

Oil Price Shocks and Aggregate Fluctuations^{*}

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Abstract

This paper analyzes the effects of oil price shocks on the characteristics of the business cycle and on welfare in a small open economy, such as in the case of the Spanish economy. The results show the ability of the model to reproduce the business cycle path of the Spanish economy, especially in those periods when shocks in the price of oil were most dramatic. Furthermore, the model reproduces other regularities of the Spanish business cycle. Finally, it is shown that the increases in the relative price of oil had a negative and significant effect on welfare.

Key words: Oil crisis, aggregate fluctuations, welfare cost.

JEL: Q43, E32.

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1. Introduction

The real business cycle theory assumes that exogenous technological shocks, identified through Solow residual, are the main source of aggregate fluctuations in the economy. The lack of discussion on the nature of technological shocks, which are unobservable, has often been criticized, based on the idea that they are just the result of the convergence of other kinds of factors that are not specified in the model. In this sense, specifying identifiable sources of fluctuations allows unobservable sources to be reduced in the explanation of the business cycle.

One of the identifiable sources of shocks that has claimed the attention of many economists is oil price shocks. The effects of these shocks on the economies of industrialized countries have been widely recognized in the literature. Authors such as Pindyck (1979), Hamilton (1983) and Olson (1988) suggest that these shocks affect growth as well as the business cycle, thereby becoming an additional source of economic fluctuation. There is extensive empirical literature that offers evidence of an asymmetric relationship between oil prices and aggregate economic activity (see Mork 1989 and 1994). Such asymmetry has been attributed to a wide range of explanations: adjustment costs, financial stress, monetary policy (see Balke et al. 2002 for a discussion about the origin of this asymmetry). Another kind of literature, has analyzed the effects of energy price shocks on economic variables using real business cycles models in closed economies. In this framework, authors such as Kim and Loungani (1992) and Finn (1995) find that such shocks offer very little help in explaining the US business cycle.

Nonetheless, the case of the US economy, given its special characteristics, does not seem applicable to the rest of the oil importing countries. A small economy heavily dependent on oil, as is the Spanish economy, is much more vulnerable than the US economy when confronted with changes in the international oil market. The US economy has more control over some variables, such as the interest rate, and can consequently use these variables to accommodate oil price shocks. On the other hand, the international market determines the interest rate for the Spanish economy and so it has very little control over this variable. This argument highlights the importance of considering the behavior of relative oil prices when analyzing aggregate fluctuations in small open economies like Spain's.

The goals of this paper, within the framework outlined above, focus on (i) analyzing the transmission channels of oil price shocks, (ii) analyzing the importance of this source of fluctuations when characterizing the cyclical path of the Spanish economy, (iii) evaluating the capacity of the model to reproduce other empirical regularities of the business cycle and (iv) quantifying the effects of relative oil price changes on welfare.

The model we used is a standard dynamic general equilibrium model for a small open economy in which oil is included as an imported productive input. The oil price as well as the interest rate is assumed to be set by the international markets so we consider a small economy in the sense of taking those prices as given. Oil price shocks are considered the only source of fluctuation. Therefore, although the economy has been hit by many shocks, our analysis is conditional on a single shock. This analysis would allow us to verify the extent to which oil price shocks can account for the Spanish business cycle. The parameters of the model are chosen by taking data from the Spanish economy for the period 1970:1 - 1998:4. This period includes two significant oil crises.

The analysis we carried out allows us to obtain several conclusions. The model accurately mimics the cyclical path of the Spanish economy, especially during the

period in which oil market conditions were most variable. The shocks in relative oil prices account for more than half of the size of aggregate fluctuations. The model is able to match other characteristics of the Spanish business cycle. These results emphasize the importance of oil price shocks as a source of economic fluctuations. Finally, increases in relative oil prices are shown to have had a significant negative effect on welfare.

The paper is organized as follows: the model is presented in Section 2, calibration and estimation of the parameters are discussed in Section 3 and the transmission mechanisms of oil shocks are analyzed in Section 4. In Sections 5 and 6 we test the ability of the model to reproduce the path and other regularities of the Spanish business cycle. We quantify the welfare cost derived from oil crises in Section 7. Lastly, Section 8 summarizes our conclusions.

