are nonstationary.[28] The idea behind is that differencing carries the risk of losing valuable information as to the co-movements of the series. Along these lines, Lütkepohl (2006) shows that it is the overall stationarity of the model, rather than the stationarity of the individual variables, what matters to ensure the robustness of the findings. Moreover, stability is a sufficient –but not a necessary– condition for the overall stationarity of the system.[29] In this perspective, a “stable” VAR model in levels is said to be well behaved, meaning that the cumulative effects of shocks are finite and measurable.
2. The use of government revenues as a fiscal policy indicator makes it easier to identify the effects of fiscal shocks on the remaining variables of the system, as

[28] Fuller (1976, Theorem 8.5.1) demonstrates that differencing does not improve asymptotic efficiency in VAR models, even if the underlying variables are nonstationary.

[29] See Patterson (2000, Chapter 14) for details.

government revenues "seem" to capture a wider range of fiscal policy actions than government spending and even the budget deficit.

In this manner, we first proceed to assess the effects of fiscal shocks by means of the benchmark specification and then we test the robustness of the findings through alternative model specifications.

Diagnostic Tests

Unless otherwise stated, from this point on we shall be referring to our benchmark specification, whose economic structure is described by equations (9.1) through (9.7). The lag length of the model was determined empirically, given that the use of different lag length criteria failed to achieve model congruency (*i.e.*, it failed to generate relatively well-behaved residuals). Thus, the conclusion was that seven lags for each variable in each equation eliminates serial correlation and heteroskedasticity. Table 3 shows the results of the multivariate serial correlation *Lagrange Multiplier* (*LM*) tests. The *LM* statistics and their corresponding *p*-values indicate the absence of serial correlation up to lag order thirteen. Similarly, the multivariate version of the White heteroskedasticity tests reveals that, at the 5% significance level, the null hypothesis of homoscedasticity cannot be rejected in any of the cases.[30]

Table 3. Multivariate Serial Correlation *LM* Tests

Lag order (*p*)	*LM*-Statistics	Prob.
1	44.06581	0.6730
2	46.17950	0.5882
3	58.75814	0.1603
4	46.72746	0.5657
5	57.39020	0.1922
6	44.87178	0.6411
7	40.83680	0.7902
8	45.63117	0.6105
9	45.22704	0.6269
10	60.92914	0.1180

[30] For the sake of brevity, these test results are available upon request.

11	54.55956	0.2714
12	46.39228	0.5795
13	60.25459	0.1301

Notes:
1. H_0 : there is no serial correlation at lag order *p*.
2. Probabilities from *Chi*-squared distribution with 49 degrees of freedom.

Results in Table 4 indicate that our model in levels is stable and, therefore, stationary. This is in view of the fact that all the inverse roots of the characteristic autoregressive (AR) polynomial have modulus less than one and lie within the unit circle.

Table 4. Stability Condition Test
Inverse Roots of Characteristic AR Polynomial

Root	Modulus
0.990104	0.990104
0.979169 - 0.066872i	0.98145
0.979169 + 0.066872i	0.98145
0.961798	0.961798
0.924640 - 0.184564i	0.942881
0.924640 + 0.184564i	0.942881
-0.571593 + 0.684072i	0.891445
-0.571593 - 0.684072i	0.891445
0.754260 - 0.474347i	0.891018
0.754260 + 0.474347i	0.891018
0.250716 - 0.835354i	0.872167
0.250716 + 0.835354i	0.872167
0.609190 - 0.613362i	0.86448
0.609190 + 0.613362i	0.86448
-0.845382 - 0.177241i	0.863762
-0.845382 + 0.177241i	0.863762
0.822587 - 0.219601i	0.851396
0.822587 + 0.219601i	0.851396
0.299364 - 0.768748i	0.82498
0.299364 + 0.768748i	0.82498
0.101486 - 0.817817i	0.824089
0.101486 + 0.817817i	0.824089
-0.172344 - 0.794141i	0.812627
-0.172344 + 0.794141i	0.812627
-0.082740 - 0.795053i	0.799347
-0.082740 + 0.795053i	0.799347
0.651276 + 0.445146i	0.78887
0.651276 - 0.445146i	0.78887
-0.658292 + 0.420625i	0.7812
-0.658292 - 0.420625i	0.7812
-0.455111 + 0.621579i	0.770381
-0.455111 - 0.621579i	0.770381
-0.543919 + 0.509782i	0.74547
-0.543919 - 0.509782i	0.74547
0.546643 - 0.504521i	0.743882
0.546643 + 0.504521i	0.743882
-0.725452 - 0.077838i	0.729616
-0.725452 + 0.077838i	0.729616
-0.697406 + 0.202790i	0.726291

