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Macroeconomic Effects of
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Assessing the Macroeconomic Effects of Fiscal Policy in Colombia

By
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Abstract

The focus of this paper is on the short-term macroeconomic effects of fiscal policy in Colombia in a structural vector autoregression context. Government spending shocks are found to have positive and significant effects on output, private consumption, employment, prices and short-term interest rates. The cumulative output multiplier fluctuates between 1.12 and 1.19 from the first to third year after the spending innovation. Shocks to direct taxation seem to be less efficient, because they mainly affect private investment, whereas shocks to indirect taxation do not seem to affect real activities significantly. From a policy perspective, our results support the smoothing role of fiscal policy on output fluctuations, which implies its capacity to restore real activity effectively in critical times like the ones currently being forecast. From a theoretical standpoint, the results are consistent with real business cycle and Keynesian models of both traditional partial equilibrium and new general equilibrium types.

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"…little is known about how the economy reacts to fiscal shocks. Two reasons can explain this state of affairs. First, the theoretical predictions emphasized in the literature are often fragile. Second, the empirical evidence is, at best, contradictory" E. Pappa (2004)

1. Introduction.

The macroeconomic effects of fiscal policy in Colombia have not received enough attention from analysts. Little is known about the effects on private consumption and investment resulting from the repeated tax reforms that have been implemented since the middle of the eighties. Neither is there conclusive evidence about the effects on output, employment, prices and interest rates produced by the swift expansion in government expenditure that occurred during the last few decades. Despite the difficulty in evaluating these issues, this paper attempts to provide evidence on the subject for Colombia, using a structural vector autoregression (SVAR) model, which is recommended in several recognized empirical papers.

The revenue and expenditure fiscal variables are split by components to differentiate their particular effects. From the revenue side, a distinction is made between direct (income) and indirect (consumption) taxes since not all taxes give rise to similar distortions on real activities. Among the government expenditures, consumption is differentiated from investment spending since fiscal authorities do not have the same discretion to make decisions about them and macroeconomic variables could respond differently to innovations in these items. The consequences of fiscal shocks are evaluated particularly on output, private consumption, private investment, unemployment, prices, real minimum wages and the short term nominal interest rates.

Concerning tax reforms in Colombia, the most widely known changes implemented over the past two decades include increases in tariffs and the taxable-base of both consumption (value added tax) and income taxes, improvements in the tax system administration, controls on non-legitimate imports, and tax evasion. Some of these reforms were directly associated with structural changes implemented in other economic fields (such as the fiscal decentralization, the opening up of the economy, or the social security system), and others were simply designed to help bridge the increasing gap between governmental expenditures and revenues. As a result, the tax burden (at the national level) rose from 7.8% to 16.7% of the GDP between 1990 and 2008.

The size of central government spending, in turn, has increased from 9.6% to 21.8% of the GDP in the last two decades and almost 90% (on average) corresponds to consumption expenditures. Public goods (law and order and defense), merit goods (education, health and other social services) and transfers (mainly pensions) have been absorbing the majority of current governmental expenditures. An important share of government spending is also used to cover the interest payments on government debt, which reached a height of more than 50% of GDP at the beginning of the current decade. As can be seen in the literature,

some of these programs are essential for the performance of the economy, but others may not be. Essential spending can directly raise the human and physical capital stock and technical progress in the economy, but it can also do so indirectly by creating synergies for private activities.

The SVAR technique used in this paper was initially proposed by Blanchard and Perotti (2002) to assess the real effects of fiscal shocks. This technique relies heavily on the existence of consistent quarterly data over a sufficiently long period of time. It is usually recommended that fiscal data on an accrual basis for the general government be used for this type of study. Unfortunately, in Colombia quarterly fiscal data on the general government are officially available only for a short time. However, by using information contained in the Banco de la República's (BR) monthly review, data from the web sites of the National Planning Department (DNP) and, especially, data from the National Department of Statistics (DANE), a quarterly database for selected fiscal variables for the 1980:1-2007:4 period was constructed. The fiscal database is assembled on an approximately accrual basis for the general government, which is coherent with the rest of the macroeconomic variables.

The main results found in this study are consistent with the real business cycle theory and Keynesian models of both traditional partial equilibrium and new general equilibrium types. They typically predict that an increase in government expenditures will increase output, private consumption, employment and real interest rates. The effects of a positive shock on net taxes are less conclusive as a whole although some remarkable results were found. The remainder of this paper is organized as follows: the preview papers on this subject in both industrial and emerging countries are reviewed in Section 2. The data and the methodological issues related to the specification and identification of the SVAR are described in Section 3. The results of fiscal shocks are discussed in section 4, first by examining outcomes obtained through the standard three-variable VAR model and subsequently making use of our five-variable SVAR baseline model. In this section, the impact of taxes and government spending by components is also analyzed by using other extended models. Finally, conclusions are drawn in section 5.

2. Review of the Literature

Some empirical research has been done but mainly for industrial countries. For example, Blanchard and Perotti based their influential paper on U.S. data. They used a three-variable baseline VAR which included government spending, net taxes and private real GDP. The identification of the variables is obtained by imposing contemporaneous restrictions on them based on the institutional features of the U.S. tax and expenditure systems. Their results are consistent with standard Keynesian analysis in that positive public expenditure shocks and negative tax shocks have significant and positive effects on GDP and consumption. However, the response of private investment to increased expenditures is negative (and positive to tax reduction), which is more consistent with the standard neoclassical model.

A similar identification method has been employed by Perotti (2004) and Galí, López and Vallés (2005) but for different VAR specifications. In the case of Perotti, a five-variable

baseline VAR was used for 5 OECD countries (the U.S., Canada, Australia, Germany and the United Kingdom) and the monetary policy for short term interest rates and prices was included. The author found that the data showed an important structural break around 1980 for all the countries. His main results show that the effects of fiscal policy on GDP tend to be small and substantially weaker over time and that only in the post-1980 period is there some evidence of (small) positive effects of government spending on interest rates. In the case of Galí et. al., a four-variable baseline VAR which included employment and real interest rates was used for the U.S. Their results are quite similar to previous papers. Output and consumption rise in response to a positive expenditure shock. The labor variables (hours worked and the real wage) react similarly. In contrast, private investment falls slightly in the short run though the response is not significant.

Another identification technique is employed by Fatás and Mihov (2001), who used a five-variable baseline VAR for U.S. data and focused on public expenditure effects. The VAR is specifically identified with respect to spending in order to avoid modeling the contemporaneous interaction between taxes and economic activity (using Choleski's ordering of the variables). An increase in spending leads to a persistent rise in private output with consumption and residential investment being the driving factors. The expansionary fiscal policy is also associated with raising manufacturing wages and increasing total private employment. In addition, the response of the real interest rate is always positive and significant.

For the U.S., Caldara and Kamps (2008) provide new evidence over the 1955-2006 period. Controlling for differences in the way the reduced form models are specified, they showed that all identification approaches used in the literature yielded qualitatively and quantitatively very similar results as regards government spending shocks. GDP, consumption and the real wage all significantly increased while following a hump-shaped pattern. In contrast, there are strongly diverging results as regards the effects of tax shocks. Concerning the mechanics of transmission of fiscal shocks for the U.S. and OECD countries, Perotti (2007) did a comprehensive analysis whereas Pappa (2004) focused on the labor market for her study of such mechanics.

In the context of EU countries, Marcellino (2002) imposes contemporaneous restrictions to identify a VAR that includes a wide set of macro variables for the four largest countries (France, Germany, Italy and Spain). He found non-homogeneous responses from those countries along with some unexpected effects. Giordano, Momigliano, Neri and Perotti (2005) for Italy; Biau and Girard (2005) for France; De Castro (2006) for Spain, Perotti (2005) and Heppke-Falk, Tenhonfen, and Wolff (2006) for Germany are authors of other empirical studies that adopted a methodology that is relatively homogeneous to the one used in our study on Colombia.

The results for UE economies are mixed but, in general, (i) the short term impact of expenditure shocks is expansionary with different degrees of persistence and, for the majority of cases, the output multipliers are larger than one; (ii) positive effects on private consumption are passed through by the previous result; (iii) shocks to net tax revenue have negligible effects on the majority of macroeconomic variables and, in some cases, the signs are contrary to what is expected in a Keynesian framework; (iv) it is usual (with some

exceptions) for the reaction of inflation and interest rates to expansionary fiscal policies to be positive although that may differ depending on the spending or tax component considered; and (v) there is no consensus on the effects on private investment.

There have been few attempts to apply SVAR models to the assessment of the fiscal shocks in emerging countries –particularly in Latin American economies. Cerda, Gonzáles and Lagos (2005) used the standard three-variable VAR for Chile. Their results were not conclusive since they found that a positive expenditure (tax) shock had a negative (and marginal) effect on output during the first quarter and afterwards, the effect died out. For the Czech Republic, Stiková et. al, (2006) have used two VAR specifications to evaluate the fiscal policy since 1996. Initially they applied the usual three-variable SVAR and had significant results. Afterward, they utilized the five-variable SVAR, which included inflation and short term interest rate. Surprisingly, the expansionary effects of spending (and tax cutting) became insignificant in the latter specification and the effects on prices and interest rates were not conclusive.

In a comparative study of Chile and Colombia, Restrepo and Rincón (2006) used Structural VAR and Structural VEC (Vector Error Correction) models to characterize fiscal shocks in these countries. Following Blanchard and Perotti's original paper, they employed the standard three-variable SVAR for the 1990 to 2005 period. Their results show that, for the Chilean case, an increase in tax revenues (expenditures) had a transitory negative (positive) effect on GDP. Nevertheless, for Colombia, the results are at odds with intuition since a tax revenue shock had no impact on GDP and the effect of an expenditure shock was almost negligible. In a subsequent study focused on Colombia, Campo (2007) again used the three-variable SVAR but for a longer period (since 1980). His results were quite similar to Restrepo and Rincon's study mentioned above.

We presume that the negligible results for Colombia could be related in particular to the fiscal data used in both studies. In one case, tax revenue and total expenditures, both of which were used on cash basis, corresponded to the central government (Campo) and non-financial public sector –including state-owned companies– (Restrepo et. al.). Neither of these definitions (basis of recording and the public sector coverage) is coherent with national accounting. To solve these obstacles, a quarterly fiscal database is assembled on an approximately accrual basis for the general government. In other case, these studies used aggregate fiscal variables only and, in Campos' paper, whether or not subsidies and social security transfers had been subtracted from tax revenue was not clear. As was mentioned earlier, the chief components of taxes and expenditures are considered in our exercises and their effects are evaluated on not only output but also the main macroeconomic variables. Thus we hope that this paper will contribute to the limited amount of evidence that exists for Colombia by providing a more detailed analysis of fiscal policy effects.

3. Data and Empirical Methodology

a. The baseline SVAR

Our baseline model is a five-variable VAR model, which included quarterly data on real GDP (y_t), real government spending on goods and services (g_t), real net tax revenues (τ_t),

inflation (π_t) measured by the consumer price index and nominal short term interest rates (r_t). This set of variables is the same as the one used by Perotti (2005) which followed the Fatás and Mihov (2001) tradition. As these authors pointed out, this set of five endogenous variables represents "…the minimal set of macroeconomic variables necessary for the study of the dynamic effects of fiscal policy changes" pg 5. In addition, following the Caldara and Kamps (2008) proposal, six-variable-VAR models were specified, while adding, in turn, real private consumption (c_t), real private investment (i_t), employment (hours worked) (n_t), and the real wage (w_t) to the set of variables.