2. The Model

The model described in this section is a standard dynamic general equilibrium model of a small open economy that needs to import oil to produce goods. The economy is small in the sense that its behavior does not affect the rest of the world and, in particular, oil prices are taken as given. Shocks in the price of oil are the only source of fluctuation in the economy.

The economy consists of a large number of identical infinite-lived households and firms. The economy produces an internationally tradable good (y_t), combining labor (n_t), capital (k_t) and oil (e_t), according to the following production function:

$$F(n_t, k_t, e_t) = n_t^q \left[(1-a)k_t^{-u} + ae_t^{-u} \right]^{-\frac{1-q}{u}}. \quad (1)$$

The u parameter is equal to $(1-s)/s$, where s is the elasticity of substitution between capital and oil, and the labor share is given by q

The aggregate resources constraint is given by the following expression, where c_t is private consumption, i_t is investment and xn_t are net exports:

$$c_t + i_t + xn_t = y_t. \quad (2)$$

The capital accumulation rule is given by:

$$i_t = k_{t+1} - (1-d)k_t + \Phi(k_t, k_{t+1}), \quad (3)$$

where d is the capital depreciation rate and Φ is a capital adjustment cost function, which following Bruno and Portier (1995), we assume to be quadratic:

$$\Phi(k_t, k_{t+1}) = \frac{f}{2} \left(\frac{k_{t+1} - k_t}{k_t} \right)^2. \quad (4)$$

Since the firm needs to hire capital and labor each period, the maximization problem can be characterized as the solution to a series of static one-period problems:

$$\text{Max } F(n_t, k_t, e_t) - w_t n_t - r_t k_t - p_t e_t, \quad \forall t \quad (5)$$

from which the first-order conditions are obtained:

$$w_t = F_{n_t}, \quad (6)$$

$$p_t = F_{e_t}, \quad (7)$$

$$r_t = F_{k_t}. \quad (8)$$

where w_t is the wage, r_t is the domestic interest rate and p_t is the relative price of oil that follows a stochastic first-order autoregressive process:

$$\ln p_t = \bar{p} + \mathbf{r} \ln p_{t-1} + \mathbf{e}_t, \quad (9)$$

where \bar{p} is a constant, $0 < \mathbf{r} < 1$ and $\mathbf{e}_t \sim N(0, \mathbf{S}_p)$.

The representative household has access to a perfectly competitive international capital market, where it can buy and sell international bonds at an (exogenous) international interest rate r^* . The net exports will therefore include the oil purchases as well as the net purchase of bonds:

$$xn_t = p_t e_t + b_{t+1} - (1 + r^*) b_t. \quad (10)$$

The representative household maximizes its expected lifetime utility defined over stochastic sequences of consumption (c_t) and labor (n_t) subject to the household budget constraint:

$$\text{Max } E_0 \left\{ \sum_{t=0}^{\infty} \mathbf{b}^t \frac{1}{1-\mathbf{s}} \left[(c_t - \mathbf{y} n_t^n)^{1-\mathbf{s}} - 1 \right] \right\} \quad (11)$$

$$\text{s.t. } c_t + k_{t+1} - (1 - \mathbf{d})k_t + \Phi(k_t, k_{t+1}) + b_{t+1} = w_t n_t + r_t k_t + (1 + r^*) b_t,$$

where $0 < \mathbf{b} < 1$ is the subjective rate of intertemporal discount, $\mathbf{s} > 0$ is the parameter of relative risk aversion, \mathbf{n} is one plus the inverse of the intertemporal elasticity of substitution of labor supply and \mathbf{y} is a positive parameter.

The conditions that solve the consumer's problem are the following:

$$U_{n_t} + U_{c_t} w_t = 0, \quad (12)$$

$$U_{c_t} \left(1 + \mathbf{f} \frac{k_{t+1} - k_t}{k_t^2} \right) = \mathbf{b} E_t \left\{ U_{c_{t+1}} \left(1 - \mathbf{d} + r_{t+1} + \mathbf{f} \frac{k_{t+2} - k_{t+1}}{k_{t+1}} \frac{k_{t+2}}{k_{t+1}^2} \right) \right\}, \quad (13)$$

$$U_{c_t} = \mathbf{b} E_t \left\{ U_{c_{t+1}} (1 + r^*) \right\}, \quad (14)$$

$$c_t + k_{t+1} - (1 - \mathbf{d})k_t + \Phi(k_t, k_{t+1}) + b_{t+1} = w_t n_t + r_t k_t + (1 + r^*) b_t. \quad (15)$$