-0.697406 - 0.202790i	0.726291
0.154720 + 0.705173i	0.721947
0.154720 - 0.705173i	0.721947
-0.326908 + 0.641871i	0.720325
-0.326908 - 0.641871i	0.720325
0.612293 - 0.119592i	0.623863
0.612293 + 0.119592i	0.623863
-0.372779	0.372779
0.008671 + 0.321084i	0.321201
0.008671 - 0.321084i	0.321201
Note: All inverse roots lie within the unit circle, so that the stability condition is fulfilled.	

By the same token, even though residuals do not substantially depart from Gaussian white noise, strictly speaking, they don't follow a multivariate normal distribution.[31] The nonnormality of the residuals associated with variables such as the interest rate and the real exchange rate is basically due to the existence of a small number of statistically significant outliers, particularly in 1998 (the 28-day treasury-bill rate, for instance, rose from 22.6% in August to 39.9% in September, returning to 32.9% in October). In order to account for volatility episodes and their special effects, as well as to minimize departures from normality in the VAR residuals, we introduced two impulse dummy variables. Although the estimated model is generally congruent (the lag structure is stable and residuals are for the most part well-behaved), we will resort to two different estimation procedures (the SVAR and the GVAR procedure) to rule out possible spurious results when using the Maximum Likelihood method to estimate the SVAR coefficient estimates.

Sensitivity Analysis and SVAR Parameter Estimates

The standard estimation procedure used in this case often fails to achieve convergence or the results are extremely poor, even if we set different initial values for the free parameters in matrices A and B, or if we randomly draw such initial values from a

[31] Multivariate normality tests for VAR residuals are also available upon petition.

specific probability distribution. Table 5 presents the coefficient estimates for our benchmark model:

