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Abstract

The paper evaluates the effects of oil price shocks on several macroeconomic variables for the Venezuelan economy during the periods 1921-1970 and 1985-2015. Bivariate vector autoregression models are estimated to examine the links in the causal chain between the real price of oil and the macroeconomic variables of interest through a series of Granger non-causality tests. Similarly, different symmetry slope-based tests are conducted to determine whether or not there is empirical evidence supporting the view that the effects of oil price shocks on macroeconomic aggregates are asymmetric. Finally, the time profile described by an economic variable that has been hit by an oil price shock, and the importance of these shocks as a source of short-run fluctuations are analysed through the estimation of a series of impulse response functions and forecast error variance decompositions, respectively. The main findings in the paper can be summarised as follows: firstly, the predictability from real oil price to real output (and other macroeconomic variables) was found to be not significant in the period 1921-1970 while its importance has increased substantially in more recent years. Secondly, evidence of asymmetric effects of oil price shocks was found only for variables such as real output in the oil sector and investment during the years 1985-2015; unexpected oil price increases are significantly correlated with a rise in the economic variables while oil price decreases show not significant correlation. Thirdly, positive association between oil price movements and most macroeconomic variables as well as the relevance of oil price shocks as an important source of business cycle fluctuations in the economy has been observed; although significant differences are found in the responses of these variables to the shock for different time spans.

Key words: Oil price shocks, Macroeconomic fluctuations, Granger causality

JEL classification: E32

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I. **Introduction**.

Unexpected oil price changes have long been considered an important source of short-run fluctuations in the economy. Several studies have provided evidence of an empirical association between unexpected oil price increases and economic recessions (e.g. Hamilton, 1983). This has sparked a large number of academic papers seeking to identify the macroeconomic effects of oil price shocks in several countries. The dominant view in the extant literature is that the effects of unexpected oil price changes on the economy are asymmetric; oil price increases are significantly correlated with a decrease in economic activity while the effects of oil price decreases are uncorrelated to real output changes.

Economic theories have been put forward to explain the claimed asymmetric effects of unexpected oil price changes. Lilien (1982), for example, explains the asymmetric impacts of oil price shocks in terms of the sectoral shifts that oil price changes could generate in the economy; an oil price increase (decrease) would lead to a reduction (increase) in economic activity in those sectors where oil is employed during the production process. Consequently, the increase (decrease) in the price of oil will expand (contract) economic activity in energy-efficient sectors relative to energy-intensive sectors. Nevertheless, given that in the short-run the sectoral re-allocation of resources is costly, the overall effect of an unexpected oil price increase will be a reduction of real output. The asymmetric effect of the oil price shock arises because of this loss in output, which exacerbates the economic contraction whenever the oil price increases, while deterring the possible benefits of a fall in the price of oil.

Although the macroeconomic effects of oil price shocks have been studied in both net oil-exporting and net oil-importing countries, the bulk of the existing empirical evidence comes from research conducted for developed countries, which are mostly net oil-importing nations - clear exceptions are Canada, Norway and the United Kingdom. A considerably lower number of studies have been conducted in the case of net oil-exporting countries. The empirical evidence found for these economies is that in most countries oil price changes show a statistically significant positive correlation with real output, a relationship which according to some studies seems to take place through the fiscal policy channel (i.e. oil price changes have an impact on fiscal revenues, which in turn exacerbates economic fluctuations in the short-run, see, Husain, Tazhibayena and Ter-Martirosyan, 2008).

This paper gives empirical evidence of the macroeconomic effects of unexpected oil price changes on a net oil-exporting country, Venezuela. The study is part of the literature where systematic country-level assessments of the impact of oil price shocks on the economy is provided, which is not only rigorous and economic theory informed, but also confers relevance to countries' specificities and idiosyncrasies.