A *competitive equilibrium* for this economy is a set of allocations $\{c_t, n_t, k_{t+1}, e_t, b_{t+1}\}$ and prices $\{w_t, p_t, r_t, r^*\}$, that satisfy the following conditions: (i) $\{c_t, n_t, k_{t+1}, b_{t+1}\}$ solves the consumer's problem given the prices $\{w_t, r_t, r^*\}$, (ii) $\{n_t, k_t, e_t\}$ solves the firm's problem given the prices $\{w_t, p_t, r_t\}$, and (iii) the goods, labor, capital, bond and oil markets are cleared.

3. Calibration and Estimation

The parameters of the model are chosen so that the model economy produces values for the stationary variables which match the corresponding averages of actual data during the period, 1970:1 - 1998:4. Therefore, many of the parameters are chosen from the equations of the model in steady state, while other parameters are taken directly from the literature. Finally, the stochastic process parameters of relative oil prices are estimated. Table 1 reports the parameter values.

[INSERT TABLE 1]

Following Christiano and Eichenbaum (1992), we fixed the individual's productive time to 1369 hours per quarter. The international interest rate r^* is taken from the value suggested by Kydland and Prescott (1982). The parameter of preferences, α , is borrowed from Greenwood et al. (1988), while the parameter of risk aversion, σ , is obtained from Mendoza (1991). As far as the production function parameters are concerned, the ν parameter, which is related to the substitution elasticity between capital and oil, is taken from Kim and Loungani (1992), whereas the labor share, θ , is taken from the calculations made by Martín-Moreno (1998) for the Spanish economy.

The rate of capital depreciation δ is chosen through its accumulation law (3) in the steady state:

$$d = \frac{i}{k},$$

where the investment/capital ratio is obtained from the average value of the data.

Given ν , the value of a , which represents the importance of oil with respect to capital, is obtained from equations (7) and (8) calculated in the steady state:

$$a = \frac{1}{\left(\frac{e}{k}\right)^{-(u+1)} \left(\frac{r^* + d}{p}\right)^{+1}},$$

where e/k and p are average values over the sample and the depreciation rate (δ) takes on the previously calibrated value.

The subjective rate of intertemporal discount (β) is calculated, given the international interest rate, from equation (14) in the steady state:

$$1 = b(1 + r^*).$$

The value of \mathbf{y} is chosen from equations (12) and (6) in the steady state, assuming that the fraction of hours worked in the steady state is equal to the average fraction of the data in the Spanish economy (31.7%):

$$y = \frac{q \frac{y}{n}}{v n^{(u-1)}}$$

where y/n is the output per hour worked on average according to the data.

The steady state value of international bonds is chosen to reproduce the net exports share in the Spanish economy.

The parameter of adjustment costs (f) is calibrated so the variability of investment relative to output would be suitably reproduced by the model.

Finally, to complete the calibration, the parameters corresponding to the stochastic process of relative oil prices are estimated from equation (9). The relative oil price data are the series of price per liter of oil in the Brent market corrected for the implicit GDP deflator.

Once the different parameter values are calibrated, we are ready to calculate the steady state of the model numerically and compare it to some of the long-run features of the Spanish economy during the reference period. This acts as a test of validation for the model with respect to the objective sought by the calibration. Table 2 contains the values of the comparison where we can see that the model adequately reproduces the long-term characteristics of the economy.

[INSERT TABLE 2]

4. Transmission Mechanisms of Oil Price Shocks

In this section we describe the dynamic mechanism in which an oil price shock is propagated. This shock is equal in size to the standard deviation calculated in the estimation process of the price. Figure 1 shows the response of the different endogenous variables of the model in presence of such shock¹.

