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# SUPPLY SHOCKS IN THE TRANSITION TOWARDS AN INFLATION TARGETING REFORM: AN EMPIRICAL EVIDENCE FOR GUATEMALA

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## Resumen

Los efectos de un shock de oferta, tal como el actual shock petrolero, son analizados en base a un modelo semi-estructural calibrado para la economía de Guatemala. Se propone en el documento que un incremento en los precios del petróleo a nivel mundial afecta los precios domésticos a través de un canal directo y de un canal indirecto. El primero se produce por medio de la importación directa de productos derivados del petróleo, cuyo precio se incrementa, mientras que el segundo se produce por medio de la importación de bienes, en cuyo proceso productivo, se empleó algún derivado de dicho producto y como consecuencia su costo de producción también registró un alza. Adicionalmente, se analizan y comparan tres posibles escenarios de política monetaria ante el shock de oferta: una política monetaria pasiva; una política monetaria en la cual el banco central tiene metas para el nivel de la producción doméstica; y una política monetaria en la cual el banco central actúa bajo un régimen de metas de inflación. Se concluye que el escenario en el cual el banco central actúa bajo un régimen de metas de inflación, constituye el mejor escenario de política monetaria para contrarrestar los efectos negativos de un shock petrolero. Dicho régimen monetario estará funcionando completamente en Guatemala a partir de 2006.

## Abstract

Supply shock effects comming from high import prices, such as the current oil price shock, are analyzed based on a dynamic semi-structural model calibrated for the Guatemalan economy. It is argued that a worldwide oil price increase affects domestic prices through a direct and an indirect channel. The former derives from the direct import of petroleum related products, which become more expensive, while the latter channel derives from the import of commodities whose production costs involve expenditures on any petroleum derivative product. In addition, three different central bank monetary policy responses to the oil shock namely a passive position, an output targeting policy, and inflation targeting are simulated and their results are compared. It is concluded that an inflation targeting regime, which is expected to be fully functioning in Guatemala by 2006 would be a better monetary policy response to contrarrest the negative effects of an oil shock, rather than the output targeting policy that is currently being undertaken.

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Document presented at the First Monetary Policy Research Workshop in Latin America and the Caribbean on Monetary Policy Response to Supply and Asset Price Shocks, Santiago, Chile, November 17-18,2005. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Central Bank of Guatemala's Executive Board or any other member of its staff.
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# 1 Introduction

The recent geopolitical conflicts in Afganistan and Irak, the increasing oil demand from China, and the price effect of Katrina, among others, are triggering a new oil price shock, making the price of petroleoum derivatives to attain their highest historical levels, and raising production costs worldwide.[1] For a small oil-importer open economy, this new supply shock might affect domestic prices through two main channels. The first channel is through the direct imports of oil and its derivatives, such as diesel, gasoline, and gas, which become more expensive. The second channel (also called the second round effects of an oil shock) is through the import of commodities whose production costs have risen due to the higher price of oil or any of its derivatives. Although the indirect effect might not occur given that firms could absorve the production price increase so that their products can remain competitive in the international market, it is quite likely that it occurs given that most manufacturing companies around the world are being affected by the same oil shock. According to Roubini (2004) an oil shock can affect domestic prices, and the intensity of such an effect will depend on the size of the shock, the shock's persistence, a country's elasticity of demand for oil, and a country's degree of commercial openess. Without any central bank intervention, the more inelastic a country's demand for oil, the higher the impact, while the higher a country's openess to trade, the higher the ratio of imports to GDP, and the higher the impact of the oil shock in the economy.

In the event of such a shock, a central bank might choose to remain passive, and share the costs of the shock between higher inflation and lower output. However, if it reacts to the shock it has to decide whether to execute monetary policy actions to lower inflation at the cost of a short run fall in output, or to maintain the current output growth trend at the cost of higher inflation. Central banks that use inflation targeting as their monetary policy framework, will tend to bias their policy decision towards the first option, while central banks with large preferences towards output smoothing will tend to bias their policy decision towards the second option.

Guatemala is a small open economy, which is currently at the doors of embarking on a fully fledged inflation targeting regime as framework for its monetary policy. But despìte all institutional and operational reforms that the central bank has made since 2001 in order to confront the challenges imposed by the new monetary policy regime, the current oil price shock has contributed to reveal the existence of strong central bank preferences for output smoothing.[2] As a result, the monetary policy actions performed so far have endangered the acomplishment of the inflation target established for the present and the upcomming year. Based on these circumstances, a semi-structural dynamic macroeconomic model is used to determine the time paths for inflation and output

[1] See Sorkhabi(2005).

[2] The loosen monetary and fiscal policies pursued by the U.S. in the past years have produced an inflow of capitals into Guatemala, generating a currency appreciation, which is also a concern for the central bank, given its impact in exports and output.

that Guatemala would have if its monetary authority were already an inflation targeter, and such results are compared with the current output targeting policy and a passive central bank response. It is found that an inflation targeting regime is superior than the other two options. Even though the loss in output would be slightly above than the loss in output derived from a passive position or from an output targeting policy, the inflation rate would have remained at its target during the whole time, generating more credibility for the central bank monetary policy actions and a more efficient resource allocation derived from efficient decisionmaking.

The remaining of this document is divided as follows: Section 2 illustrates the static theoretical effects of a supply shock under output an inflation targeting; Section 3 deals with some stylized facts of the Guatemalan economy; Section 4 describes the macroeconomic model used to obtain the simulation results; Section 5 indicates the simulations and the results obtained; and finally, Section 6 concludes.