Oil production has had a profound effect on the Venezuelan economy. Its production at a commercial scale started during the first years of the twentieth century. By 1918, publication of uninterrupted official statistics for both production and exports began to be available in the country. The significance of oil production measured in terms of the share of total real GDP during the twentieth century was very notable, which in some years accounted for near one third of the total real output of the nation. Although, during the twenty-first century the contribution of oil production on real GDP has been considerably more modest with an average share of 14 percent of real output, it is still the most important source of fiscal revenue and foreign currency in the country.

Given the importance of the oil sector in the Venezuelan economy, it is expected that assessments of the impact of oil price shocks on the economy have been studied previously. This work builds on these studies and extends the investigation in different directions. Firstly, a comparative analysis of the macroeconomic effects of oil price shocks is provided for different time spans using the most recent data available nowadays. The main finding in this respect is that the effects of oil price shocks on the economy can vary substantially over time; Granger causality tests suggest that the predictability of oil price changes on the future behaviour of the main macroeconomic variables in Venezuela is considerably more important during the years 1999-2015 than for most part of the twentieth century. Similarly, the evidence found indicates that unexpected oil price changes have stronger and more persistent effects on the economy during the first years of the twenty first century than it used to have in previous years. Secondly, a wide range of statistical tests have been conducted to assess the likely asymmetric effects of oil price shocks on the economy. Both linear and non-linear (asymmetric, scaled and net) specifications for the real price of oil are employed to assess the relationship between oil price shocks and real economic activity. The empirical evidence suggests that only real output in the oil sector and real investment respond asymmetrically to unexpected changes in the price of oil. Output in the oil sector increases after a positive shock to the price of oil while not statistically significant response is observed for oil price decreases during the sub-period 1985-1998. Similarly, investment increases whenever the real price of oil reaches new hikes and shows a not statistically significant response to oil price decreases in the period 1985-2015. Evidence of the asymmetric effect of oil price shocks on real output in the non-oil sector has not been found in this paper, a result that contrast with the evidence provided in previous studies. Thirdly, empirical evidence on the importance of unexpected oil price changes as a source of short-run fluctuations in the economy is given. Variance decomposition analysis indicates that oil price shocks can be a major source of business cycle fluctuations in the country, although its relevance can change significantly over time. Finally, the study has employed rolling impulse-response functions, which has been used in this area recently, to assess the effect of an unexpected oil price change on several macroeconomic variables. The new approach enables the determination of gradual changes in the response of the macroeconomic variables of interest to an innovation to the oil price equation instead of assuming a discrete break in a particular time period.

The remainder of the paper is organised as follows: Section II provides a brief review of the relevant economic literature. Section III presents a description of the methodology and the empirical results in the study; the section documents the relationship between unexpected changes in the real price of oil and several macroeconomic variables of interest during the time periods 1920-1970 and 1984-2015. Concluding remarks are given in Section IV.

II. **Literature Review**.

There is well-established literature on the effects of oil price shocks in the economy. Early articles in this area are those of Mork and Hall (1980), Bruno and Sachs (1981), and Darby (1982). These papers present small structural macroeconomic models for an open economy, which were designed and simulated to explain the effects of an increase in the price of oil on variables such as real output and inflation. The models were mainly built in order to provide an economic framework that explains the observed stagflation of the early 1970s, which at the time was associated with the increase in the price of oil.[1]

Hamilton (1983), which is nowadays considered one of the main studies in the extant empirical literature, estimated a modified version of Sims (1980) multivariate time series model (vector autoregression model, VAR model) for the US economy using data for the years 1948-1972.[2] The study concludes that during the aforementioned period, an increase in the nominal price of oil was typically followed by a decrease in the rate of growth of real output. In a similar work, Burbidge and Harrison (1984) conducted a study for five OECD countries using the same econometric technique for the time period 1962-1982.[3] Their results corroborated the prediction made by oil price shocks models in which an increase in the price of oil produces inflationary effects, and found, to a lesser degree, evidence of the recessionary effects of the increases in the price of oil.