[INSERT FIGURE 1]

When an increase in relative oil prices occurs, the amount of oil used decreases more than 10%. However, this increase in price is larger than the oil use reduction. This reflects the difficulty of the substitution of oil in the model economy so that the value of imported oil increases. The reduction in the use of oil determines the capital response due to the complementarity of both inputs in the production function so that the capital decreases, as does the number of hours worked. Given that the reduction in oil is much larger than the capital decrease, we can observe a considerable increase in the capital/oil ratio. The decrease in the productive inputs is translated into an output decrease of over 0.5%, which would imply a negative correlation between output and oil prices. Another effect of the decrease in oil use is the decrease in the marginal productivity of domestic capital, thereby increasing the purchase of foreign bonds. This effect, with the increase in the value of oil imports, implies that net exports will have a countercyclical character relative to the GDP. Finally, consumption exhibits a similar response to the output.

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¹ This implies an initial increase of about 20% with respect to its steady state value.

In this section we test the ability of the model to reproduce the Spanish business cycle for the period 1970:1-1998:4. We simulate the model by including the path of the relative price of oil as the only source of fluctuation. The analysis allows us verify the extent to which oil prices actually give rise to the Spanish business cycle path.

Figure 2 represents the evolution of the relative price of imported oil, and the comparison between the evolution of the Spanish GDP and the output path simulated by the model. Given that we focus on the business cycle, both series have been detrended using the Hodrick-Prescott filter. The periods when changes in oil prices were most dramatic are shaded in order to easily verify if the model is able to reproduce the behavior of the Spanish economy during the oil crises.

[INSERT FIGURE 2]

The first great oil crisis was triggered by the Arab-Israeli Yom Kippur War when OPEC imposed an oil embargo on western countries, thereby dramatically increasing oil prices. The Figure 2 shows an increase of about 200% in the relative price of oil in the first quarter of 1974. The increase had immediate effects in the evolution of the output in the model as well as in the Spanish economy, even though in the latter case its drop-off was drawn out over several periods. Therefore, the model satisfactorily reproduces the negative effect on output during the first oil crisis. The next period which calls for our attention is the second oil crisis, which brings us back to 1979 and was triggered by the Iranian Revolution, causing the relative price of oil to double in less than a year. Again, the increase in oil prices reduces the output of the economy, even though the decrease is much less than that experienced at the beginning of the decade. The model reflects the magnitude of the drop as well as its path. In following years, relative oil prices were held steady at a very high level, this had a long, negative effect on Spanish economy output. This is accurately depicted by the model. At the beginning of 1986 the oil market collapsed bringing about a significant drop in oil prices. This situation affected output in a positive way, which quickly recovered. The model reacts instantly when confronted with the fall in oil prices, while the recovery in the data begins some periods later.

Summing up, the model guided by changes in oil prices is able to mimic episodes of dramatic changes in the oil market quite accurately, especially for the two crises in the 70s and the situation in the mid-80s.

Focusing on the evolution of output during the whole period in question, we find that the model accurately reproduces the Spanish business cycle between the end of 1973 and the beginning of 1986, coinciding closely with the period of largest fluctuations in the relative price of oil. However, when oil market conditions were stable, that is, in the periods between 1970 and the middle of 1973, and the middle of 1986 to 1998, the model fails to reproduce the cyclical path of the Spanish GDP.

The results show the vulnerability of a small open economy heavily dependent on imported oil, such as the Spanish economy, when confronted with large changes in the conditions that control the international oil market, highlighting the importance of considering the behavior of relative oil prices when analyzing the Spanish business cycle.

6.- Business Cycle Properties

In the previous section we have seen how the model can satisfactorily reproduce the cyclical behavior of output for a small open economy dependent on the international

oil market, such as in the case of Spain. Nonetheless, we would also like to verify the ability of the model to reproduce other empirical regularities of the Spanish business cycle. In order to do so, we proceed to the stochastic simulation of the model with the parameters obtained in the calibration and estimation section, where the only source of fluctuations comes from the stochastic process estimated for relative oil prices. Table 3 reports a selection of second-moment properties for the HP-filtered series corresponding to the Spanish data and the simulated economy respectively.