# 2 A Supply Shock under Output and Inflation Targeting

Following Romer (2000), the economic effects of a supply shock are illustrated in Figure 1. Suppose an economy that is initially in steady state. Aggregate demand and aggregate supply are in equilibrium at point A, where the central bank meets its inflation target, and the economy achieves 's its potential output (output gap is zero). A supply shock (such as an oil price shock) causes a temporary shift in the aggregate supply from AS to AS', and ti shifts the overall equilibrium from A to B, under a higher inflation rate, $\pi'$, and a lower level of output, $y'$. Notice that such a shift already includes both the direct and indirect supply shock effects on domestic inflation mentioned earlier. As a response to the supply shock, a central bank would try to adjust its policy actions to affect aggregate demand. At this respect, it faces several possibilities. In the first place, an output targeting central bank might decide to loose its monetary policy to expand aggregate demand in order to leave output at its potential level. Such a case is illustrated by a shift in aggregate demand from AD to AD', where the new short run equilibrium is at C. On the other hand, an expansion of aggregate demand in the event of such a shock is an unlikely outcome for an inflation targeting central bank, since such a policy would generate even more inflation, $\pi''$, which is costly in terms of credibility. Therefore, an inflation targeter central bank will try to obtain a combination of output and inflation that lies within the shadowed triangle in Figure 1. Since the supply shock is a temporary shock, it might decide to act pasively, without modifying its previous monetary policy, and then just sit and wait until the supply curve shifts back to its original position. This kind of policy would make it miss the inflation target in the short run, but achieve it once again in the medium to long run. On the other hand, it might decide to pursue an activist role, and shift its monetary

policy interest rate up to a point where inflation reach again its target in the short run. In such a case, aggregate demand will shift to AD" where the new short run equilibrium will be at D. At this new equilibrium the inflation rate will reach its target, but output will fall by even more from its potential level. Central bank credibility will be fostered, at the cost of a higher sacrifice ratio.

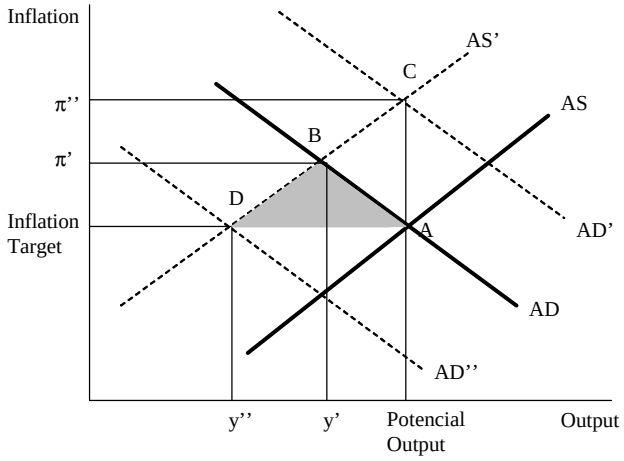


Figure 1. Aggregate Supply Shock under Inflation Targeting

It is clear from such figure that in the event of a supply shock, an inflation targeting central bank will face a loss in output in the short run, and the extent of such a loss will depend on how strictly the bank is about accomplishing its inflation objective. A strict central bank that wants inflation to remain on target all the time will rise its monetary policy interest rate to reduce inflation within two quarters. A more flexible central bank might decide to rise its monetary policy so that inflation will be again on target within six or eight quarters. The latter kind of policy is pursued by most inflation targeting central banks, as pointed out by Svenson (1997). The macroeconomic model described in Section 4 assumes that the Central Bank of Guatemala will adopt a flexible inflation targeting policy, so that under the event of a supply shock, inflation is expected to return to target after six quarters after the shock.

# 3 Stylized facts of the Guatemalan Economy

The following three subsections deal with some empirical facts of the Guatemalan economy. The first subsection refers to recent developments in the main macroeconomic variables (domestic inflation, output gap, interest rates and the exchange rate); in the second subsection the impact of petrolum derivatives on the Guatemalan inflation is analyzed in order to determine the source and extent of the direct effect of the oil shock on inflation; finally, the third subsection

deals with the current impact of foreign prices on domectic inflation, that is, the indirect oil shock channel.

## 3.1 Recent Developments

Guatemala is a small developing open economy, which is in the process of implementing inflation targeting as a framework for monetary policy. Figure 2 illustrates inflation, real output gap, the monetary policy interest rate and the exchange rate from 2001 to June 2005. The inflation rate corresponds to the seasonally adjusted, annual change in the consumer price index computed by the guatemalan statistical institute (INE).[3] The Central Bank of Guatemala has established an annual inflation target since 1991, and it is currently set in the range of 4 to 6 percentage. As illustrated in Figure 2a, such a target has been accomplished most of the time, but due to the monetary authority concern over output and exchange rate fluctuations, there are some periods in which the inflation target has been missed. Indeed, this is the current situation, since the price increase of petroleum derivatives has contributed to increase domestic inflation, while the monetary authority has reduced its monetary policy interest rate in order to avoid hindering the actual economic recovery, and to avoid a further exchange rate appreciation (see Figures 2c and 2d). Indeed, by the second quarter of 2005, inflation was 2.5 basic points above its central target (5 percent).

The output gap is the percentage deviation of observed production from its potential output. Observed production is computed by the seasonally adjusted index of economic activity, computed by the central bank of Guatemala, while potential output is obtained through a Hoddrick-Presscot filter of the former variable. As depicted in Figure 2b, Guatemala is currently comming out from a long recesion period that started in the third quarter of 2001, and the economic recovery has been influenced mainly by the US economic growth. As mentioned earlier, the increase in oil prices has barely affected such an output growth, given that the monetary authority has avoided to disrupt the output growth's positive dynamics.

[3] The seasonal method employed for all variables analyzed in this document is the X-12 Arima.