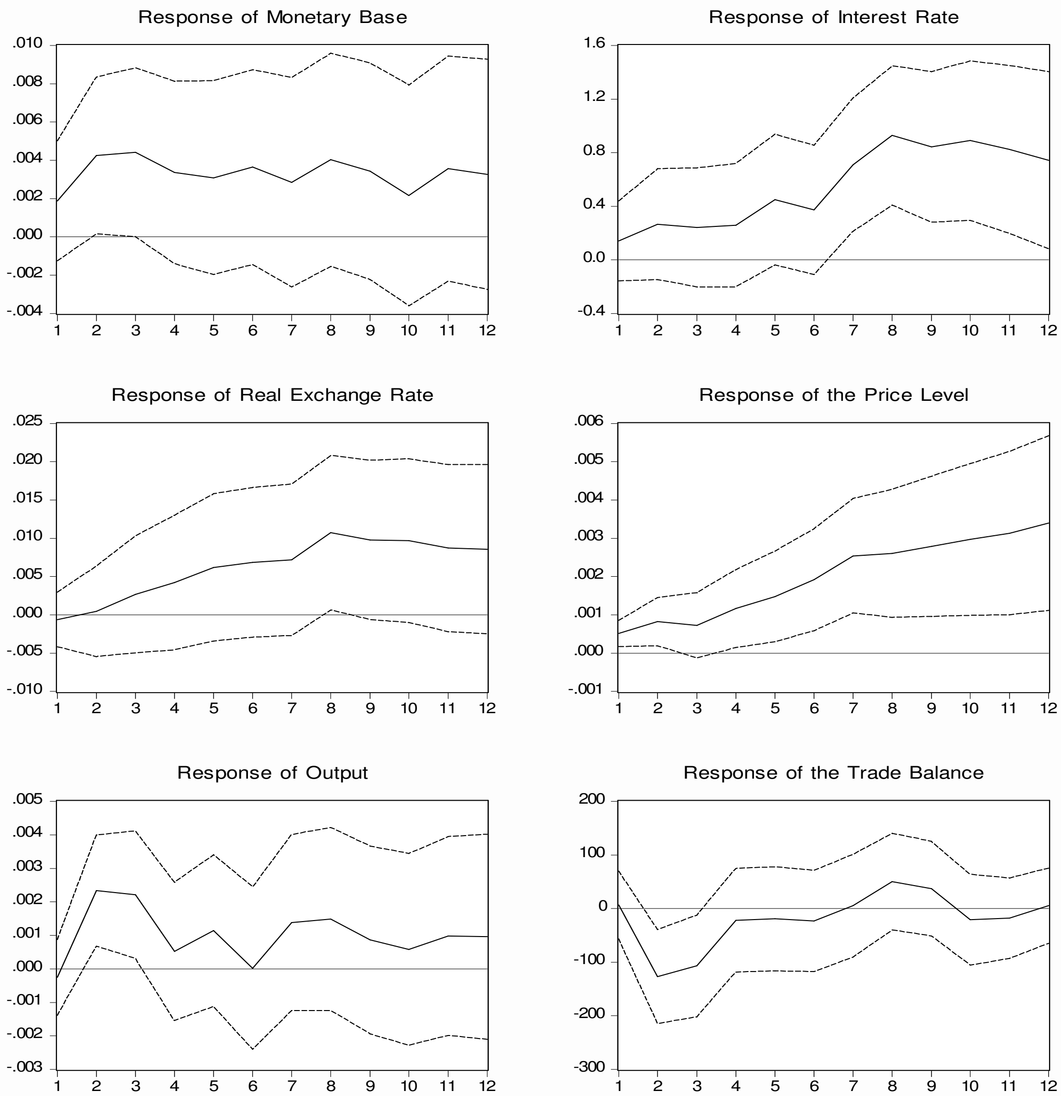
Table 5. Estimates of SVAR Parameters					
Coefficient	Estimate	Expected Sign	Coefficient	Estimate	Expected Sign
a_{13}	-0.72	-	a_{61}	-1.11	-
a_{14}	0.05	- or +	a_{63}	-0.74	+
a_{16}	0.46	+	a_{64}	1.26	- or +
a_{32}	-0.42	+	a_{67}	0.53*	-
a_{35}	1.96	-	a_{71}	-1.80	+
a_{36}	-0.90	-	a_{74}	-1.89**	-
a_{43}	-0.28	+	a_{76}	0.28	+
a_{45}	0.24	+	b_{11}	0.10	+
a_{47}	1.93	+	b_{22}	0.94***	+
a_{51}	-0.21***	-	b_{33}	1.17	+
a_{52}	-0.56***	-	b_{44}	0.54	+
a_{53}	0.93***	-	b_{55}	0.09***	+
a_{54}	-0.86***	-	b_{66}	0.53	+
a_{56}	-1.22***	-	b_{77}	0.24***	+

Notes:
1. Estimation by *ML*. The log likelihood is maximized by the scoring methodology (analytic derivatives).
2. Asterisks '*', '**' and '***' denote significance at the 10%, 5% and 1% levels, respectively.

Despite the fact that only ten estimated coefficients are statistically significant and two of them have signs contrary to economic theory,[32] the resulting structure (*i.e.*, the structure of contemporaneous correlations among the orthogonalized innovations depicted by equations (9.1) through (9.7)) generates theoretically meaningful impulse responses and variance decompositions. In Figure 1 we have a set of twelve-month impulse response functions with two standard error bands, representing the dynamic response of each variable of the system to a tax cut.

[32] The elements of matrix B are the standard deviations of the structural shocks, so that they are all positive.