[INSERT TABLE 3]

From the analysis of these statistics we obtain that oil prices are an important source of aggregate fluctuations in a small open oil-dependent economy such as Spain's. Oil price shocks can account for almost 60% of output volatility, whereas the significance of this source of disturbances in other economies is considerably less. For example, concerning the U.S. economy, Kim and Loungani (1992) found that energy price shocks account only for 16% of aggregate fluctuations. In a closed economy model, such as the one Kim and Loungani (1992) use for the US economy, the interest rate is procyclical. This partially absorbs the effects on output of an energy price shock. However, in a small open economy this does not happen because the interest rate is exogenous. As a result the Spanish economy is more sensitive to this kind of shock.

This kind of shock does not only account for a large percentage of output fluctuations but it also satisfactorily performs some other features of the business cycle. Therefore, the model matches the volatility of both oil use and oil prices, despite the fact that the model fails to reproduce the cross correlation of both variables with output. In the simulated economy oil use is decidedly procyclical and oil price countercyclical, while both variables are acyclical in the data.

Furthermore, including oil as productive input also plays a role in accounting for the countercyclical character displayed by net exports in relation to the GDP, as well as its volatility. In other papers this countercyclical character has been accounted for by the increase in capital imports which follows a positive productivity shock, though the value obtained is far from the value obtained in the data². In this case, and due to the complementarity between capital and oil, the decrease in net exports is amplified via oil imports, thus the model adequately reproduces the countercyclical character of this variable.

7.- Oil Price Shocks and Welfare

The last two sections have highlighted the significant influence that oil price shocks have not only on the size and path of aggregate fluctuations, but also as an explanatory factor for other regularities of the Spanish business cycle. This implies analyzing the features of the business cycle without having to resort to unobservable technological shocks. However, oil price changes do not only affect the business cycle but they also have effects on welfare as well. These effects are particularly important in the framework of a small open economy dependent on oil imports, since there is no domestic oil production, and the possibilities of substituting this input with capital are limited due to the complementarity between capital and oil. In this section we evaluate the loss of welfare occasioned by oil price increases registered from the first half of the 70s until the second half of the 80s. The relative price in the last quarter of 1973 was

² See, among others, Correia et al. (1995) for the Portuguese economy and Martín-Moreno (1998) for the Spanish economy.

very similar to the value registered in the third quarter of 1986, therefore we can consider the intermediate period as a transitory price increase whose welfare cost we will calculate.

The utility functions only enable us to establish ordinal comparisons so we have to turn to a measure that allows us to evaluate the quantitative importance of the decrease in welfare. In order to do so, we calculate the welfare cost derived from the increase in oil prices with respect to the initial situation. This cost is defined at each moment as the percentage of the increase in consumption that an individual would require to enjoy the same level of welfare with respect to the starting point. The welfare cost at each moment is calculated through the x variable that solves the following equation:

$$\bar{U} = U[\tilde{c}(1+x), \tilde{n}], \quad (16)$$

where \bar{U} is the level of utility reached at the initial situation, in this case the last quarter of 1973, while \tilde{c} and \tilde{n} represent consumption and hours worked at each moment, which provide a level of welfare U . Thus, the product $\tilde{c}x$ indicates the total increase in consumption required to restore the initial level of welfare. This welfare cost measure usually is expressed as a percentage of output.

The results show that the price increases registered between 1973 and 1986 had an average cost per period of 4.1% of the output. In other words, in each period, consumers should have been compensated with more than four points of the GDP in consumption terms, in order to make up for the loss in welfare derived from the different oil crises. This gives us an idea of the significant magnitude of the loss in welfare occasioned by the different oil crises for a small open economy, such as the Spanish economy.

8.- Conclusions

In this paper we have analyzed the effects of oil price shocks on the features of the business cycle and on welfare in the context of a small open economy such as is the case of the Spanish economy. The model used for this analysis is based on the standard dynamic general equilibrium model for a small open economy in which oil is included as an imported productive input. The price of oil as well as the interest rate is assumed to be set by the international markets. The calibration of the parameters of the model is made by taking data from the Spanish economy during the period 1970:1-1998:4.

The results show the ability of the model to reproduce the cyclical path of the Spanish economy, especially in those periods when oil price shocks were most dramatic. This kind of shocks accounts for more than half the size of the aggregate fluctuations of the economy. In addition, the model reproduces other regularities of the business cycle. Finally, we have shown that the increases in the relative price of oil had a negative and significant effect on welfare.