By collecting the five endogenous variables in the k-dimensional vector Y_t, the reduced form of the VAR model can be written as:

$$Y_t = B(L)Y_{t-1} + U_t \qquad (1)$$

where $B(L)$ is lag polynomial, and U_t is the vector of reduced form innovations with $E(U_t) = 0$, $E(U_t U_t^{'}) = \sum_U$ and $E(U_t U_s^{'}) = 0$ for s≠t. To transform the reduced form model into a structural model, an AB-model is usually employed.[1] The AB-model describes the relationship between the reduced form disturbances, U_t, and the structural disturbances V_t:

$$AU_t = BV_t \qquad (2)$$

where it is assumed that the structural disturbances are not correlated with each other, i.e., the variance-covariance matrix of structural disturbances $\sum_V$ is diagonal. Taking into account the reduced form of the VAR (eq.1), and the relationship between residuals and disturbances (eq. 2), the structural form of the VAR can be obtained by pre-multiplying the first equation with matrix A:

$$AY_t = AB(L)Y_{t-1} + AU_t = AB(L)Y_{t.1} + BV_t = D(L)Y_{t-1} + BV_t \qquad (3)$$

In (3), matrix A describes the contemporaneous relationship between the variables collected in vector Y_t. Solving this equation for Y_t, the structural moving-average representation, whose coefficients are the structural impulse response functions, is obtained. As will be discussed in next section, without restrictions on the parameters in A and B, the structural model is not identified.

b. Identificación

- **Blanchard-Perotti Approach**

Identification under the Blanchard-Perotti approach is procured by imposing contemporaneous restrictions based on the institutional features of the tax and expenditure system as well as of the timing of tax and expenditure responses to economic activity. This approach implies, first, using institutional information to estimate the cyclically adjusted

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[1] This structural form representation is recognized in the literature as a AB model (see Lütkepohl, 2005)

taxes and government expenditures and, second, estimating the macroeconomic effects of the unexpected fiscal shocks. More explicitly, the identification for a five-variable VAR model involves the following procedure.

i) In the first step, the reduced form of the VAR model is estimated, which yields the reduced form residuals $U_t = [u_t^y + u_t^\pi + u_t^r + u_t^g + u_t^\tau]'$. According to Perotti (2005), innovation in the fiscal variables, u_t^g and u_t^τ, can be expressed as a linear combination of the macroeconomic variable innovations as well as structural fiscal variable innovations. Therefore,

$$u_t^g = \alpha_y^g u_t^y + \alpha_\pi^g u_t^\pi + \alpha_\tau^g u_t^\tau + \alpha_r^g u_t^r + \beta_\tau^g v_g^\tau + v_t^g$$
$$u_t^\tau = \alpha_g^\tau u_t^g + \alpha_y^\tau u_t^y + \alpha_\pi^\tau u_t^\pi + \alpha_r^\tau u_t^r + \beta_g^\tau v_\tau^g + v_t^\tau$$

(4)

where v_t^g and v_t^τ, are the structural shocks to government expenditure and government net revenue respectively. In addition, the coefficients α_j^i represent the *automatic* response of variable i to variable j (the elasticity) and the coefficients β_j^i show how the structural shock of j affects the i variable contemporaneously.[2]

ii) Given that the reduced form residuals are correlated with the structural shocks, v_j^i, it is not possible to estimate the α_j^i coefficients by OLS without further restrictions. It is necessary to estimate exogenous and contemporaneous elasticities, α_j^i, in order to construct the *cyclically adjusted* (CA) reduced form residuals for the fiscal variables.[3] Through this procedure, the system is entirely identified, so

$$u_t^{g,CA} \equiv u_t^g - \alpha_y^g u_t^y + \alpha_\pi^g u_t^\pi + \alpha_\tau^g u_t^\tau + \alpha_r^g u_t^r = \beta_\tau^g v_g^\tau + v_t^g$$
$$u_t^{\tau,CA} \equiv u_t^\tau - \alpha_g^\tau u_t^g + \alpha_y^\tau u_t^y + \alpha_\pi^\tau u_t^\pi + \alpha_r^\tau u_t^r = \beta_g^\tau v_\tau^g + v_t^\tau$$

(5)

iii) The third step implies making a decision about the order of the fiscal variables. If it is assumed, for instance, that spending decisions come first, then $\beta_t^g = 0$. Consequently, the equation (5) becomes

$$u_t^{g,CA} = v_t^g$$
$$u_t^{\tau,CA} = \beta_g^\tau v_\tau^g + v_t^\tau$$

(6)

---

[2] Since fiscal authorities need more than one quarter to react to macroeconomic shocks, the *automatic* response of government expenditure and revenue to real output, inflation, and interest rate innovations becomes relevant. It also means that other possible responses, such as *systematic* or *random-discretionary* responses of fiscal policy to shocks to the macro variables are irrelevant.

[3] In particular, as will be mentioned in the next section, calculating α_y^τ α_π^τ, α_y^g, α_π^g, α_r^g α_r^τ α_τ^g is required.

where β_t^τ can be estimated by a simple OLS regression of $u_t^{g,CA}$ on the estimate of the government expenditure shock.

iv) In the final step, the remaining coefficients of the equations for the macroeconomic variables are estimated recursively using the structural shocks as instruments. Thus,

$$u_t^y = \alpha_g^y u_t^g + \alpha_\pi^y u_t^\pi + \alpha_\tau^y u_t^\tau + \alpha_r^y u_t^r + v_t^y$$

$$u_t^\pi = \alpha_g^\pi u_t^g + \alpha_y^\pi u_t^y + \alpha_\tau^\pi u_t^\tau + \alpha_r^\pi u_t^r + v_t^\pi \qquad (7)$$

$$u_t^r = \alpha_g^r u_t^g + \alpha_y^r u_t^y + \alpha_\pi^r u_t^\pi + \alpha_\tau^r u_t^\tau + v_t^r$$

Finally, these steps allow us to construct the A and B matrices which are used to calculate the impulse response functions for fiscal shocks. Taking into account our α_j^i estimates (these elasticities are explained in more detail in the next section), the A and B matrices take the following form:

$$
\begin{bmatrix}
1 & 0 & 0,5 & 0 & 0 \\
-\alpha_y^g & 1 & 0 & -\alpha_y^\tau & 0 \\
-\alpha_\pi^g & -\alpha_\pi^y & 1 & -\alpha_\pi^\tau & 0 \\
0 & -1,47 & -1,29 & 1 & 0 \\
-\alpha_r^g & -\alpha_r^y & -\alpha_r^\pi & -\alpha_r^\tau & 1
\end{bmatrix}
\begin{bmatrix}
u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^\tau \\ u_t^r
\end{bmatrix}
=
\begin{bmatrix}
\beta_g & 0 & 0 & 0 & 0 \\
0 & \beta_y & 0 & 0 & 0 \\
0 & 0 & \beta_\pi & 0 & 0 \\
\beta_g^\tau & 0 & 0 & \beta_\tau & 0 \\
0 & 0 & 0 & 0 & \beta_r
\end{bmatrix}
\begin{bmatrix}
v_t^g \\ v_t^y \\ v_t^\pi \\ v_t^\tau \\ v_t^r
\end{bmatrix}
\quad (8)
$$

- **Recursive Approach**

Notice that in the Blanchard and Perotti method, seven parameters are exogenously imposed in order to achieve the full identification of the five-variable SVAR model (see matrix A in (8) and footnote 3). Under the recursive approach, no parameter is imposed exogenously. This implies that matrix B is restricted to a k-dimensional identity matrix while matrix A is restricted to a lower triangular matrix with a unit diagonal (equation 9). In practice, the recursive approach requires a causal ordering of the model variables. The order suggested by Caldara and Kamps et. al., which was based on previous papers as well as on "conjectures" about contemporaneous and non-contemporaneous effects between the macroeconomic variables, was adopted. In particular, for a five-variable VAR model, these authors propose the following order: g_t; y_t; π_t; τ_t; and r_t. As a result, the relationship between the reduced-form disturbances, U_t, and the structural disturbances, V_t, takes the following form:

According to Caldara and Kamps et. al., pg 13, this particular order of the variables was based on following conjectures: (i) because spending is placed first (g_t), government expenditures do not react contemporaneously to shocks to other variables in the system;[4]

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[4] This assumption also implies that movements in government expenditures, unlike movements in taxes, are largely unrelated to the business cycle.

(ii) output is placed second (y_t), which implies that it does not react contemporaneously to tax, inflation and interest rate shocks but is affected contemporaneously by expenditure shocks; (iii) inflation is third in the order (π_t) meaning that inflation does not react contemporaneously to tax and interest rate shocks but is affected contemporaneously by government spending shocks; (iv) tax revenue is in fourth place (τ_t), which implies that it does not react contemporaneously to interest rate shocks but is affected contemporaneously by government spending, output and inflation shocks[5] and, finally, (v) the interest rate is last (r_t) because it is assumed that it is affected contemporaneously by all shocks to the system. The placement of the interest rate in the order is justified on two counts. One is on the grounds of the central bank reaction function, since the interest rate is set as a function of the output gap and inflation, and the other is because spending and revenue as defined here (net of interest payments) are not sensitive to interest rate changes.

$$
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 \\
-\alpha_y^g & 1 & 0 & 0 & 0 \\
-\alpha_\pi^g & -\alpha_\pi^y & 1 & 0 & 0 \\
-\alpha_\tau^g & -\alpha_\tau^y & -\alpha_\tau^\pi & 1 & 0 \\
-\alpha_r^g & -\alpha_r^y & -\alpha_r^\pi & -\alpha_r^\tau & 1
\end{bmatrix}
\begin{bmatrix}
u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^\tau \\ u_t^r
\end{bmatrix}
=
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
v_t^g \\ v_t^y \\ v_t^\pi \\ v_t^\tau \\ v_t^r
\end{bmatrix}
\quad (9)
$$

c. Exogenous elasticities

The identification technique suggested by Blanchard and Perotti requires exogenous (and contemporaneous) elasticity of fiscal variables with respect to the macroeconomic variables in order to construct the *cyclically adjusted* (*or structural*) reduced form residuals for the fiscal variables. In this type of process, the adjusted tax revenue is one of the most important variables. For this case, the structural component of the tax revenues can be estimated by using the actual output (Y_t^a) and the potential output (Y_t^p), as

$$
T_t^s = T_t^a * \left(\frac{Y_t^p}{Y_t^a} \right)^{\alpha_\tau^y}
\tag{10}
$$

where α_τ^y represents the tax elasticity with respect to output, T_t^a is the actual tax revenue and T_t^s is the structural (*or cyclically adjusted*) tax revenues. The tax-output elasticity, in turn, can be calculated as:

$$
\alpha_\tau^y = \sum_{i=1}^{n} \alpha_{\tau_i}^{B_i} * \alpha_{B_i}^y * \frac{T_i}{T}
\tag{11}
$$

---

[5] Placing y_t and π_t before τ_t can be justified on the grounds that the output and inflation shocks have an instantaneous effect on the tax-base and, therefore, a contemporaneous impact on tax revenues

where $\alpha_{\tau_i}^{B_i}$ denotes the elasticity of taxes of type i to their tax base B_i; α_B^y means the elasticity of the tax base to GDP, and $T = \sum_i T_i$.