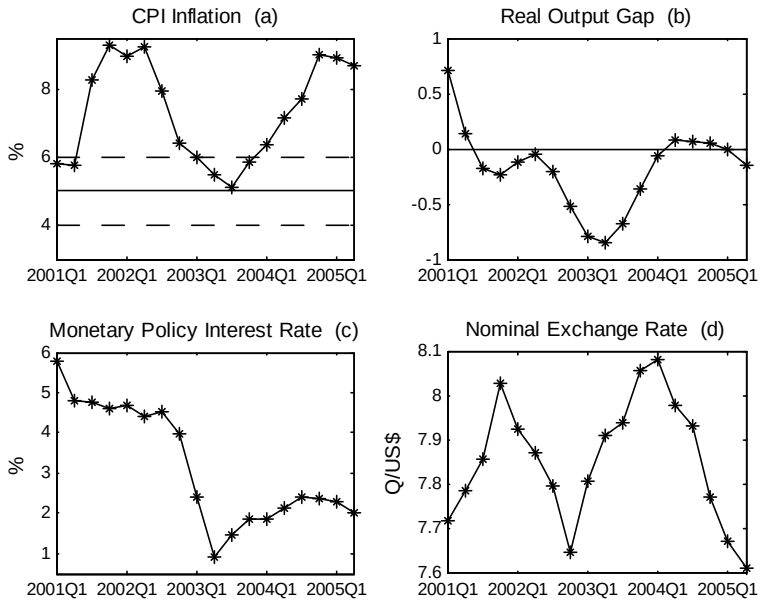


Figure 2. Stylized Facts of the Guatemalan Economy

The monetary policy interest rate corresponds to the short run annualized interest rate in repurchase agrement operations (REPO-7).[4] As illustrated in Figure 2, the REPO-7 rate has shown a decreasing trend since the fourth quarter of 2004, when the rise in oil prices were first experienced in Guatemala.

Guatemala has a flexible exchange system, where the central bank is supposed to intervene just to avoid sharp volatility in the foreign exchange market. However, the recent exchange rate appreciation period, illustrated in Figure 2d, has been a concern for the central bank given its effect in net exports and output. In fact, the monetary authority has intervened in the foreign exchange market to avoid a sharp appreciation in the domestic currency, further contributing to expand domestic aggregate demand and hence, domestic inflation.

[4] Although the central bank's official monetary policy interest rate is the rate in deposit certificates issued by the central bank at 7 day of maturity (CDP-7), the REPO-7 rate is used as the short run monetary policy rate because the trend behavior of CDP-7 has sometimes conflicted with the behavior of interest rates for CDPs issued at different maturities. This has been the case because the CDP-7 rate is not a market rate, but it is imposed by the monetary authority, while interest rates in CDPs at longer maturities are determined by the market. On the other hand, the REPO-7 is determined by market forces, it follows the CDP-7 trend, and it is also affected by the excess liquidity generated by the central bank intervention in the foreign exchange market. Therefore, it is considered to be a better indicator of the monetary policy stance.

## 3.2 Oil Prices and Domestic Inflation

Oil itself is not imported into the country since there are no major petroleoum refineries in the country. Nevertheless, there are significant imports of diesel, gasoline, bunker, and gas, which are used either in the production process as intermediate commodities, or for transportation purposes. Table 1 shows the proportion of such commodities in total imports. It can be observed that imports of diesel and gasoline are the most significant. Therefore, it is expected that their price variation be reflected in domestic production costs, and hence, in domestic inflation.

| *Commodity* | 2001 | 2002 | 2003 | 2004 | 2005* |
|---|---|---|---|---|---|
| Diesel | 32.7 | 31.3 | 33.4 | 35.6 | 35.7 |
| Gasoline | 33.3 | 32.1 | 30.2 | 34.0 | 30.7 |
| Gas | 11.1 | 8.9 | 10.0 | 10.4 | 11.6 |
| Bunker | 8.7 | 12.8 | 14.2 | 10.2 | 11.7 |
| Others | 14.2 | 14.9 | 12.2 | 9.9 | 10.2 |

* Information at June 2005

Table 1. Imports of Petroleoum Derivatives as a proportion of Total Fuel Imports

Table 2 shows the contemporary and one-period-lagged cross correlations between the Guatemalan inflation, and the price variation in gasoline, diesel, gas and petroleum. As it can be observed, the contemporary cross correlations between domestic inflation and the prices of petroleum products are low. Indeed, those between inflation and the contemporaneous price variation of gas and petroleum are negative. Nevertheless, the cross correlations between current inflation and the first lag of the petroleum derivatives' price variations are higher. This means that the price increase in such commodities affects domestic inflation with a one period lag. In addition, it appears that diesel price variations are the most important in explaining domestic price fluctuations. Such a result was expected since Diesel is the petroleum derivative mostly imported to the country, as it was shown in Table 1.

| CPI-inflation | Gasoline Premium | Gasoline Regular | Diesel | Gas | Petroleum |
|---|---|---|---|---|---|
| Current Period | 0.08 | 0.07 | 0.07 | -0.03 | -0.07 |
| One-period Lag | 0.11 | 0.13 | 0.22 | 0.15 | 0.20 |

Table 2. Cross Correlations between Inflation and the Price variation of Petroleum and its Derivatives

Therefore, a shock to diesel prices will be interpreted, in the macroeconomic model described in Section 4, as a supply shock to the Guatemalan economy. Now, the extent of such a shock can be determined by analyzing the recent deviation of diesel prices from its long run trend. Figure 3a illustrates the evolution of diesel prices from 2001 to June 2005 on quarterly form. It can

be observed that the current increase in such prices began in the fourt quarter of 2004, so that by the second quarter of 2005, the diesel price is about thirty cents above its trending price.