Figure 1. Dynamic Effects of a Tax Cut (Stable SVAR Model in Levels)



It is worth mentioning that, in order for an impulse response function to be statistically significant, the corresponding upper and lower two standard error bounds must exclude the zero value at some point on the twelve-month horizon. Moreover, the tax cut in this setting is of size one standard deviation and should be regarded as unexpected and temporary (*i.e.*, the tax alleviation is maintained for only one month). Along these lines, Figure 1 indicates that a tax cut produces the following effects:

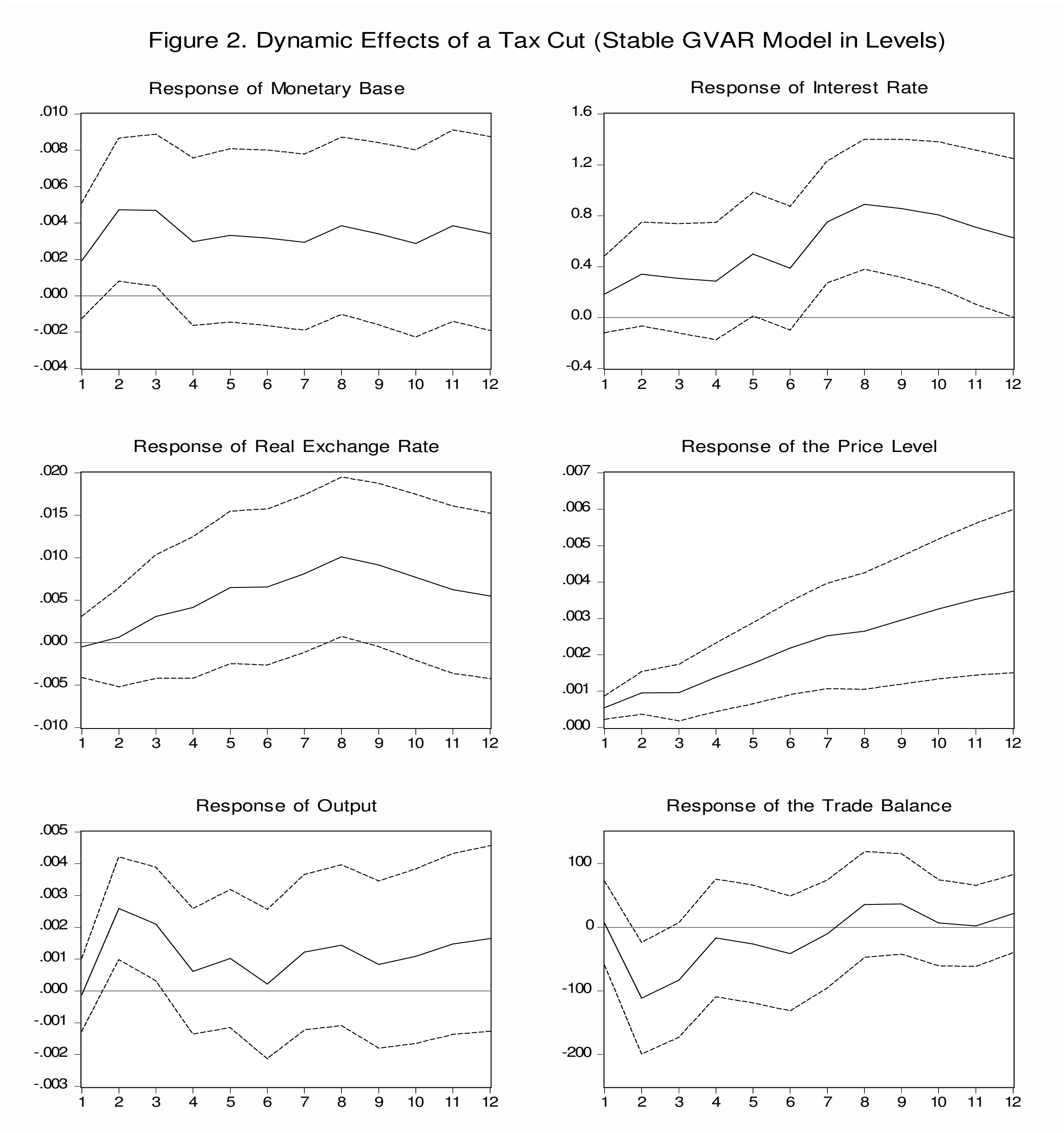
1. The monetary base increases around the second month and this positive effect dies down very quickly. The economic intuition behind this particular finding is

that lower taxes entail a higher budget deficit, which is partially financed through money creation.