Using this methodology, Lozano and Toro (2007) estimated $\alpha_\tau^y = 1.47$ for Colombia, which is comparable to what international evidence has shown (using the same technique).[6] Since there were a large number of tax reforms during the period of study (1970-2005), the authors introduced dummies to control for the effect of such reforms on estimated output elasticities. This estimate was used in our exercises. The other elasticities, also based on institutional information (price-elasticity of government spending, price-tax elasticity, etc), were simply calculated as:

$$\ln(x) = \beta_0 + \beta_1 \ln(y) \tag{12}$$

where coefficient β_1 measures the automatic elasticity of x with respect to y (Table 1 shows the results)

Table 1. Exogenous Elasticities

	GDP	GDP-Deflator
Government revenue	1,47	1,29
Government Spending	0	-0,5
Public Consumption	0	-0,33
Public Investment	0	-0,24
Direct Taxes	2,43	0,46
Indirect Taxes	1,13	0,21

Following Perotti (2002), we imposed a non-zero price elasticity of government expenditure (-0.5) since some spending decisions are fixed in nominal terms or change with price evolution. In addition, price-tax elasticity is estimated at 1.29, using the deflator of GDP, which means that tax revenue is also affected by prices within the quarter. With respect to the short-term interest rate, in line with other studies the assumption was made that it reacts to output and price evolution, but not in the same quarter; i.e., the contemporaneous response of interest rate to shocks to taxes is also set at zero. Finally, it was assumed that government revenue also responds contemporaneously to private consumption and investment (the elasticity of tax revenue to private consumption is calculated at 1.34 and to private investment at 0.42).

d. Data description and policy issues

Quarterly data for Colombia ranging from 1980Q1- 2007Q4 was employed. The macroeconomic variables, real GDP, real private consumption, real private investment, the

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[6] The income tax to GDP elasticity is, on average, 1.3 for OECD; 1.5 for Euro area and 1.1 for new EU members (Girouard and André, 2005).

3-month nominal interest rate, and GDP deflator stem from the database of the Banco de la República (BR), the central bank of Colombia. In regards to the fiscal data, as was mentioned in the introduction, a database for selected general government variables was assembled. The fiscal database is compiled on a basis that is approximately accrual, using information from the BR monthly review, data from the web sites of the National Planning Department (DNP) and, especially, data from the National Department of Statistics (DANE).

According to national accounting, the general government covers fiscal operations of both national and sub-national governments as well as of the social security sector. Public spending (g_t) is the result of the sum of public consumption –purchases of goods and services and compensation of civil servants– and public investment. The net tax revenue (τ_t) is defined as the difference between tax revenues (with social security contributions) minus transfers to households (including social security payments as well as interest payments on public debt). Regarding taxes, income tax is differentiated from the consumption tax at national and sub-national levels. Fiscal variable definitions are made in line with papers written by Blanchard and Perotti and Fatás and Mihov. Figure 1 plots the macro-fiscal variables used in both our baseline model and our complementary models. For illustrative purposes, some of these variables are shown in percentages of GDP.

Throughout of the period of the study (28 years), Colombian policymakers undertook a series of far-reaching economic and political reforms to modernize the State, improve democratic institutions and strengthen their productive activities. In the economic field, the reforms introduced significant changes to the trade, financial, exchange, labor, social security, and public finance systems. The purpose of these changes was essentially to: (i) achieve greater macroeconomic stability by reducing inflation and interest rates and decreasing both external and fiscal deficits; (ii) introduce broader deregulation and a wider opening of the capital markets; and (ii) foster free trade policies, foreign investment, and the privatization of state-owned companies. Some laws emerged from the Constitution adopted in 1991 and others rose from governmental initiative, which was in tune with the trends in economic globalization.[7]

Time-behavior of the macro-fiscal variables shown in Figure 1 could have been influenced by the reforms as well as by external shocks, which are usually associated with changes in commodity prices and financial turmoil. The deep recession recorded at the end of the 1990s when the Colombian economy dropped to a growth rate of –4.3% was evident in the GDP growth-trend (Panel A). Prior to that, the economy had exhibited an extraordinary record of five decades of uninterrupted, positive GDP growth. However, like many other emerging economies, Colombia was affected by the Asian and Russian financial crisis of 1997-98. Throughout those years, domestic interest rates were exceptionally high and policymakers faced the perils of exchange rate attacks and a sharp financial crisis all at once. To reduce inflation and stabilize the private capital inflows, the BR switched to a flexible exchange rate regime, and adopted an inflation targeting framework to anchor inflationary expectations in September 1999.

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[7] Lozano (2002) offers a complete analysis of the structural reforms introduced in the nineties.

Real economic growth recovered to 4 percent a year in 2003–04 and, later, reached its highest figure for the current decade (7.8% in 2007). The recovery and boom growth phases were driven by the economic authority's strategy of fostering the financial system, lowering inflation and interest rates and introducing some economic reforms which was implemented at the beginning of the new century (Panel D). The subsequent shock in terms of trade and the positive path taken by the world economy as well as the better security conditions for domestic investment facilitated the expansion of real output. In recent times, private investment has recovered to levels recorded in the middle of the nineties while the unemployment rate has dropped to the levels reached in the mid-eighties (Panels C and H).[8]

From the fiscal point of view, the decentralization process, which had begun by the early 1980s and was subsequently endorsed by the Constitution of 1991 as well as other programs related to the constitutional changes and modernization of the State pushed government spending up in the first part of the nineties (Panel E).[9] At the same time, the fiscal deficit grew despite the recurrent tax reforms implemented during this time. Between 1990 and 2000, there were, at least, eight national tax reforms, the common features of which were constant changes to VAT coverage and rates. Other widely known tax changes were adjustments to the income tax (tariffs and tax-bases); improvements in the tax system administration; controls on non-legitimate imports and tax evasion. Currently, the VAT revenues are the main source of central government financing as can be deduced from Figure 1 (panel F).

After the recession at the end of the nineties, the government had to make additional structural reforms, particularly in fiscal programs. To reduce the actuarial deficit in the public pension system, two pension reforms were adopted. To smooth out the transfer of resources from the central government to local governments to finance education, health and other local services, the transfer system was adjusted twice, initially in 2001 and then in 2007. Between 2002 and 2006, three additional tax reforms were introduced. In addition, in 2002 a labor market reform intended to make it more flexible was established. Other reforms focused on restructuring and downsizing the nonfinancial public sector, improving financial supervision, and privatizing or liquidating the remaining state-owned banks.

4. The empirical results

The impulse-response functions and multipliers derived from fiscal baseline shocks and other models are presented in this section. In all cases, the shocks correspond to one-standard deviation and the impulse-response paths are reported for a horizon of 20 quarters (five years). Error bands are calculated by Monte-Carlo simulations based on 1000 replications. Institutional changes related to fiscal episodes described in the previous section are captured through the use of dummy variables. According to the significance

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[8] The expansionary cycle of private consumption and investment recorded in the early nineties was fostered by large capital inflows and ample domestic credit (Panels B and C).

[9] The social security (pensions and health) and judicial systems in particular demanded increasing public resources after the new constitution

test, a dummy variable is included in our model in 1994Q1, which coincides with the jump in the public spending level. The models also include a constant term.

Initially, the variance decomposition of the baseline model was analyzed (Table 2). This computation allows us to decompose the prediction of each variable depending on the innovations of the model at different temporal horizons. The two fiscal variables play a marginal role in explaining each other. The forecast error of government spending, g, twenty quarters ahead, is mainly self- explanatory (by above 60%), whereas net taxes explain only around 3%. Output helps to explain the forecast error of g, especially after the second year (near 28%). A similar pattern was found for the prediction error of net taxes, τ: the main share is self-explanatory (around 79%), followed by output (8%) and government spending (5%).

Table 2: Variance decomposition in the baseline model

% of the forecast error of	Quarter	Explained by shocks in:				
		g	y	π	τ	r
g	4	84,0755	8,5109	2,2260	2,3082	2,8794
	8	63,5067	28,1376	2,7387	3,0117	2,6053
	12	63,0868	27,4049	3,0046	3,3835	3,1202
	16	62,0711	27,4165	3,8748	3,4100	3,2277
	20	61,3861	27,7724	4,1594	3,3631	3,3191
y	4	34,4970	50,2943	0,8530	7,8147	6,5409
	8	32,6760	42,3571	0,7179	12,5367	11,7123
	12	33,4621	41,6627	1,1010	11,7289	12,0452
	16	32,1372	42,7873	1,4748	11,2326	12,3681
	20	32,1759	42,7927	1,5225	11,1142	12,3947
π	4	0,1841	13,6192	77,1236	8,5343	0,5389
	8	3,8432	25,7525	64,2828	5,5542	0,5673
	12	8,9018	30,0075	56,1123	4,4004	0,5779
	16	8,5367	34,3757	52,2859	3,8597	0,9420
	20	9,4615	35,8690	50,0620	3,5621	1,0453
τ	4	3,9541	8,0136	4,5727	81,5887	1,8708
	8	4,7665	8,1413	4,9305	80,0715	2,0903
	12	5,2422	8,2245	4,9261	79,3057	2,3015
	16	5,2879	8,4446	4,9131	78,9567	2,3977
	20	5,3329	8,5304	4,9049	78,8211	2,4108
r	4	4,5831	14,1159	4,0424	23,1298	54,1288
	8	12,8242	31,9131	4,8318	14,7907	35,6402
	12	15,1503	42,7464	3,8398	10,6475	27,6160
	16	15,0295	46,5652	4,0009	9,1889	25,2155
	20	15,4110	48,0493	4,4090	8,4243	23,7064

Regarding the forecast error for output, notice the significant contribution of public expenditures (one third) and net taxes (12% after the second year), and the reduced contribution explained by inflation (less than 1.5%). These outcomes are relevant for the impulse-response exercises. The relevance of public spending could be due to the rapid

expansion of the size of the state in the nineties as a consequence of the political and economic reforms previously described. Finally, shocks to interest rates and prices only seem to play an evident role in explaining their own forecast errors even though the prediction of these two variables appears to be notably affected by output shocks.

Before analyzing the macroeconomic effects of the fiscal shock in the baseline model, we briefly comment on the results of fiscal innovation in the simplest model (three-variable SVAR model: g_t, y_t, τ_t), which has been used the most at the empirical level (Figure 2). In both cases, that is, an unexpected increase in government spending or an unexpected reduction in taxation, the GDP clearly responds positively and significantly during the first six quarters; thereafter, the effects tend to disappear steadily in the medium term. The fiscal shocks themselves are reasonably persistent with 66% and 75% of the respective shock still present after six quarters. This behavior is precisely coherent with the Keynesian prediction according to which fiscal policy is an effective tool for smoothing out the real business cycle. In addition, these findings contrast with the negligible results found previously for Colombia.

a. The effects of government spending

Figure 3 shows the impulse-response functions for a government spending shock in our baseline model (g_t, y_t, π_t, τ_t, r_t) with the individual columns displaying the results for the Blanchard-Perotti and recursive identification approaches. The results reveal a number of interesting issues, some of which have been found in previous studies particularly for the developed countries. First of all, GDP responds positively and significantly during the first six quarters and shows a typical hump-shaped form with a peak effect in the third quarter at around 0.76%. Subsequently, it declines gradually and becomes temporally negative before returning to zero after the fourth year. The spending shock itself is moderately persistent with 98% of the shock still present after four quarters.