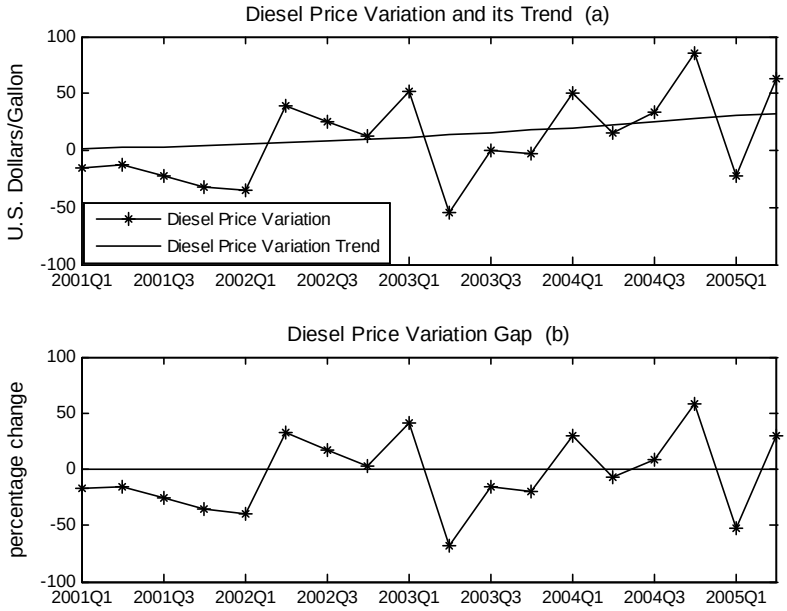


Figure 3. Guatemala: Annualized Diesel Price Variation (2001Q1 - 2005Q2)

Figure 3b depicts the quarterly diesel price variation gap (DPG). According to such figure, the DPG is about two standard deviations above from its long run trend. Hence, in the simulation exercises performed in Section 5, the supply shock can be made equivalent to two standard deviations.

## 3.3 Foreign and Domestic Prices

The fluctuation observed in domestic prices through time is not only generated by local factors. Depending on the degree of openess of a given economy, its price level variation is quite related to foreign inflation. At this respect panel (a) of Table 3 depicts imports, exports and the GDP of Guatemala and its main trading partners. The information is reported in billions of US Dollars of 2003. From such data the degree of openess, $m$, for each country was computed as the ratio of total trade (exports plus imports) to GDP. There are two aspects that are important to remark. First, the degree of openess of the industrial countries depicted in the table is lower than the degree of openess of the developing countries of Central America and México.[5] Therefore, the domestic

[5] The degree of openess, $m$, for Guatemala, Mexico, El Salvador, Costa Rica, and Honduras averages 60.1, while that for the U.S., Japan, and the Euro Area averages 21.2.

rates of inflation in the developing nations depicted in Table 3 are more prone to be influenced by foreign inflation than their industrial nations' counterparts. Second, Guatemala is less open to trade than its developing commercial parters, since its degree of openess, 37.3, is the lowest among Mexico (54.9), El Salvador (57.5), Costa Rica (76.7), and Honduras (74.1). Therefore, Guatemalan prices are expected to be less influenced by foreign price fluctuations than those in Mexico and the rest of Central American countries.

| | Guatemala | The US | Mexico | El Salvador | Costa Rica | Honduras | Japan | Euro Area |
|---|---|---|---|---|---|---|---|---|
| | a. Degree of Commercial Openess (m) for Guatemala and its main trading partners | | | | | | | |
| Total Imports FOB (M) /1 | 6.2 | 1,260.7 | 170.5 | 5.4 | 7.3 | 3.1 | 342.7 | 1,056.9 |
| Total Exports FOB (X) /2 | 3.0 | 716.4 | 164.9 | 3.2 | 6.1 | 2.1 | 449.1 | 1,176.6 |
| GDP (Y) /3 | 24.7 | 11,004.1 | 610.6 | 14.9 | 17.5 | 6.9 | 4,294.2 | 8,189.2 |
| Degree of Openess (m) | 37.3 | 18.0 | 54.9 | 57.5 | 76.7 | 74.1 | 18.4 | 27.3 |
| | b. Proportion of Guatemalan Imports per Country of Origin (r) | | | | | | | |
| $r_{2004}$ | | 33.7 | 8.1 | 3.5 | 2.5 | 1.0 | 4.4 | 6.2 |
| $r_{2005}$ /4 | | 39.0 | 7.4 | 5.0 | 3.3 | 1.5 | 2.7 | 6.3 |

Note: $r = (M_i^{GUA}/M_{TOT}^{GUA})*100$

where: $M_i^{GUA}$ corresponds to Guatemalan imports from Country i; where i: trading partner refered to each column in the table

$M_{TOT}^{GUA}$ corresponds to total Guatemalan imports

$m = ( (M + X) / Y ) *100$

/1, /2, /3: Billions of US Dollars in 2003

/4: Value obtained with Information up to May 2005

Source: Central Bank of Guatemala and International Financial Statistics, IMF

Table 3. Commercial Statistics of Guatemala and its main trading partners

Panel (b) of Table 3 describes the proportion of Guatemalan imports from each of its main trading partners. As it can be observed, the US is by far the Guatemala's most important trading parter, followed by the combined Central American region (9.8 percen of total imports in 2005), and Mexico. The Euro Area and Japan are also important trading parters, although in lower proportions. Combined imports from all countries listed above represent about 60 percent of total Guatemalan imports. Therefore, it is expected that the American and the Mexican price fluctuations should have, if any, more influence in Guatemalan prices that the rest of Guatemalan main trading parterns. The crosscorrelations between domestic and foreign inflation rates are depicted in Table 4. Each inflation rate is computed as the annualized quarterly variation in the headline CPI of each country.[6] The first row indicates the contemporaneous cross correlations, while the second row depicts the cross correlation between current Guatemalan inflation and foreign inflation lagged one period. The last row of such a table indicates the two-period average cross correlation for each country depicted in the table.