As more data became available researchers started to find a weaker negative association between oil price changes and real output. Following Hamilton (1983), Mork (1989) estimated a six-variable VAR model for the U.S. economy for the extended period 1949-1988, which showed mostly negative oil price coefficients in the output equation, but only statistically significant at the 10% level. Mork's central argument was that the years analysed in Hamilton (1983) were characterised by large upward movements in the price of oil with few periods of significant declines such as those observed in 1985-86, and that the effects of positive and negative changes in this variable on economic activity need not be symmetric. By estimating a model in which real oil price increases and decreases were introduced separately, he found a strong negative relationship between the former and real output, and no statistically significant effects of oil price declines.[4]

An alternative non-linear transformation was suggested by Lee, Ni and Ratti (1995) where oil price shocks are *scaled* by a time-varying conditional variance of the oil price changes. The

[1] An extensive study can also be found in Bruno and Sachs (1985).
[2] Hamilton's vector autoregression model includes variables such as real GNP, unemployment, implicit price deflator for nonfarm business income, hourly compensation per worker, import prices, money (M1), and nominal oil prices.
[3] The countries included in the sample were U.S.A., Japan, the Federal Republic of Germany, the United Kingdom and Canada.
[4] The positive (negative) oil price change variable was defined as equal to the real price change when it was positive (negative), and zero otherwise. It should be mentioned that some theories provide an economic rationale for the asymmetric treatment of oil price changes; Bernanke (1983) and Pindyck (1991), for example, emphasise the inverse relationship between uncertainty and investment decisions. As uncertainty is commonly proxy with volatility, both oil price increases and decreases will have a contractionary component, which would reinforce the negative effects of the higher prices, and potentially reduce the benefits of a falling price. Lilien (1982), on the other hand, argues that oil price changes could generate sectoral shifts with costly reallocation of economic resources.

idea is that oil price shocks are expected to have stronger economic effects in environments where they are relatively stable than in those characterised by large and erratic movements.[5] Lee *et al*. (1995) estimated several VAR models for the U.S. economy during the period 1949-1992 providing statistical evidence of asymmetric effects of oil price shocks; positive scaled oil price shocks are strongly correlated to negative real output growth while the effects of negative scaled oil price shocks on the economy are not statistically significant.

In order to assess the likely asymmetric effects of oil price changes in the economy, Hamilton (1996) introduced the notion of the *net oil price increase*, which compares the price of oil in a period with the maximum value observed during a given time interval.[6] This measure of oil price changes was proposed as a response to the findings obtained in Hooker (1996), who employed the VAR methodology to assess the effects of oil price shocks on U.S. real output for the period 1948:I-1994:II, and showed a breakdown of the negative relationship between the variables for the post 1973 sub-sample. Hooker's findings corroborated the negative association between oil price changes and U.S. economic activity found by several researchers for the post-war period up to the early 1970s, but found that oil prices failed to Granger cause most macroeconomic variables during the period 1973:IV-1994:II, and that once these observations were added to the sample the relation between the variables is significantly weaker. Hamilton's assertion was that most of the oil price increases after 1986 were recoveries from earlier declines, and that the use of the net oil price increase would allow one to distinguish between the variable's new highs from those increases that merely reflect a reversion from a recent decline. The new measure for oil price changes allowed Hamilton to re-establish a statistically significant negative relationship between the variable and real output growth for the whole period 1948:I-1994:II.

The asymmetric effects of oil price shocks on macroeconomic variables have also been evaluated in several industrialised countries. Mork, Olsen and Mysen (1994) estimated a reduced-form model of real GDP fluctuations as a function of the growth rate of real oil price increases and decreases as well as other macroeconomic variables for the U.S., Japan, Germany (west), France, Canada, the U.K., and Norway for the period 1967:III-1991:IV. In this study it was found that for most countries the asymmetry was significant. The investigation shows a significant negative correlation between output growth and real oil price increases, and a positive coefficient for oil price decreases, indicating that the decline of oil prices has an adverse effect in the economy, although for several countries this coefficient was not statistically significant from zero. For the two net oil-exporting countries in the sample, it was found that the U.K.'s responds to oil price changes resemble that of a net oil-importing country, while Norway's real output responds positively to oil price increases, and seems to be harmed by price declines.[7] Cuñado and Pérez de Gracia (2003), on the other hand, estimated

[5] Oil price shocks in an environment where changes are frequent might be interpreted as temporary movements in the price of oil while those that take place in a stable environment are likely to be associated with permanent changes.