2. There is a long-lived positive effect on the interest rate, which becomes statistically significant in the course of the sixth month. Such an effect is probably the result of an enhanced public demand for funds associated with the fall in government revenues.
3. The real exchange rate depreciates around the eighth month notwithstanding the interest rate increase. This is consistent with the country risk view of fiscal policy, which states that fiscal expansion (especially in developing countries) may induce risk-averse investors to transfer funds abroad to avoid domestic inflationary taxes, exchange rate risks and other potential drawbacks of unsound public finances. This flow of funds out of the country may weaken the national currency, even in the face of higher interest payments to investors.
4. There is a long-lived positive effect on the price level and a transitory increase in economic activity. This finding is consistent with the conventional view that tax alleviation generates demand-pull inflation. On the one hand, people spend a fraction of the *extra* after-tax income, raising not only consumption and aggregate demand but output as well. If slack in production capacity is extremely restricted in some industries, prices will rapidly begin to rise (premature inflation) and the inflationary effect could be persistent over time. On the other hand, people save a fraction of the extra after-tax income, pulling up savings. But savings, or supply of funds, increase by less than the public demand for funds linked to the tax cut, so that interest rates go up as illustrated before.

5. Lastly, the trade balance deteriorates around the second month but this negative effect rapidly fades away. The trade balance deterioration is probably due to: (i) the higher domestic absorption brought about by the tax reduction, and (ii) the rise in imports of capital and intermediate goods induced by a higher economic activity. Moreover, the hypothetical time path of the trade balance following a tax cut suggests that the current account balance can be affected by fiscal developments. As a matter of fact, the relationship between a fiscal deficit and a current account deficit is commonly referred to as the “twin-deficit problem.”

Next, to establish robustness we resort to a different estimation technique: the GVAR technique. Figure 2 reports the impulse response functions associated with the second specification, which is a stable GVAR model in levels with government revenues as a fiscal policy indicator. The six graphs in Figure 2 are quite similar to the previous case, proving that the *ML* method (used to estimate the structural parameters reported in Table 5) is not leading to spurious impulse responses in spite of the convergence difficulties and residual departures from normality that we had to deal with.



As the reader might recall, the third and fourth specifications are stationary SVAR and GVAR models, respectively, in differences with government revenues as an indicator of fiscal policy. Under both specifications we can observe that a tax reduction raises the monetary base, the interest rate, prices and output. The effects on the real exchange rate and the trade balance are not statistically significant anymore, perhaps because differencing leads to losing valuable information as Sims (1980), Doan (2000) and others point out.[33]

Generally speaking, the more we differentiate the variables of the system, the less significant impulse response functions become. Furthermore, the use of alternative fiscal policy indicators, that is, the use of government spending or the budget deficit, results in estimation difficulties or non-significant impulse response functions. The fifth and ninth specifications systematically produced near-singular Hessian matrices and could not be estimated, in spite of the usage of several convergence criteria and the specification of different starting values and maximum number of iterations. The rest of the specifications, namely, specifications 6 through 8 and 10 through 12, basically yield non-significant impulse responses. There are, however, two notable exceptions: (i) under the sixth specification, an increase in government spending worsens the trade balance, and (ii) under the twelfth specification, a higher budget deficit causes a short-lived rise in the price level.[34]

Forecast Error Variance Decompositions

Next, we decompose the forecast error of each variable over different time horizons (*i.e.*, 12 and 24 months) into the components attributable to unexpected changes in all the variables of the system. Tables 6 and 7 report the variance decompositions of the first and second model specifications, respectively. As we can see, such tables are not only consistent with each other but also support the empirical evidence provided by Figures 1 and 2. In Table 6 we notice that, 24 months ahead, shocks to tax revenues

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[33] For the sake of brevity, impulse responses corresponding to specifications number 3 and 4 are available upon request.
[34] These results are also available upon petition.

explain a significant portion of the variations in the other variables of the system: 25.77% of money supply, 25.12% of the interest rate, 13.87% of the real exchange rate, 50.87% of the price level, 20.63% of output, and 8.72% of the trade balance.