[6] In the case of the U.S. the core CPI index was used instead of the headline CPI index, since the inflation computed from the former one is more related to Guatemalan inflation. This situation arises because the core index excludes price fluctuations in vegetables, fruits, and oil products, which are not exported to Guatemala, so their impact are not directly reflected in Guatemalan inflation.

| Guatemalan-inflation | The US | Mexico | El Salvador | Costa Rica | Honduras | Japan | European Union |
|---|---|---|---|---|---|---|---|
| Current Period | 0.63 | 0.16 | 0.37 | 0.01 | 0.24 | 0.15 | 0.00 |
| One-period Lag | 0.30 | 0.14 | 0.21 | 0.36 | 0.38 | -0.19 | 0.34 |
| Average | 0.47 | 0.15 | 0.29 | 0.19 | 0.31 | -0.02 | 0.17 |

Table 4. Cross Correlations between the Guatemalan Inflation and the Inflation of its main trading partners

As expected, the correlation between the Guatemalan and the US inflation rate is very high, since the U.S. is the Guatemalan most important trading partner. Tndeed, the Guatemalan inflation also appears to be highly related to price fluctuations in El Salvador. In this case, Guatemalan prices are also affecting prices from El Salvador given the high volume of Guatemalan exports of vegetables and fruits to such country. In addition, such a high correlation shows evidence of common demand patterns, labor supply homogeneity, and similar wage contract agreements between both countries.

As a result from such evidence, it is assumed in this document that a foreign inflation shock to Guatemalan prices will be manifested by a shock to the U.S. core inflation rate. However, it is important to determine whether such a shock is currently taken place, and if so, to what extent. Figure 4(a) shows the behavior of inflation in the U.S. and its trend from 2001 to 2005 in quarterly form. It is clear from the picture that the inflation rate in such a country is currently above its trend.

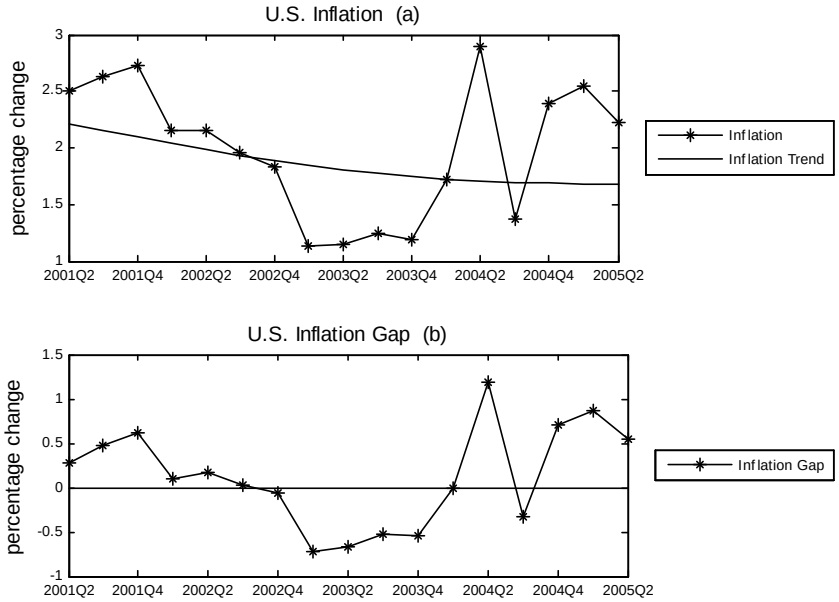


Figure 4. U.S. Inflation 2001-2005

Figure 4(b) depicts the U.S. inflation gap. As observed, prices seem to have experienced a sudden shock in the second and fourth quarters of 2004, the latter shock about the same time than oil prices began to increase, and since then inflation has not returned to its trend value. Therefore, US inflation is about one standard deviation above its long run level. Therefore, in Section 5, the current behavior in the U.S. inflation will be taken as evidence to simulate the existence of an indirect channel through which the oil price shock is being reflected in Guatemalan inflation.

# 4 Macroeconomic Model and Calibration

This section is subdivided into two subsections. The first one comprises the mathematical description of the macroeconomic model used to emulate the Guatemalan economy, while the second section contains the description of the parameter estimation and calibration procedures.

## 4.1 The Macroeconomic Model

The macroeconomic model used to analyze the supply shock effects is a dynamic semi-estructural macroeconomic model that follows the spirit of the modeles depicted by Rotemberg and Woodford (1998), Clarida, Galí and Gertler (1999), and Christiano and Eichenbaum (2005). Such a model is composed of six

behavioral equations: i) an aggregate demand; ii) an aggregate supply (phillips curve); iii) an imported price inflation equation; iv) a monetary policy rule; v) an uncovered interest rate parity; and vi) the fisher equation. In addition, inflation and exchange rate expectations are explicitly defined along with the law of motion for exogenous variables and some additional definitions. Such equations are the following:

**Aggregate Demand**

$$y_t^{gap} = A_1 y_{t-1}^{gap} + A_2 R_t^{gap} + A_3 z_t^{gap} + \varepsilon_{1t} \tag{1}$$

Where:

$y_t^{gap}$ : Output gap in period t
$R_t^{gap}$ : Real long term interest rate gap in period t
$z_t^{gap}$ : Real exchange rate gap in period t
$\varepsilon_{1t}$ : Aggregate demand shock in period t