References

- Balke, N. S., S. P. A. Brown and M. K. Yücel (2002). "Oil Price Shocks and the U. S. Economy: Where Does the Asymmetry Originate?" *The Energy Journal*, vol 23 No. 3: 27-52.
- Bruno, C. and F. Portier (1995), "A small open economy RBC model: the French economy case." In Pierre-Yves Henin (ed.). *Advances in Business Cycle Research. With Application to the French and US Economies*, Springer, Berlín.
- Christiano, L. J. and M. Eichenbaum (1992). "Current Real Business Cycles Theories and Aggregate Labor Market Fluctuation." *American Economic Review*, 82: 430-450.
- Correia, I., J.C. Neves and S. Rebelo (1995). "Business Cycle in a Small Open Economy." *European Economic Review*, 39: 1089-1113.
- Estrada, A. and M. Sebastián (1993). "Una serie de gasto en bienes de consumo duradero." Working Paper 9305, Banco de España.
- Finn, M. (1995). "Variance properties of Solow's productivity residual and their cyclical implications" *Journal of Economic Dynamics and Control*, 19: 1249-1281.
- Greenwood, J., Z. Hercowitz and G. Huffman (1988). "Investment, Capacity Utilization and the Real Business Cycle." *American Economic Review*, 78: 971-987.
- Hamilton, J. (1983). "Oil and the Macroeconomy since World War II." *Journal of Political Economy* 91: 228-248.
- Kim, I. and P. Loungani (1992). "The Role of Energy in Real Business Cycle Models." *Journal of Monetary Economics*, 29: 173-189.
- Kydland, F. and E. Prescott (1982). "Time to build and aggregate fluctuations" *Econometrica*, 50: 1345-1370.
- Martín-Moreno, J. M. (1998). "Ciclos Reales en Economías Abiertas. Una Aplicación al caso Español." *Moneda y Crédito*, n.207: 87-113.
- Mendoza, E. G. (1991). "Real Business Cycles in a Small Open Economy." *American Economic Review*, 81: 791-818.
- Mork, K. A. (1989). "Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results." *Journal of Political Economy*, 97 (June): 740-744.
- Mork, K. A. (1994). "Business Cycles and the Oil Market." *The Energy Journal*, Special issue, *The Changing World Oil Market*: 15-38.
- Olson, M. (1988). "The Productivity Slowdown, the Oil Shocks, and the Real Cycle." *The Journal of Economic Perspectives* 2: 43-70.

Pindyck, R. S. (1979). "The Structure of World Energy Demand." The MIT Press, Cambridge, MA.

Table 1.- Parameters of the economy.

Preferences		
Subjective Discount Rate	<i>b</i>	0.99
Parameter of the Utility Function	<i>γ</i>	1.140
Risk Aversion	<i>s</i>	1.001
Parameter of the Utility Function	<i>α</i>	1.7
Technology		
Labor Share	<i>q</i>	0.65
Rate of Depreciation	<i>d</i>	0.027
Parameter of the Production Function	<i>ν</i>	0.7
International Interest Rate	<i>r</i>[*]	0.01
Oil Price Process		
Constant	<i>μ</i>	0.152
Persistence Coefficient	<i>D</i>	0.945
Standard Deviation	<i>σ_p</i>	0.180

Table 2.- Average ratios.

	Data	Model
Oil Imports/GDP	0.0318	0.0271
Net Exports/GDP	-0.0194	-0.0194
Private Consumption/GDP	0.7563	0.7546
Capital/GDP	9.5615	8.5224
Oil/GDP	0.0018	0.0016
Oil/Capital	0.00019	0.00019