As is illustrated in Table 3, the cumulative output multiplier fluctuates between 1.12 and 1.19 from the short to medium term, which is broadly consistent with what is found for Colombia using other methodologies.[10] The cumulative multiplier is calculated as the ratio of the cumulative response of GDP and the cumulative response of government expenditure for each quarter. Recently, Leigh (2008) found a short-run output multiplier of 1.15 for Colombia, using a Global Integrated Monetary and Fiscal (GIMF) model developed by the International Monetary Fund. A similar short-run multiplier was also found by Abrego and Österholm (2007) by using a Bayesian VAR approach.

Secondly, as expected, both inflation and nominal interest rates respond positively and significantly to a positive shock in government spending, particularly after the second year after the shock. Nonetheless, the size and time persistence of the interest rate responses are greater than inflation, which implies that interest rates, in real terms, go up with increases in government expenditure. The peak effects on interest rates and inflation attained around seventh quarter are 1.03% and 0.006% respectively. These findings are coherent with the

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[10] The cumulative multipliers are lower than one only for the second year when the response function becomes temporally negative

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textbook macroeconomic models and have not usually been found in previous empirical papers.

Table 3
Cumulative output multipliers to a government expenditure shock

	Quarters			
Shock to:	4th Q	8th Q	12th Q	16th Q
Government Spending	1,11740	0,59364	1,19500	2,11002

Thirdly, the short-run dynamics of net taxes differ substantially from the evolution of expenditures. As was mentioned previously, while the spending shock is moderately persistent with 98% of the shock still present after four quarters, the response of net taxes to this shock is virtually zero. This unusual result can be associated with the net tax definition[11] and the increase in the amount of interest payments on debt and pension expenditures, which are discounted from tax revenues.

Finally, the robustness of our baseline results was checked by means of two alternative identifications (the Blanchard-Perotti-approach vs. the recursive approach); an alternative definition of inflation (GDP-deflator instead of CPI); the use of a 3rd order lag polynomial instead of a 4th order lag polynomial[12]; and through the use of other elasticity-values calculated for Colombia. The results do not change substantially. To some degree, the results described in this section are consistent with a large variety of economic theories, including Keynesian, Neo-Keynesian and real business cycle theories as all of these theories predict that increases in government spending have an expansionary effect on economic activity with rising output and real interest rates.

b. The effects of net taxes

The response of the various macro variables to a positive shock in net taxes in our baseline model is presented in Figure 4. The most surprising result comes from the response of output. Contrary to what was found in the three-variable SVAR model, the GDP responds positively, which is counter-intuitive. Nonetheless, this unexpected result is short-lived and has little significance. In addition, the response of net revenue to its own shock does not present a conclusive trend and is insignificant over time

The positive response of GDP to an increase in taxes has been found in other countries, especially in the European ones. In Italy, for instance, Giordano et. al. (2005) found this effect although it was extremely small. In Germany, Heppke-Falk et. al. (2006) found that output did not react to a net revenue shock. The value estimate was very small and insignificant for all of the quarters shown. For Spain, De Castro et. al. (2006) found that

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[11] The net tax revenue results from the difference between gross tax revenue minus interest payments on public debt minus pension expenditures.
[12] The 3rd and 4th order lag-polynomial is coherent with the optimal criterion of Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQC).

GDP went up after the third quarter and then declined gradually and became negative and significant –but only after sixteen quarters (four years). For the Czech Republic, Štiková, R. (2006) found a pattern that was similar to our results: in the three-variable VAR model, the output declined as result of a positive revenue shock, but in a five-variable VAR model, the effect became positive and insignificant.

Inflation and, especially, short term interest rates responded with a significant downward drop to an increase in taxes, which is consistent with intuition. However, the responses of these variables did not continue beyond the second year after the shock (their significance disappeared in the fourth and sixth quarters respectively). In the case of interest rates, the highest drop of 1.2% was recorded in the third quarter in response to a positive shock of one standard deviation in taxes, whereas inflation fell 0.47% in the second quarter. The most common interpretation of these results is that an unexpected increase in taxes, *ceteris paribus*, negatively affects the disposable income of households and the aggregate demand. For a given short term offer supply, this negative effect generates a downward pressure on prices and interest rates. However, the international evidence offers mixed results on this matter.

c. The effects on private consumption and private investment

Figures 5 and 6 display the responses of private consumption and private investment to a positive shock in both government spending and taxes respectively. The impulse-response functions came from the following six-variable VAR model: $g_t, y_t, x_t, \pi_t, \tau_t, r_t$; where x_t is the new variable (private consumption or private investment) that is added in turn to the baseline model. This particular order of variables was suggested by Caldara and Kamps op. cit., (2008) who, in turn, based their idea on previous papers (Fatás and Mihov (2001), Perotti (2002)) as well as on a conjecture explained in section 3.b.

In particular, x_t is placed third in the order which means that private consumption (or private investment) does not react contemporaneously to prices, taxes and interest rate shocks but is affected contemporaneously by output and government spending shocks. However, with this placement in the order the x_t component is allowed to affect prices, taxes and interest rate within the same quarter. The decision to analyze the responses of private consumption or private investment is self-explanatory because of their share of GDP. In the figures, the results are shown with the identification suggested by Blanchard and Perotti, albeit the recursive approach provides similar outcomes.

The impulse responses show a significant positive response of private consumption to a spending shock, reproducing the GDP pattern, which is to increase steeply until it reaches its peak in the fifth quarter at around 0.65% and then decline gradually to become temporally negative and insignificant in the third year. Private investment presents a similar pattern, even if its response is greater and is shorter-lived. Regarding the tax effect (Figure 6), notice that private investment responds with a significant downward drop to a positive shock in taxes. After that, it increases gradually to become transitorily positive but non-significant after the second quarter.

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The patterns of response for consumption and investment are in accordance with previous evidence from VAR analysis. In particular, the positive response of consumption to a spending shock has been found in most studies since Blanchard and Perotti published their influential paper in 1999 (the first version). In contrast, the effect on investment has been less empirically conclusive. From a theoretical point of view, neoclassical theory broadly predicts that consumption should fall in response to a (temporary) spending shock while (new) Keynesian models predict that consumption will increase. Going beyond that, the simple Keynesian theory predicts that the response of private investment to a tax shock should be the opposite of its response to a spending shock. The results offered in this section are in line with the latter approach.

d. The effects of government spending by components

The responses of GDP, private consumption and private investment to a positive government spending shock are depicted by component in Figures 7 and 8. The main components of government spending include personnel expenditure and other operating expenditures (public consumption) as well as financial expenditures on capital formation (public investment). The impulse-response functions emerge from the following six-variable SVAR model: x_t, y_t, z_t, π_t, τ_t, r_t; where x_t represents the component of public spending (consumption or investment), and z_t is added in turn to capture the private consumption or private investment responses. Once again, this particular order is suggested by previous empirical studies.

We found a strong and significant response of output to a shock to government investment (with a peak of 0.8% in the first quarter) at the same time as the effect of government consumption is weak and non-significant. [13] The spending shocks themselves are moderately persistent with around 76% of the shock still present after four quarters. The private investment response after a shock to public investment is, in general, significant in the short term (five quarters). Initially it responds with a significant upward jump and subsequently declines gradually and becomes temporally negative before returning to zero after the third year.

The significant response of output to a change in public investment was found previously for Colombia by Leigh op. cit., who concluded that a permanent cut of 0.5 percentage points of GDP in public investment leads to a long term contraction of 0.86 percent of GDP due to a contraction in the supply capacity of the economy. However, if public investment is not productive, a cut in capital expenditures has an effect that is broadly similar to a reduction in public consumption (GDP declines 0.58 percent).

Our results are in line with those found for Italy by Giordano et. al. (2005) and Perotti (2005) and for Germany by Heppke-Falk et. al. (2006), but contrast with the findings of Fatás and Mihov (2001) for the U.S. and De Castro (2006) for Spain, who reported that public consumption (purchases of goods and services) was a highly effective way of

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[13] The cumulative output multiplier to shocks on public investment, which is estimated in the simplest model as the ratio of the cumulative response of GDP and the cumulative response of government investment, rises to 3.64 in the fourth year.

boosting private consumption and output while public investment expenditure has little effect. The large positive output multipliers for government investment were found initially by Aschauer (1989) and Baxter and King (1993) even though they depended on the productivity parameter of public capital.

e. The effects of taxes by component

The responses of the main macroeconomic variables to tax shocks by component will be briefly studied in this subsection. Colombia's core taxes include corporate and personal income taxes, the value added tax, the financial transaction tax and other tariffs collected on domestic and foreign operations at the national level. In addition, there are taxes on tobacco, liquor, and beer consumption at the provincial level. Property and valorization taxes as well as taxes on gross business receipts constitute the main revenue for municipalities. Finally, gasoline taxes are levied at national and local levels. Following the national account criteria, all these taxes were classified into two components: indirect (consumption) and direct (income) taxes. To assess the tax effects, a six-variable VAR model was used (g_t, y_t, z_t, π_t, x_t, r_t) while maintaining the same order as before. In these cases, x_t represents the tax component and z_t is added in turn to capture the private consumption or private investment responses.

A positive shock to indirect taxes shows little persistence and becomes non-significant after two quarters (see Figure 9). This shock reduces GDP and private consumption initially, but these responses are non-significant in both cases. Clearly, the short term interest rate reacts negatively and significantly to a shock to indirect taxes in line with what one could expect.[14] However, the interest rate response is short lived. It becomes non-significant after the fifth quarter.

The shock to direct taxes (Figure 10) looks a little more persistent than the shock to indirect taxes. The response of GDP and private consumption are negative and significant in the first two quarters although these become slightly positive but non-significant in the medium term. The direct-tax shocks do appear to have significant effects on private investment in the short term. Initially, private investment responds with a significant downward drop and, thereafter, increases gradually to become transitorily positive (but non-significant) after the third quarter. Once more, notice that the short term interest rate reacts negatively to a positive shock to direct taxes and the response is statistically significant for a longer period (seven quarters after the shock). The fall in interest rates could compensate for the decline in output; hence its reaction after third quarter.

In summary, shocks to direct taxation in Colombia clearly seem to cause more distortion, mainly by affecting private investment, whereas shocks to indirect taxation do not seem to affect activity significantly in the short term. In principle, these findings are in line with what has been found by public finance experts who have generally concluded that not all taxes have the same impact on the economy.[15] Value added taxes (indirect taxes) that are

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[14] As already mentioned, the shock reduces private consumption and aggregate demand and, for a given short term aggregate supply, it also reduces prices and interest rates.