**Aggregate Supply (Phillips Curve)**

$$\pi_t = B_1 \left( \frac{1}{2}(\pi_{t-1} + \pi_{t+1}^e) + B_2 y_t \right) + (1 - B_1) \left( \pi_t^M + vz_t^{tnd} \right) + \varepsilon_{2t} \tag{2}$$

Where:

$\pi_t$ : Inflation rate in period t
$\pi_{t+1}^e$ : Expected inflation in period t+1
$\pi_t^M$ : Imported price inflation in period t
$vz_t^{tnd}$ : Variation of the real exchange rate trend in period t
$\varepsilon_{2t}$ : Aggregate supply shock in period t

In this model the imported price inflation is explicitly defined through the following equation:

$$\pi_t^M = C_1 \pi_{t-1}^M + (1 - C_1)(\pi_t^* + \pi_t^{pet} + vs_t) + \varepsilon_{3t} \tag{3}$$

Where:

$\pi_t^*$ : External Inflation in period t
$\pi_t^{pet}$ : Petroleoum price variation in period t
$vs_t$ : Nominal exchange rate variation in period t
$\varepsilon_{3t}$ : Imported price inflation shock in period t

**Monetary Policy Rule**

$$i_t = D_1 i_{t-1} + (1 - D_1) \left( i_t^{tnd} + D_2(\pi_{t+6} - \overline{\pi}_{t+6}) + D_3 y_{t+6} \right) + \varepsilon_{4t} \tag{4}$$

Where:

$i_t$ : Short run monetary policy rate in period t
$i_t^{tnd}$ : Short run monetary policy rate trend in period t
$\overline{\pi}_{t+6}$ : Inflation target in period t+6
$\varepsilon_{4t}$ : monetary policy shock in period t

**Uncovered Interest Rate Parity**

$$I_t - I_t^* = (s_{t+1}^e - s_t) + \rho_t + \varepsilon_{5t} \tag{5}$$

Where:

$I_t$ : Long run nominal interest rate in period t
$I_t^*$ : Long run nominal interest rate in period t
$s_t$ : Nominal exchange rate in period t
$s_{t+1}^e$ : Expected nominal exchange rate in period t+1
$\rho_t$ : Country risk in period t
$\varepsilon_{5t}$ : Foreign exchange market shock in period t

**Fisher Equation**

$$R_t = I_t - \pi_{t+6}^e \tag{6}$$

Where:

$R_t$ : Real long run interest rate in period t

**Law of Motion for Exogenous variables**

$$\pi_t^{pet} = T_1 \pi_{t-1}^{pet} + \varepsilon_{6t} \tag{7}$$

$$\pi_t^* = T_2 \pi_{t-1}^* + (1 - T_2)\pi_{ss}^* + \varepsilon_{7t} \tag{8}$$

$$i_t^* = T_3 i_{t-1}^* + (1 - T_3) i_{ss}^* + \varepsilon_{8t} \tag{9}$$

Where:

$\varepsilon_{6t}$ : Petroleoum Price shock in period t
$\varepsilon_{7t}$ : Foreign Price shock in period t
$\varepsilon_{8t}$ : Foreign Interest shock in period t

**Expectations**

$$\pi_{t+1}^e = W_1 E_t(\pi_{t+6}) + (1 - W_1)\pi_{t-1} + \varepsilon_{9t} \tag{10}$$

$$s_{t+1}^e = W_2 E_t(s_{t+1}) + (1 - W_2)\left(s_{t-1} + \frac{1}{2}(vz_t^{tnd} - \overline{\pi}_t + \pi_{ss}^*)\right) + \varepsilon_{10t} \tag{11}$$

Where:

$\pi_{ss}^*$ : Steady state value of foreign inflation
$\varepsilon_{9t}$ : Expected inflation shock in period t
$\varepsilon_{10t}$ : Expected nominal exchange rate shock in period t

**Nominal and Real Long Term Interest Rates**

$$I_t = \left[\frac{1}{4}\sum_{i=1}^{4} i_{t+i}\right] + term \tag{12}$$

$$R_t = \left[\frac{1}{4}\sum_{i=1}^{4} r_{t+i}\right] + term \tag{13}$$

Where:

$term$ : Longer term interest premium

## 4.2 Estimation and Calibration of Parameters

In order to establish the parameter values of the model, a group of equations was estimated, while the rest of equations were calibrated. This procedure was done in order to ensure good fit to Guatemalan historical data, and hence, good forecasts, as well as impulse response functions that behave according to economic theory. In fact, the Aggregate Demand and the Phillips Curve equations were estimated using quarterly data for the period 1995Q1 to 2005Q2. Thus, the parameters for such equations were obtained from OLS and GMM estimations, respectively.[7] The remaining parameters were set in a way that impulse response funtions to a permanent reduction in the inflation target were in line with economic theory. Panels (a) and (b) of Table 5 shows both the estimated and the calibrated values for all the model parameters, excluding the ones that correspond to the monetary policy rule.

a. Value of Estimated Parameters

| $A_1$ | $A_2$ | $A_3$ | $B_1$ | $B_2$ | $C_1$ | $T_1$ | $T_2$ | $T_3$ |
|---|---|---|---|---|---|---|---|---|
| 0.65 | -0.30 | 0.40 | 0.75 | 0.90 | 0.30 | 0.92 | 0.90 | 0.90 |

b. Value of Calibrated Parameters

| $A_2$ | $W_1$ | $W_2$ | term |
|---|---|---|---|
| -0.30 | 0.85 | 0.30 | 11.00 |

c. Calibration of Parameters of the Monetary Policy Rule Equation

| Central Bank Preference | $D_1$ | $D_2$ | $D_3$ |
|---|---|---|---|
| Pasive Position | 0.75 | 0.0 | 0.0 |
| Output Targeting | 0.75 | 0.0 | 2.5 |
| Inflation Targeting | 0.75 | 2.5 | 0.0 |

Table 5. Estimated and Calibrated Parameter Values

It is important to mention that the simulation exercises of the following section allow to illustrate different central bank responses to an oil supply shock.