In this manner, variance decompositions corresponding to our benchmark specification (*i.e.*, the first specification in Table 2) are consistent with impulse response functions in the sense that a fiscal expansion brought about by lower taxes may increase money supply, interest rates and prices, depreciate the domestic currency in real terms, stimulate economic activity and deteriorate the trade balance. Variance decompositions in Table 7 are similar as regards the explanatory power assigned to tax shocks, even though they correspond to an alternative model specification (*i.e.*, the second specification.)

Table 6. Structural Variance Decompositions (Stable SVAR Model in Levels)

Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
Decomposition of variance for T_t								
12	0.000248	42.01	34.41	4.03	1.52	3.72	3.73	10.58
24	0.000299	48.76	30.02	4.12	2.18	3.00	4.15	7.79
Decomposition of variance for MB_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	0.034209	12.64	70.57	2.98	1.49	2.83	3.44	6.05
24	0.044619	25.77	59.95	2.01	2.09	2.78	2.08	5.32
Decomposition of variance for R_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	3.839169	29.59	4.08	37.91	9.03	2.07	14.15	3.17
24	4.438464	25.12	4.81	30.79	11.52	1.74	22.64	3.37
Decomposition of variance for Q_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	0.060223	13.57	0.28	9.97	70.68	3.74	1.17	0.59
24	0.068072	13.87	1.45	10.84	62.69	3.22	6.57	1.37
Decomposition of variance for P_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t

12	0.012743	43.77	0.67	13.03	5.45	33.83	2.30	0.95
24	0.020456	50.87	0.57	5.52	9.59	22.44	9.56	1.46
Decomposition of variance for $GEAI_t$								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	0.017452	7.54	26.59	1.08	1.72	3.17	58.93	0.97
24	0.022597	20.63	25.91	0.75	5.25	3.80	43.01	0.64
Decomposition of variance for TB_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	541.3063	8.59	5.72	1.43	1.37	5.00	11.35	66.52
24	550.1418	8.72	5.88	2.18	1.47	4.87	11.72	65.15

Notes:

1. S. E. = Standard Error.
2. The percentage of the variance resulting from shocks may not add up to 100.

Table 7. Generalized Variance Decompositions (Stable GVAR Model in Levels)								
Decomposition of variance for T_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	0.000261	42.03	34.50	2.40	1.56	5.63	2.90	10.97
24	0.000307	45.90	31.57	2.15	3.42	4.33	3.19	9.46
Decomposition of variance for MB_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	0.035265	11.22	70.02	1.70	1.20	1.71	5.82	8.33
24	0.045563	22.47	60.41	1.07	2.14	1.27	4.19	8.46
Decomposition of variance for R_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	3.797749	32.30	5.77	32.97	9.22	3.26	13.25	3.22
24	4.356974	30.76	6.25	25.55	9.62	3.00	20.61	4.194
Decomposition of variance for Q_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	0.06231	15.87	0.18	7.88	72.11	2.50	1.26	0.20
24	0.069823	16.42	2.68	9.63	61.61	2.94	5.59	1.13
Decomposition of variance for P_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	0.012296	39.60	1.71	19.85	7.12	28.31	2.92	0.48
24	0.019797	49.60	0.97	9.70	9.73	20.26	9.11	0.63
Decomposition of variance for $GEAI_t$								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	0.017156	6.48	26.13	0.66	1.73	1.32	62.97	0.70
24	0.021851	15.15	24.87	1.53	8.20	0.95	48.73	0.57

Decomposition of variance for TB_t								
Months Ahead	S. E.	Shock to T_t	Shock to MB_t	Shock to R_t	Shock to Q_t	Shock to P_t	Shock to $GEAI_t$	Shock to TB_t
12	539.1701	11.61	4.75	0.69	2.42	4.89	9.49	66.15
24	551.2665	11.76	5.13	0.94	3.10	4.73	9.98	64.34

Notes:
1. S. E. = Standard Error.
2. The percentage of the variance resulting from shocks may not add up to 100.