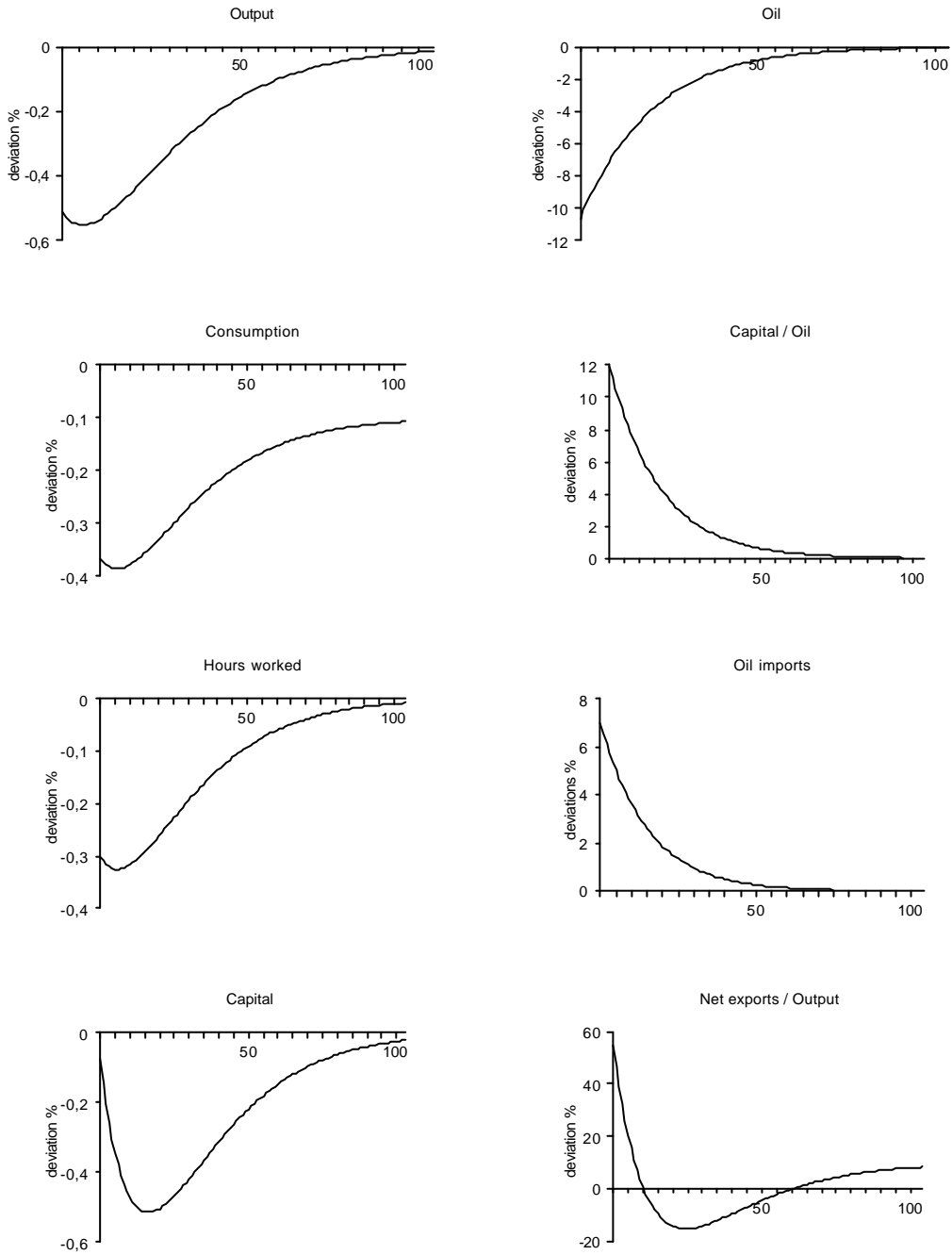
Table 3.- Second Moments.

Variables	Data		Model	
	σ_x	ρ	σ_x	ρ
GDP	1.27	1.00	0.70 (0.14)	1.00 (0.00)
Consumption ³	1.03	0.65	0.51 (1.13)	0.98 (0.01)
Investment	4.57	0.81	4.57 (1.98)	0.88 (0.05)
XN/GDP	1.20	-0.35	0.78 (0.38)	-0.77 (0.06)
Price	19.84	-0.04	22.63 (2.63)	-0.94 (0.03)
Oil	16.38	-0.05	14.18 (1.66)	0.95 (0.02)

All the statistics of the model are averages, across 100 simulation data sets, each with 116 observations. Standard deviation in brackets. For each variable x we show the absolute volatility σ_x and the contemporaneous correlation with GDP, ρ .

³ The consumption data are the updated series on consumer durables from Estrada and Sebastián (1993).

Figure 1: Impulse responses to an oil price shock.⁴



⁴ Time periods are quarters.

Figure 2: Comparison between the predictions of the model and the data