[7] The only exception is made of the parameter $A_2$,whose estimated sign was opposite to the one expected. This result basically obeys to the poor national account statistics that exist in Guatemala. An statistical reform is being undertaken, but it will take about two more years to have a new output series for the Guatemana economy.

In particular, there are three cases being considered. The first case is a pasive response from the monetary authority, a situation that is depicted by point B of Figure 1. The second case is the monetary policy response to an oil shock when the central bank follows an output targeting policy, a situation that is illustrated by point C of Figure 1. Finally, the third case corresponds to the monetary policy response to an oil shock when the central bank follows an inflation targeting policy, which is illustrated by point D in such a figure. Therefore, in order to emulate each of such cases, the calibrated values given to parameters $D_2$ and $D_3$ of the monetary policy rule, expression (4), were modified for each case. Panel (c) of Table 5 shows the calibrated values for such parameters according to each of the central bank monetary policy responses.

# 5 Simulation Experiments

This section contains the description of the economic effects that result from an oil shock to the Guatemalan economy using the macroeconomic model described in the previous section. As mentioned before, It is argued in this document that a worldwilde oil price increase affects domestic prices through a direct and an indirect channel. The former channel derives from the direct import of petroleum related products, which become more expensive. The indirect channel derives from the import of manufactured commodities that use any petroleoum derived product as a raw material in its production process. In the model described in Section 4, the direct channel is represented by a two standard deviation increase in $\varepsilon_{6t}$, expression (7), while the indirect channel is represented by a one standard deviation increase in $\varepsilon_{7t}$, expression (8). Both direct and indirect channels follow an autoregressive path defined by the law of motions represented by the equations just mentioned. The simulations presented in this section include both, a direct and an indirect channel from where the oil shock is being transmitted to the Guatemalan economy, where three different types of policy response from the central bank are modeled: i) a pasive response; ii) a response based on an Output Targeting policy; and, iii) a response based on an Inflation Targeting policy.

## 5.1 Pasive Position

The direct and indirect effects of the diesel price shock are illustrated in panels (a) to (d) of Figure 5. In this case, the central bank remains pasive to such a shock since it mantains unchanged its short run monetary policy rate, as depicted in panel (c) of such a figure. The initial impact of the shock is an increase in import price inflation, which is directly transmitted to domestic prices through the Phillips Curve. As a result, domestic inflation jumps on impact by one percentage point, and it keeps increasing during the following three periods. Then it begins to covenverge to its long run target. Panel (d) illustrates the effect on the real exchange rate gap, which decreases during the period given the higher domestic prices. Such effect is transmitted to the

Aggregate Demand curve, producing a reduction in the output gap following the shock, as it is illustrated in Panel (b). According to this simulation, the cummulative annualized cost in terms of output is equivalent to a reduction in the rate of growth of 1.7 percent below its long run growth trend.

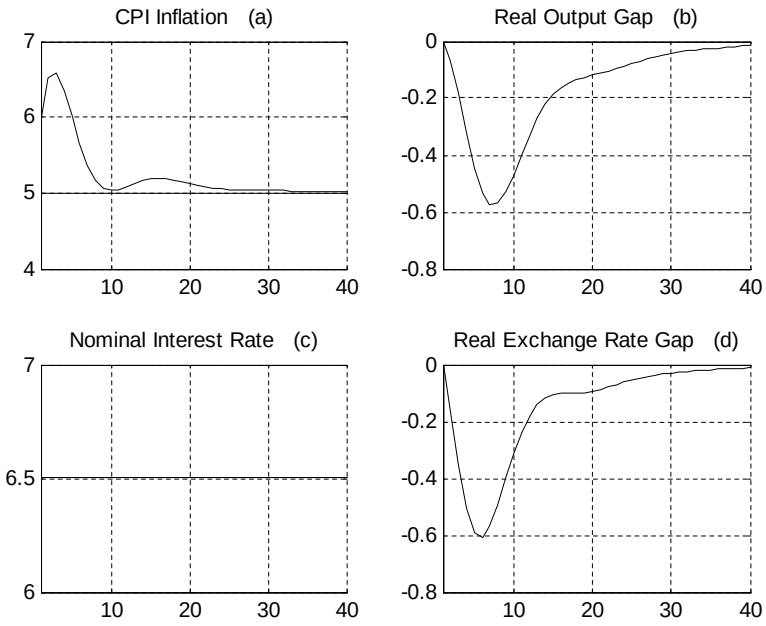


Figure 5. Passive Position

## 5.2 Output Targeting

The monetary poliyc response to the oil shock comming from an output targeting central bank is illustrated in Panel (c) of Figure 6. According to such response, the central bank reduces its monetary policy rate on impact by 25 basic points, and it keeps decreasing it during the following 8 periods in order to avoid a fall in output following the shock. As depicted in Panel (b), such a policy response have a positive short run effect, since output gap is above its trend in the short run. Indeed, such a policy produces an annualized cummulative increase in the rate of growth of output of 0.3 percent above its long run trend during the two years that follow the impact. Nevertheless, such a policy cannot avoid the negative consequenes for output in the long run, since the total annualized cummulative cost of the shock in terms of output is equivalent to a reduction of 1.5 percent in the rate of output growth. Furthermore, such a policy is more costly in terms of inflation, given that the aggregate demand channel provides a further impulse in domestic prices, which in this case increase to 9.8 percent in the fourth quarter following the shock.