[15] See, for instance, Mendoza, E, et. al., (1994); Tanzi, V. and Zee, H. (2000); Afonso A, et. al. (2005).

basically proportional taxes on consumed income are preferred to personal income taxes (direct taxes) that are often applied with high marginal tax rates on both consumption and saving.

f. The effects on the labor market

Finally, Figures 11 and 12 present the responses of the labor market to a fiscal shock by means of six-variable SVAR models. The systems added one variable from the labor market to the five variables of the baseline model, either the unemployment rate, μ, or the real index of minimum wage, w. In the first case, the unemployment rate is defined as the ratio of people classified as unemployed to the total labor force of the seven major cities (for the 1984Q1- 2007Q4 period). In the second, minimum wage is deflated using the consumer price index. Both labor variables are constructed by employing quarterly information from the BR web site.

The impulse responses are calculated under the recursive identification approach with the following order: g_t, y_t, π_t, μ_t, τ_t, r_t, in the first system and g_t, y_t, π_t, τ_t, w_t, r_t, in the second one. This particular order of the variables implies two important conjectures suggested by previous studies: (i) as unemployment rate is fourth in the order, it does not react contemporaneously to taxes and interest rate, but it is affected contemporaneously by government spending, output and price shocks; and (ii) the real minimum wage is affected by spending, output, tax and price shocks contemporaneously, but it does not react to short-term interest rate shocks.

The spending shock has a positive and significant effect on GDP, replicating the hump-shaped pattern found initially. Both prices and short term interest rates move from a negative to a positive response, which becomes significant after the third year. All these effects are coherent with what was found in the baseline model. However, the finding that was novel came from the unemployment responses (Figure 11). The unemployment rate reacts negatively and significantly to a positive shock in government spending in line with what one could expect. The unemployment rate falls on impact by 0.12%, then decreases further to reach a maximum effect of 0.31% in the fourth quarter and subsequently stabilizes around 0.25%. The effect on the unemployment rate is remarkably persistent over time. Figure 12 shows that the response of the real wage index to the spending shock is not statistically significant, but GDP, inflation and the short term interest rate react in a manner that is statistically significant just as the previous case does.

Our results are consistent with the findings of Perotti (2007) and Fatas and Mihov (2001), etc. who observed that employment increases (or unemployment decreases as in our case) after a government spending shock. However, our findings do not support the positive responses of real wages found by these authors. From the theoretical point of view, the positive response of employment is consistent especially with the real business cycle theory and Keynesian models of both traditional partial equilibrium and new general equilibrium types. They typically predict that an increase in government expenditure will increase the demand for labor, consumption and output. The mechanics of the transmission of fiscal

shocks to labor markets under these models are described by Pappa (2005). With lump-sum taxation, the neoclassical model studied by Baxter and King, op. cit. also predicts a positive effect of a shock to government spending on total employment even though the real wage declines under this approach.

5. Conclusions

The short term macroeconomic effects of the fiscal policy in Colombia for the 1980–2007 period were studied using a structural vector autoregression (SVAR) model which has been widely recommended by several previous empirical papers. Since the VAR approach heavily relies on the existence of consistent quarterly data over a sufficiently long period of time, a database of selected fiscal variables for the general government –organized on what is an approximately accrual basis and which is coherent with the rest of macroeconomic variables– was assembled.

Throughout the period of study, the policymakers for the country undertook a series of far-reaching economic and political reforms to modernize the state, improve democratic institutions and strengthen their productive activities. Fiscal policy played a crucial role in attaining these objectives. After the recurrent tax reforms, the Colombian tax burden (at the national level) rose from 7.8% to 16.7% of GDP between 1990 and 2008. The amount of central government spending in turn, increased from 9.6% to 21.8% of the GDP in this period and almost 90% (on average) corresponded to consumption expenditures. For the total sample, the GDP per capita (in 1990 dollars) went up from US$ 4,265 in 1980 to US$6,898 in 2008. [16]

Initially, macroeconomic effects of the fiscal shock were assessed by means of the simplest model (3-variable SVAR: government spending, output and tax net revenues), which has been used the most. Either an increase in government spending or a reduction in taxation significantly expand the GDP during the first six quarters; thereafter, the effects tend to disappear steadily in the medium term. These findings contrast with the negligible results found previously for Colombia. In contrast, our benchmark is a 5-variable SVAR model which adds CPI-inflation and short term nominal interest rates to the previous specification. According to some specialists, this set of five endogenous variables represents the minimal set of macroeconomic variables necessary for the study of the dynamic effects of fiscal policy changes. In addition, we specified six-variable-VAR models, adding in turn private consumption, private investment, the unemployment rate and the real minimum wage to the last set of variables. We also split fiscal revenue and expenditure by components to distinguish between their particular effects.

Using the baseline model and the others, the following effects of a positive government spending shock (of one standard deviation) are found. First, the GDP responds positively and significantly during the first six quarters and shows a typical hump-shaped form with a peak effect in the third quarter. Subsequently, it declines gradually and reaches zero after the four year. The cumulative output multiplier fluctuates between 1.12 and 1.19 from the

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[16]   Information taken from the Conference Board and Groningen Growth and Development Centre, Total Economy Database

short to medium term, which is broadly consistent with what is found for Colombia using alternative methodologies. Second, as expected, both inflation and nominal interest rates also respond positively and significantly, particularly after the second year. Nonetheless, the size and time persistence of the interest rate responses are greater than inflation, which implies that interest rate, in real terms, goes up when government expenditure increases.

Third, the exercises show a significant positive response by both private consumption and private investment although the response of the later is greater and shorter-lived. Fourth, with regards to the effects of public spending shown by component, the strong and significant response of output and private investment to a public investment shock, at the same time that the effect of government consumption is weak and non-significant is remarkable. And fifth, the unemployment rate reacts negatively and significantly to a positive shock in government spending. The unemployment rate falls on impact by 0.12%, then decreases further to reach a maximum effect of 0.31% in the fourth quarter and subsequently stabilizes around 0.25%. The effect on unemployment rate is remarkably persistent over time.

Macroeconomic effects of a positive net tax shock are less conclusive as whole although we find some remarkable results. In one case, inflation and especially short term nominal interest rates respond with a significant downward drop, which could be consistent with intuition. However, the responses of these variables do not continue beyond the second year. In the other, shocks to direct taxation in Colombia clearly seem to cause more distortion, because they mainly affect private investment, whereas shocks to indirect taxation do not seem to affect real activities significantly in the short term. In principle, these findings are in line with what has been found by public finance experts, who have concluded that indirect taxes, which are basically proportional taxes on consumed income, are less inefficient than personal income taxes (direct taxes), which are often applied with high marginal tax rates on both consumption and saving.

Two alternative identification techniques (Blanchard-Perotti-approach and recursive approach) and other tools are used in the VARs to check the robustness of our results. In general terms, the results found in this study are consistent with real business cycle theory and Keynesian models of both traditional partial equilibrium and new general equilibrium types. They typically predict that an increase in government expenditures will increase output, consumption, employment and real interest rates. Our empirical findings do not support the neoclassical prescriptions according to which increases in government expenditure crowd out the private sector through the induced wealth effect. From a policy perspective, our results support the smoothing role of fiscal policy on output fluctuations, which implies its capacity to restore real activity effectively in critical times like the ones currently being forecast. However, it is essential that fiscal stimulus not be seen by markets as seriously calling into question medium term fiscal sustainability. The sustainability analysis is beyond the scope of this paper and should be the subject of further research.

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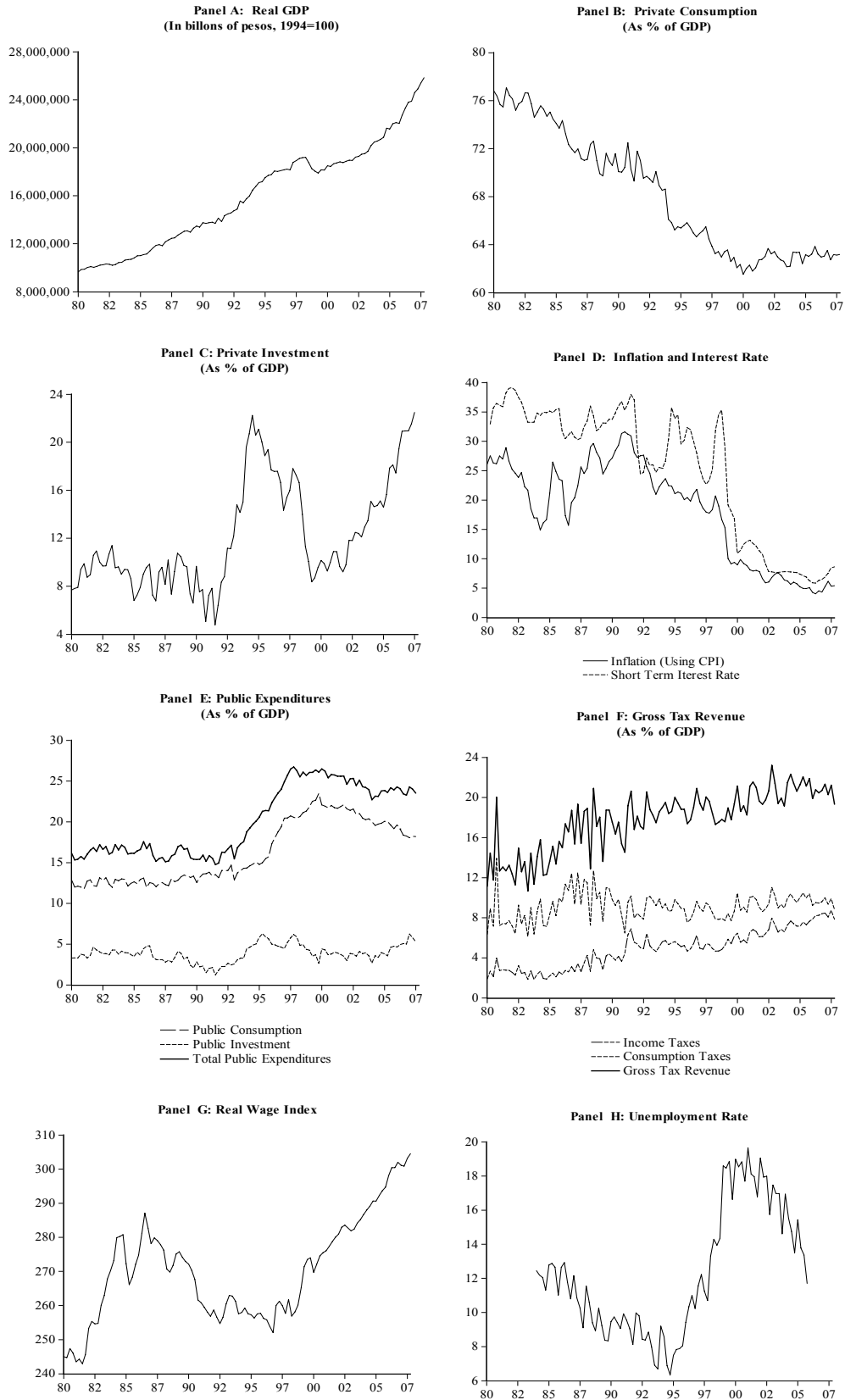# Figure 1. Macroeconomic and Fiscal Variables: 1980Q1 – 2007Q4

Panel A: Real GDP
(In billons of pesos, 1994=100)