Conclusions

The analysis has focused on the short-term effects of fiscal policy on the Mexican economy. To that end, we have resorted to two different estimation techniques (the SVAR technique, on the one hand, and the GVAR or non-structural VAR technique, on the other), two approaches to deal with the stationarity issue (standard VARs in first or second differences, and nonstandard but "stable" VARs in levels), and three indicators of fiscal policy (spending, revenues and the deficit). All in all, the above gives rise to twelve different model specifications, which are used to perform a variety of diagnostic tests and estimations. As already noted, our benchmark specification is a "stable" SVAR model in levels with government revenues as a fiscal policy indicator (specification 1 in Table 2). Such a specification is consistent with a small open economy with a flexible exchange rate and free capital mobility.

First of all, the empirical evidence shows that using government revenues as a fiscal policy indicator makes it easier to identify the effects of fiscal policy shocks on the economy, as this particular variable seems to capture a more extensive range of fiscal policy actions than government spending and even the budget deficit. Secondly, differencing the VAR variables leads to losing valuable information as Sims (*op. cit.*) and Doan (*op. cit.*), *inter alia*, have suggested. In fact, the more we differentiate the variables of the system, the less significant impulse response functions become. Along these lines, there are two model specifications pointing to clear-cut empirical conclusions: the stable SVAR and GVAR models in levels with government revenues as a fiscal policy indicator, corresponding to specifications 1 and 2 in Table 2. Under these specifications a fiscal expansion, resulting from a tax cut, brings about the following effects: (i) the money supply rises, suggesting that lower taxes lead to a higher budget deficit which, in turn, is partially financed through money creation, (ii) the interest rate notably escalates, presumably, as a result of an enhanced public demand for funds, (iii) the real exchange rate depreciates in spite of the growing interest payments, (iv) there is long-lived positive effect on prices and a transitory improvement in economic activity, which is consistent with the conventional view that tax alleviation leads to demand-pull inflation, and (v) the trade balance deteriorates.

Even though some of the findings are broadly consistent with the New Keynesian view and the *Mundell-Fleming* model (*i.e.*, the increase in interest rates, prices and economic activity coupled with the trade balance worsening), the real exchange rate depreciation supports the country risk theory of fiscal policy. According to this theory, an expansionary fiscal policy, especially in developing countries, may induce risk-averse investors to transfer funds abroad in order to avoid domestic inflationary taxes, exchange rate risk and other inherent vulnerabilities of unsound public finances. The massive capital outflows so originated may, in turn, be the source of exchange rate depreciation even in the face of higher rates of return on the peso-denominated bonds. Under the *Mundell-Fleming* model, by contrast, increased interest rates result in substantial capital inflows and exchange rate appreciation.

By the same token, the evidence is also consistent with the conventional notion that a tax cut generates demand-pull inflation. The rise in economic activity and prices indicates that people spend a fraction of the *extra* after-tax income. If slack in production capacity is restricted in some industries, the price level will quickly begin to climb (premature inflation) and the inflationary effect may be persistent over time. Moreover, we can expect savings (*i.e.*, the supply of funds) to go up as well, given that people save a fraction of the *extra* after-tax income. Savings, however, increase by less than the public demand for funds associated with the fiscal relaxation, pushing interest rates up as already shown. In this perspective, the trade balance deterioration could be explained by: (i) the higher domestic absorption resulting from the tax alleviation, and (ii) the positive relationship between economic growth and the volume of imports of capital and intermediate goods. Thus**,** the dynamic response of the trade balance to an unexpected tax reduction indicates that fiscal developments may have some influence on the current account balance.

Lastly, it is worth mentioning that under the third and fourth model specifications (representing the SVAR and GVAR models in differences, respectively, with government revenues as a fiscal policy index) we can observe that a tax reduction raises the monetary base, the interest rate, prices and output. The effects on the real exchange rate and the trade balance are not statistically significant anymore, perhaps because differencing leads to losing valuable information as Sims (1980), Doan (2000) and others point out. In any event, this evidence is still consistent with the notion that an expansionary fiscal policy generates demand-pull inflation. The remaining model specifications (that is, specifications 5 through 12) lead to either estimation difficulties or non-significant impulse response functions.

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