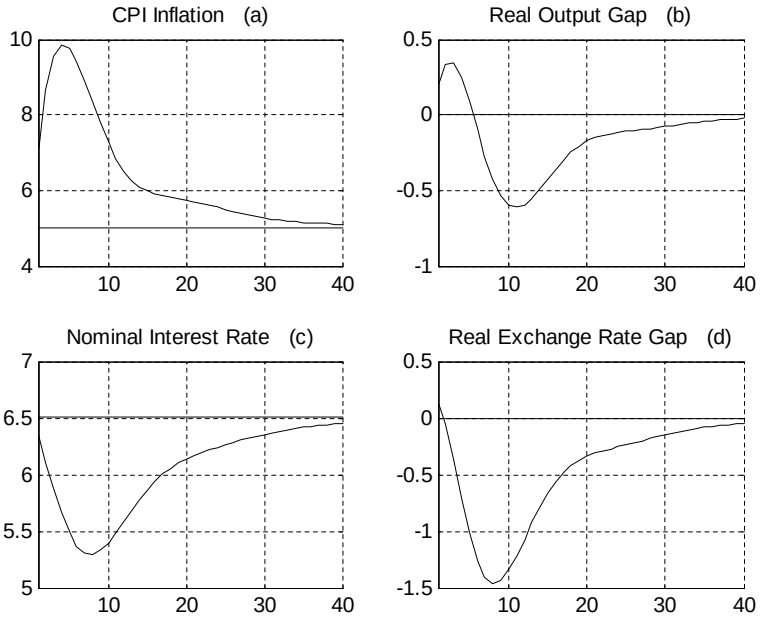


Figure 6. Output Targeting

The simulation illustrated in Figure 6 reflects the current monetary policy stance in Guatemala. As mentioned before, the central bank is planning to move towards an inflation targeting framework in the short run. However, it is currently pursuing an output targeting policy in order to avoid disrupting the current burst in output growth after almost two years of recession. Such a policy has made the central bank to miss its inflation target, and it is expected to produce negative consecuences in the rate of output growth in the long run.

## 5.3 Inflation Targeting

The interest rate response to the oil shock comming from the inflation targeting central bank is illustrated in Panel (c) of Figure 7, which indicates that the central bank increases its monetary policy rate on impact by 25 basic points, and it keeps slightly increasing it during the following four periods. The increase in the monetary policy rate, as well as the fall in the real exchange rate generated by higher domestic prices, produces a reduction in output equivalente to 1.8 percent below its long run trend growth, as depicted in Panel (b).

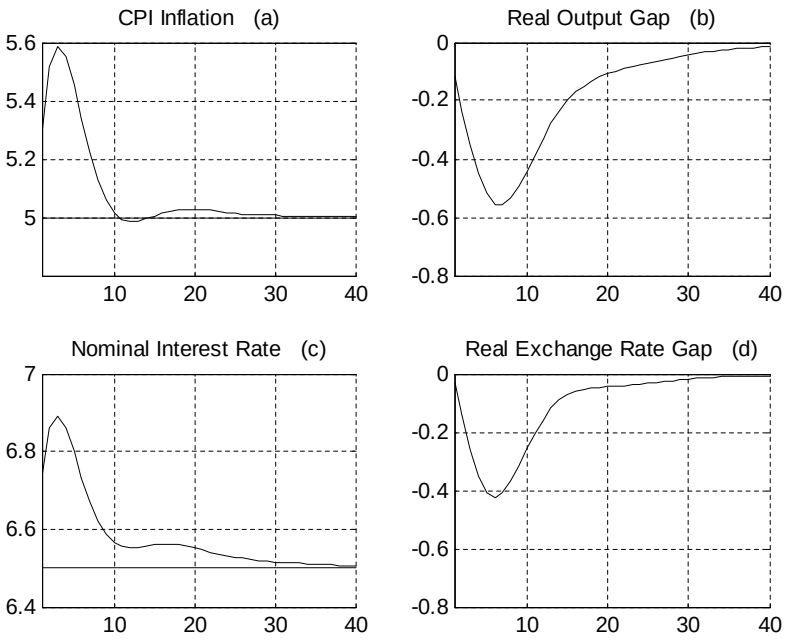

Figure 7. Inflation Targeting

From the three simulation exercises, we can conclude that inflation targeting is a superior framework for monetary policy, because the cummulative loss of output would be just slightly above the cummulative losses under output targeting or the passive response (1.8 vrs. 1.5 and 1.7, respectively). However, the inflation rate would not surpass 6%, which is the upper bound for the inflation target in Guatemala. Hence, inflation would have remained on target all the time despite the shock.

# 6 Conclusions

The impact of an oil shock for the Guatemalan economy were simulated based on a semi-structural dynamic macroeconomic model. The simulations included the direct and indirect channels generated by such a shock, as well as different central bank policy responses. It is concluded that the output targeting monetary policy that is currently being pursued by the central bank of Guatemala has been costly in terms of inflation, and even though it has been efficient by not allowing current output to decrease, in the long run there will be output losses of about 1.5 percent points below the long run economic growth. On the other hand, if the central bank of Guatemala would already be operating under an inflation targeting scheme, the loss in output would have ammounted

to 1.8 percent of the economic growth trend, but the inflation rate would have remained on target, generating more credibility for the central bank monetary policy actions. Hence, inflation targeting is a superior monetary policy response.

A fully fledged inflation targeting framework for monetary policy is supposed to be functioning in the Central Bank of Guatemala since 2006. However, the monetary authority's credibility might be endangered since the early establishment of the new regime if the central bank continues to pursue its current policy actions.

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