Panel B: Private Consumption
(As % of GDP)

Panel C: Private Investment
(As % of GDP)

Panel D: Inflation and Interest Rate

Inflation (Using CPI)
Short Term Iterest Rate

Panel E: Public Expenditures
(As % of GDP)

Public Consumption
Public Investment
Total Public Expenditures

Panel F: Gross Tax Revenue
(As % of GDP)

Income Taxes
Consumption Taxes
Gross Tax Revenue

Panel G: Real Wage Index

Panel H: Unemployment Rate

Figure 2. Fiscal shocks in a simplest model (three-variable SVAR)

Responses to an increase in government spending (left column) and
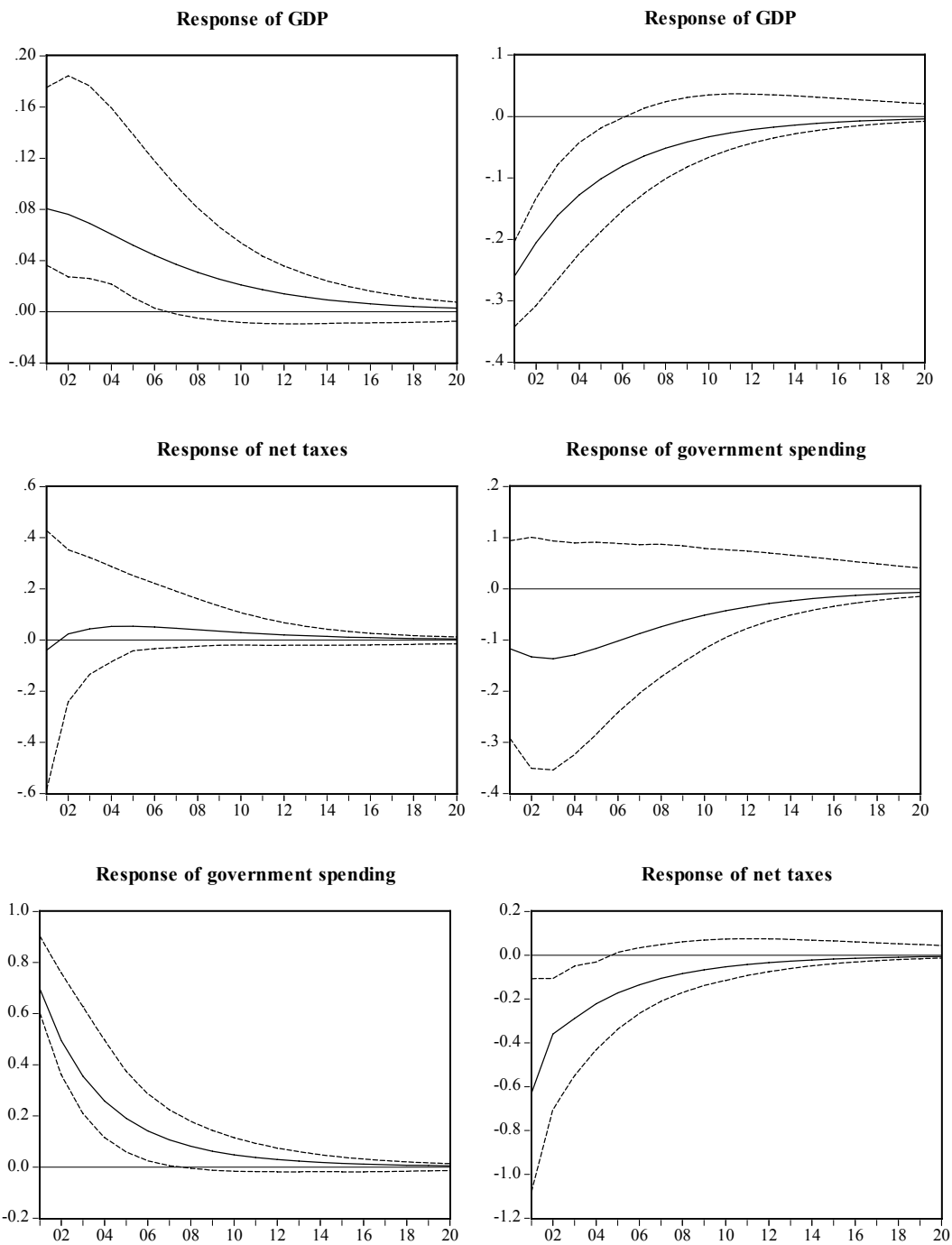net taxes (right column)

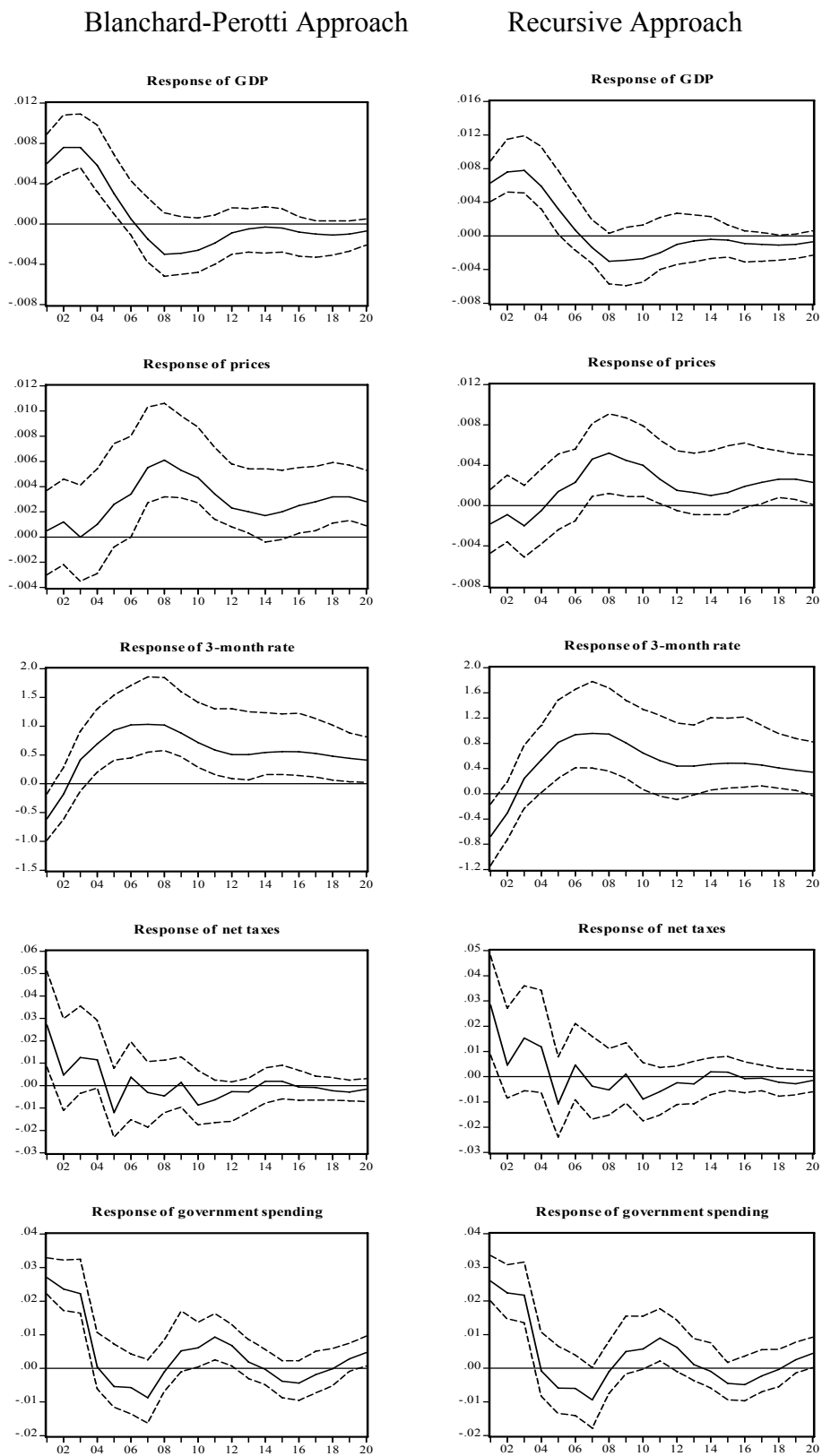**Figure 3. Responses to an increase in government spending (Baseline Model)**

Blanchard-Perotti Approach   Recursive Approach

Figure 4. Responses to an increase in net taxes (Baseline Model)

Blanchard-Perotti Approach   Recursive Approach
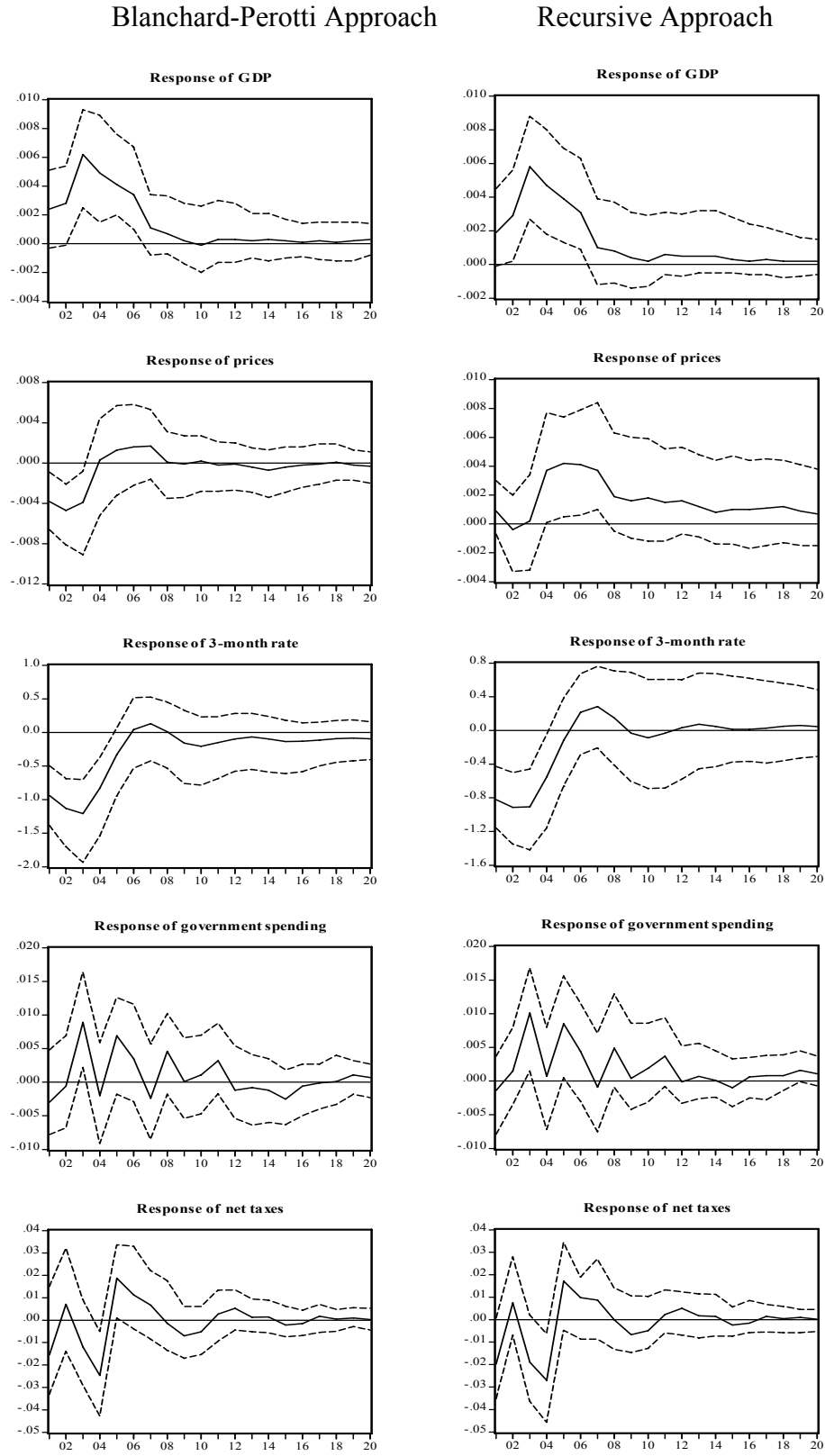
Figure 5. Responses to an increase in government spending/*

Response of private consumption

Response of private investment
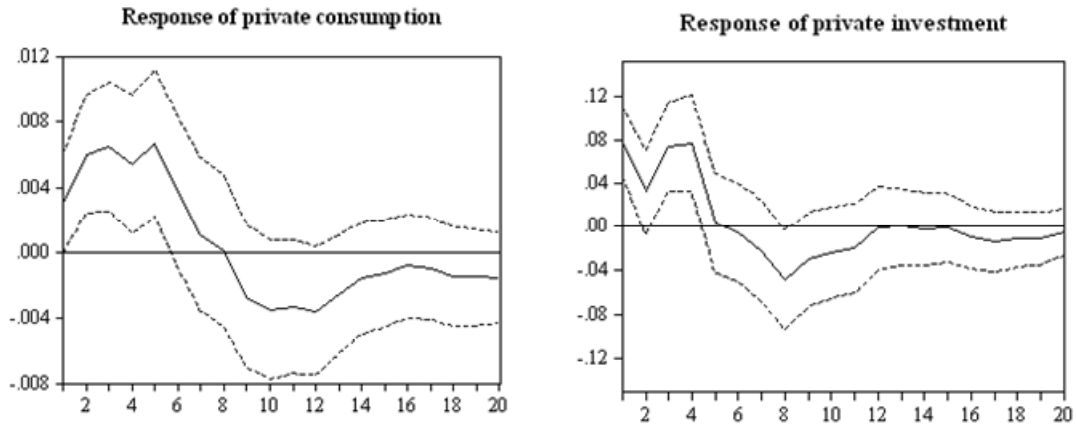
Figure 6. Responses to an increase in net taxes/*

Response of private consumption

Response of private investment

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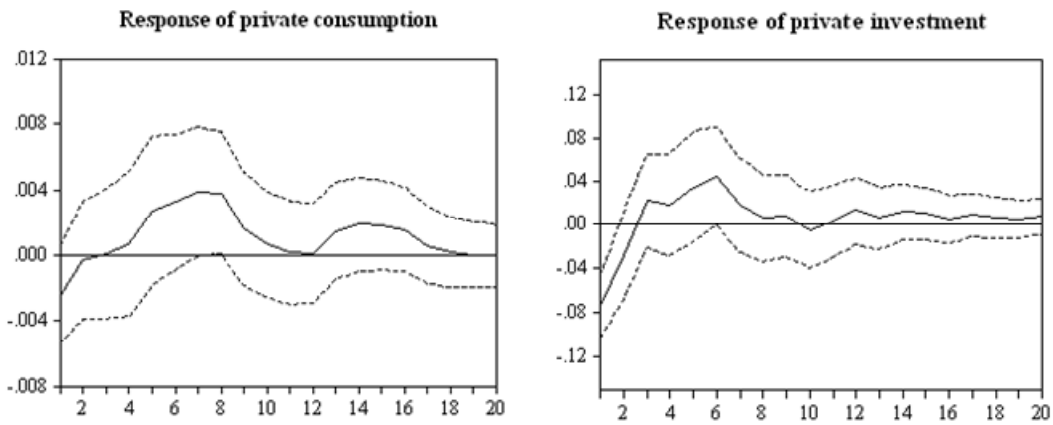
* / Using the Blanchard and Perotti identification approach

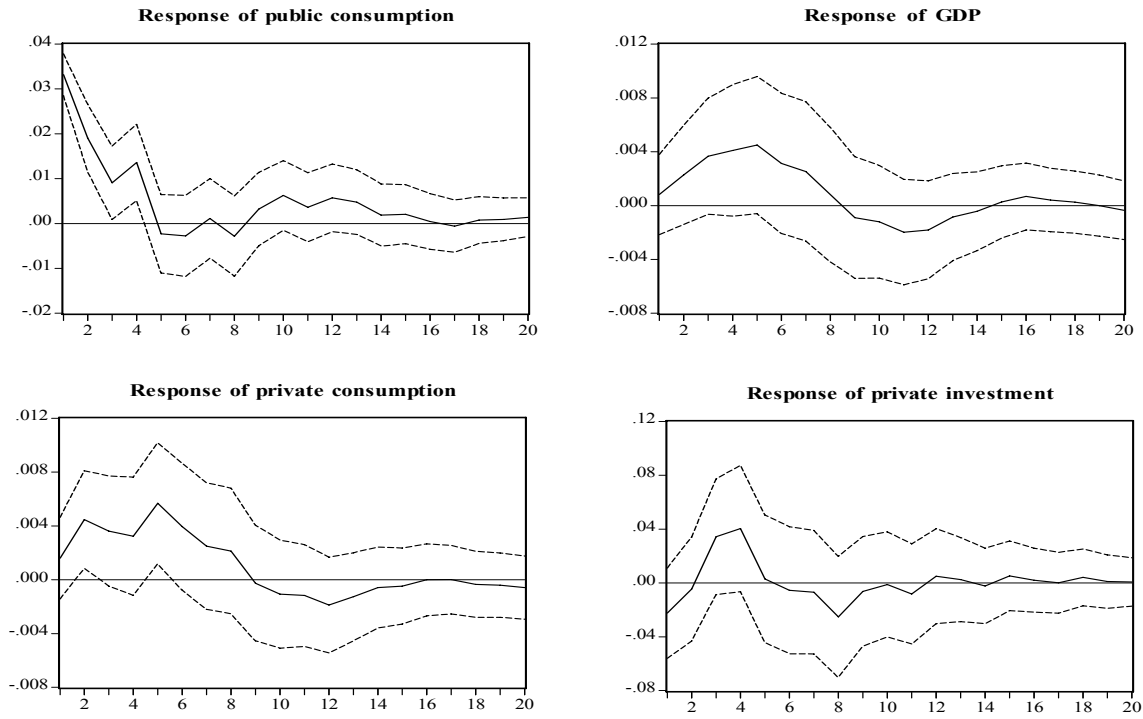## Figure 7. Responses to an increase of public consumption

Response of public consumption

Response of GDP

Response of private consumption

Response of private investment

Figure 8. Responses to an increase in public investment

Response of public investment

Response of GDP

Response of private consumption

Response of private investment

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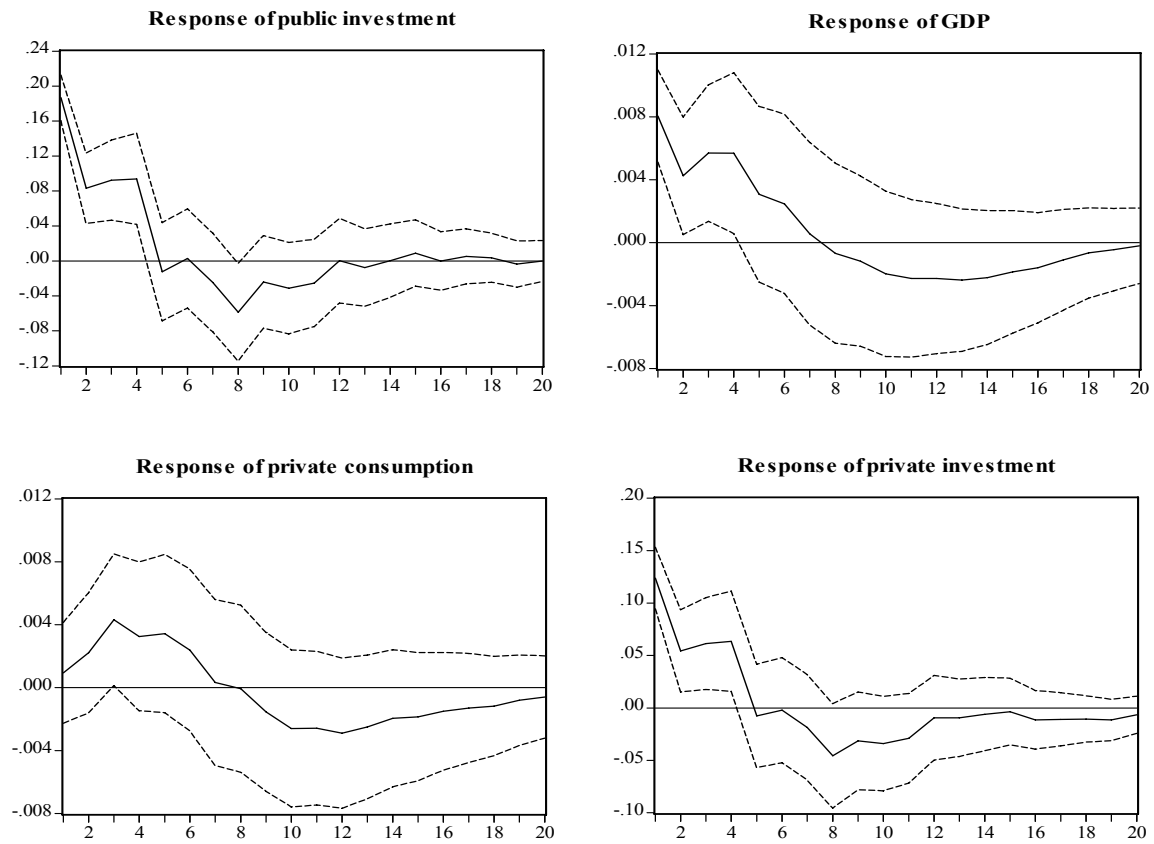
Figure 9. Responses to an increase in indirect taxes

Response of indirect taxes

Response of GDP

Response of private consumption

Response of private investment

Response of 3-month rate
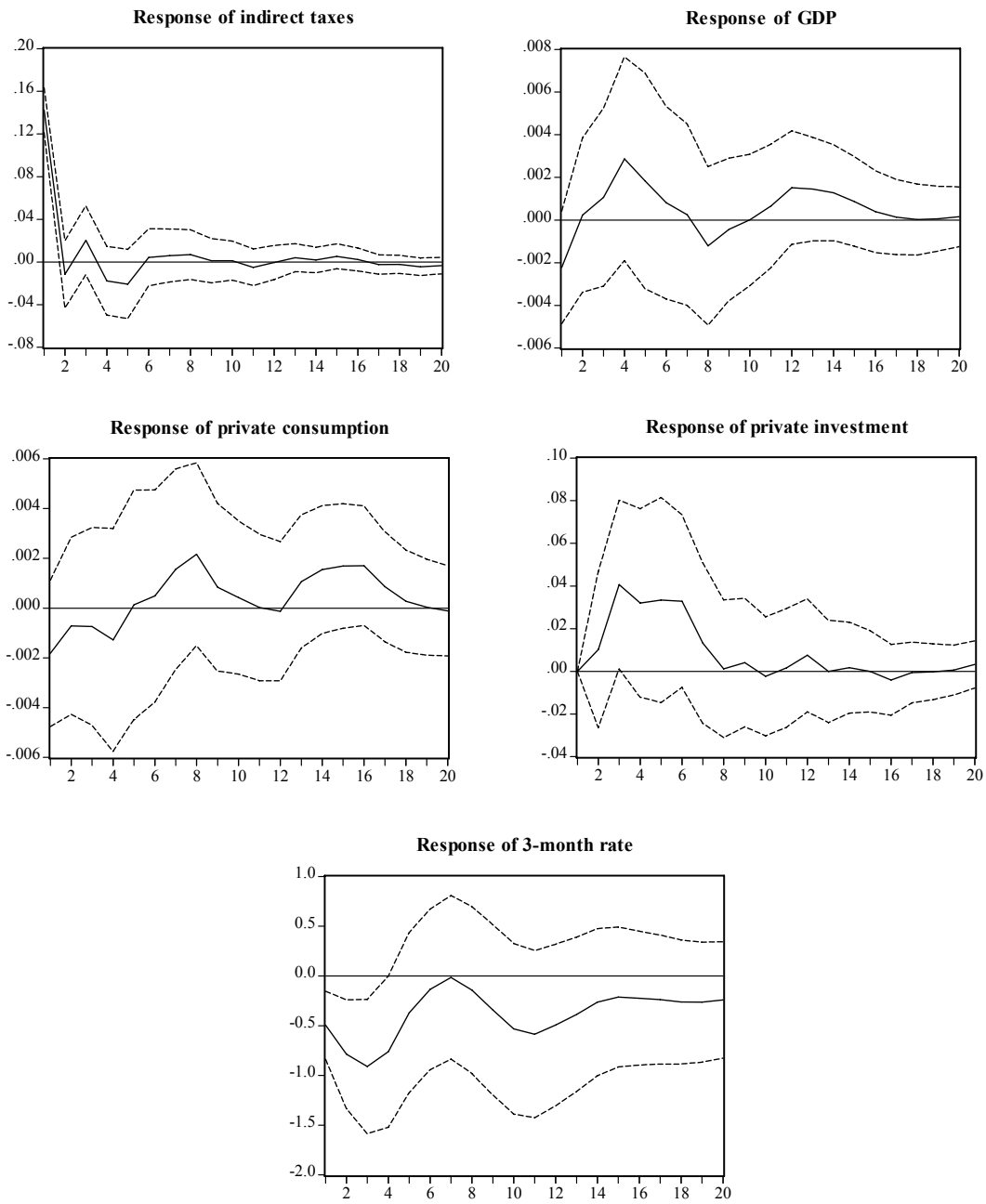
Figure 10. Responses to an increase in direct taxes

Response of direct taxes

Response of GDP

Response of private consumption

Response of private investment

Response of 3-month rate
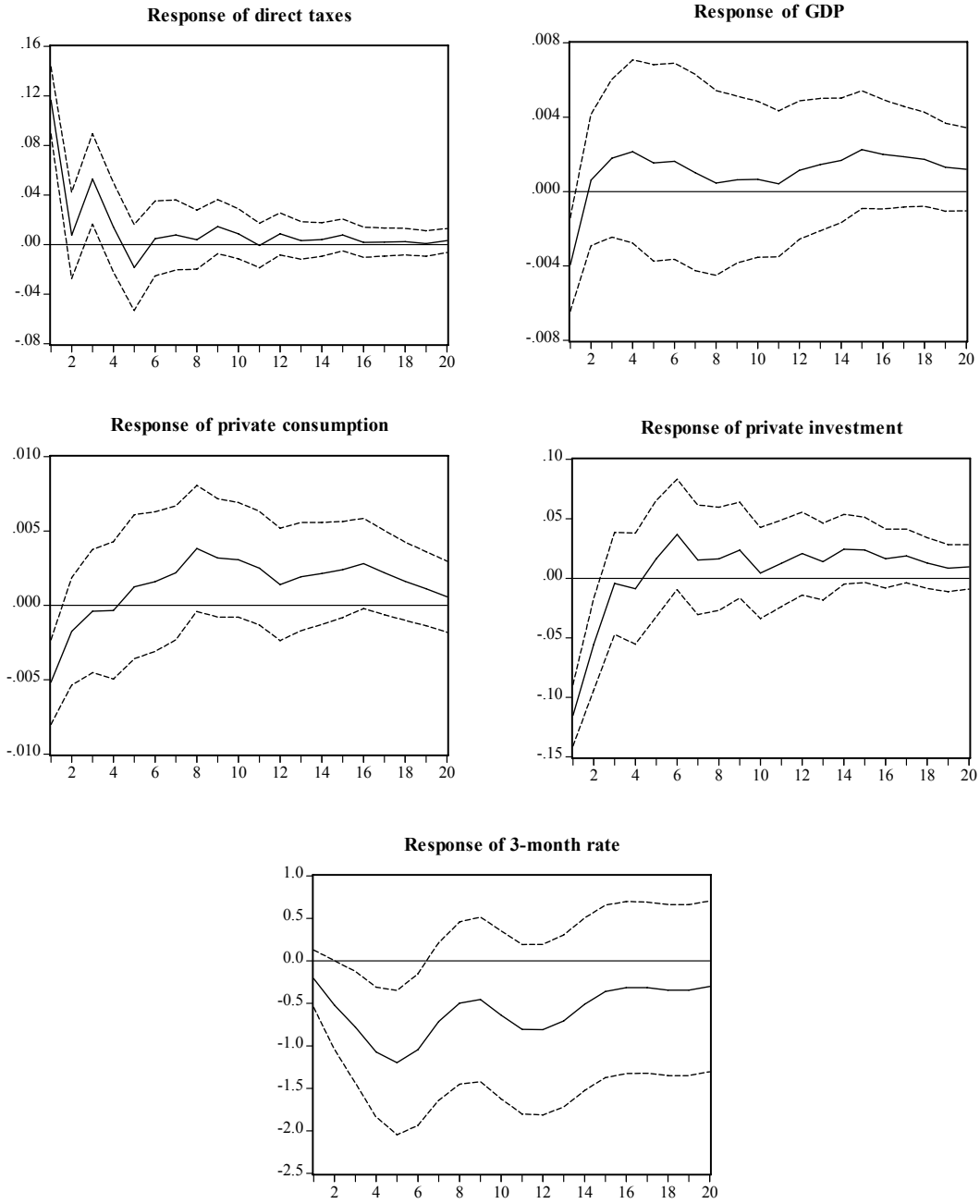
Figure 11. Response of unemployment rate to a government spending shock

Response of government spending

Response of GDP

Response of unemployment rate

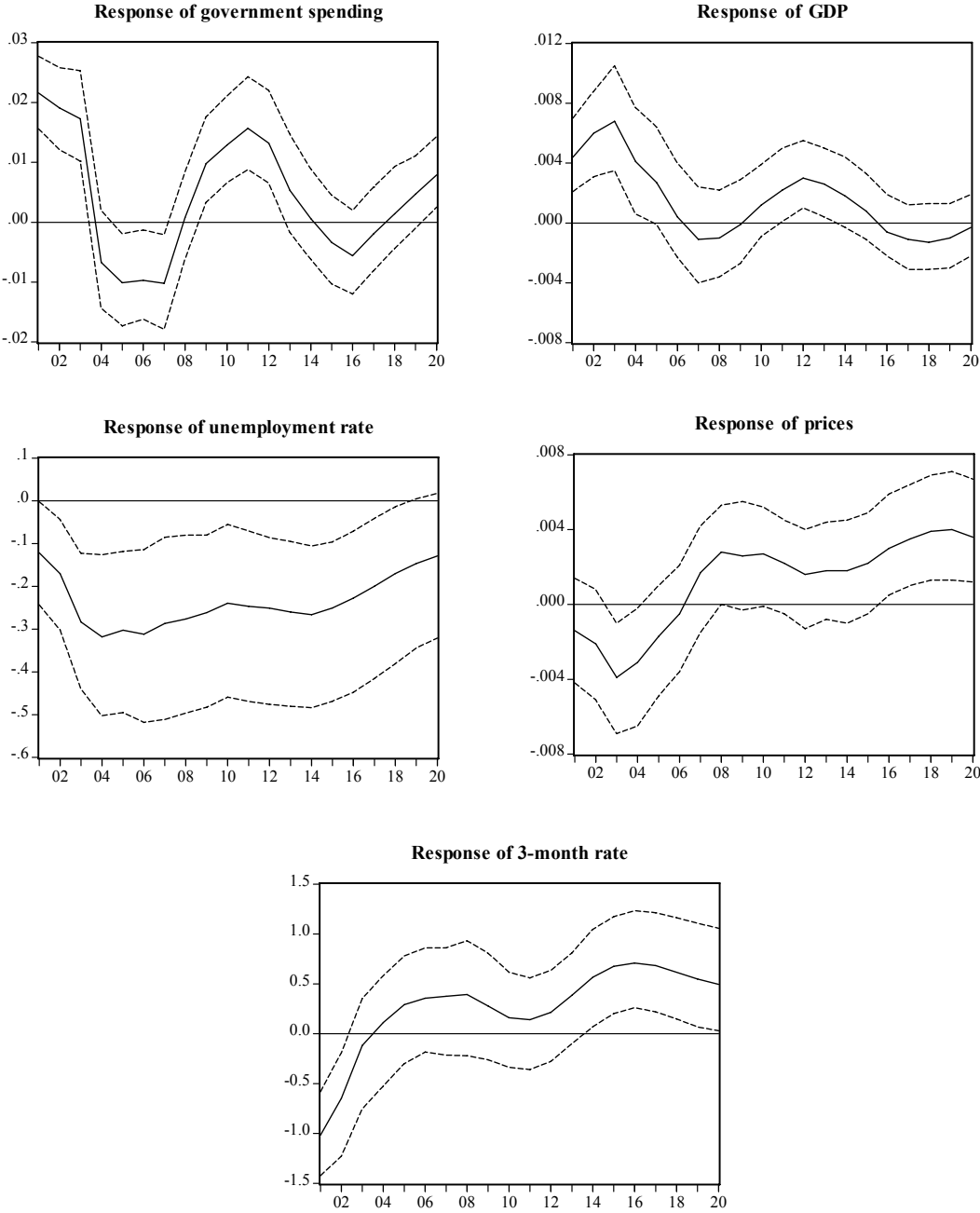**Response of prices**

Response of 3-month rate

Figure 12. Response of real minimum wage to a government spending shock

Response of government spending

Response of GDP

Response of real wage

Response of prices

Response of 3-month rate