[6] Specifically, Hamilton's net oil price increase compares the price of oil in a given quarter with the highest valued observed in the previous four quarters (twelve quarters are used in Hamilton, 2003); if the price is higher than the previous year's maximum (or three years' maximum), the percentage change is recorded, alternatively, the observation is defined to be zero for that quarter.

[7] The unexpected response of the U.K. economy to the oil price increases is commonly explained in terms of the Dutch disease argument, that is, oil price hikes lead to a sharp appreciation of the real exchange rate, which harms the trade balance of the country.

multivariate time series models to assess the effects of real oil price changes on real output growth (VAR models) and inflation (vector error-correction models, VEC models) for fifteen European countries during the period 1960-1999.[8] The research contemplates both linear and non-linear specifications for the oil price-output growth/inflation relationship. Real oil price changes are introduced in these models in different ways: inter-annual changes, oil price growth increases and decreases, net oil price increases, and scaled oil price changes. The results of the study provides supportive evidence of the presence of asymmetric effects of oil price shocks on economic activity for most countries in the sample. A similar study is conducted by Jiménez-Rodríguez and Sánchez (2005) where linear and non-linear VAR models are estimated for individual G-7 countries, Norway and the euro area as a whole for the period 1972:III-2001:IV. The study corroborates the non-linear effects of oil price shocks on real economic activity for both net oil-importing and oil-exporting countries in the sample; in the case of the former, oil price increases have a negative effect on real output and decreases result in either no significant effect or harm to economic activity, while in the latter oil price increases benefit only the Norwegian economy.

Although the economic effects of oil price shocks in countries where the oil sector accounts for a sizable share of the economy have been documented in cases like the U.K., Canada and Norway, this area of research has been, to a certain extent, neglected in the literature. A related paper on the subject is Husain, Tazhibayena and Ter-Martirosyan (2008), where three-variable panel VAR models are estimated for a sample of ten oil-exporting countries for the period 1990-2007.[9] In this study it is argued that although real *non-oil* output responds positively to oil price shocks, once it is controlled by the fiscal stance, these innovations do not appear to influence short-run fluctuations in the economy.[10] In other words, oil price changes do not have a significant independent effect on output, and fiscal policy is the mechanism by which the shocks are transferred to the economy.

In the case of Venezuela, some studies have been conducted to assess the effects of oil price shocks on the economy. An early paper is Vaez-Zadeh (1991) in which a small scale macroeconomic model for an open economy is estimated and simulated for the period 1965-81. The purpose of the study is to provide a comparative analysis of the effects of oil price shocks on an economy, which is characterised by having abundant natural resources, and the likely "confident effects" that this might have on economic agents' behaviour. In this model, where oil revenues are assumed to be received entirely by the government, the impact of an oil price shock becomes more pronounced as a result of the particular features of the economy, generating an increase in non-oil real output and the aggregate demand components.[11] Moreover, the rise in the price of oil initially has a positive effect on inflation, which eventually

[8] The study found evidence of cointegration for the variables inflation rates and real oil prices for most countries, but not between oil prices and industrial production. The countries in the sample are Germany, Belgium, Austria, Spain, Finland, France, Ireland, Italy, Luxembourg, Portugal, UK, Netherlands, Denmark, Greece and Sweden.

[9] The variables included in the models are oil prices, fiscal stance and output. The sample consists of the following countries: Algeria, Iran, Kuwait, Libya, Nigeria, Norway, Oman, Saudi Arabia, United Arab Emirates (UAE), and Yemen.

[10] The distinction between oil and non-oil real output is a common feature in studies for countries with a relatively large oil sector in the economy. Hence, non-oil output is described as total output excluding oil (and gas) related activities.

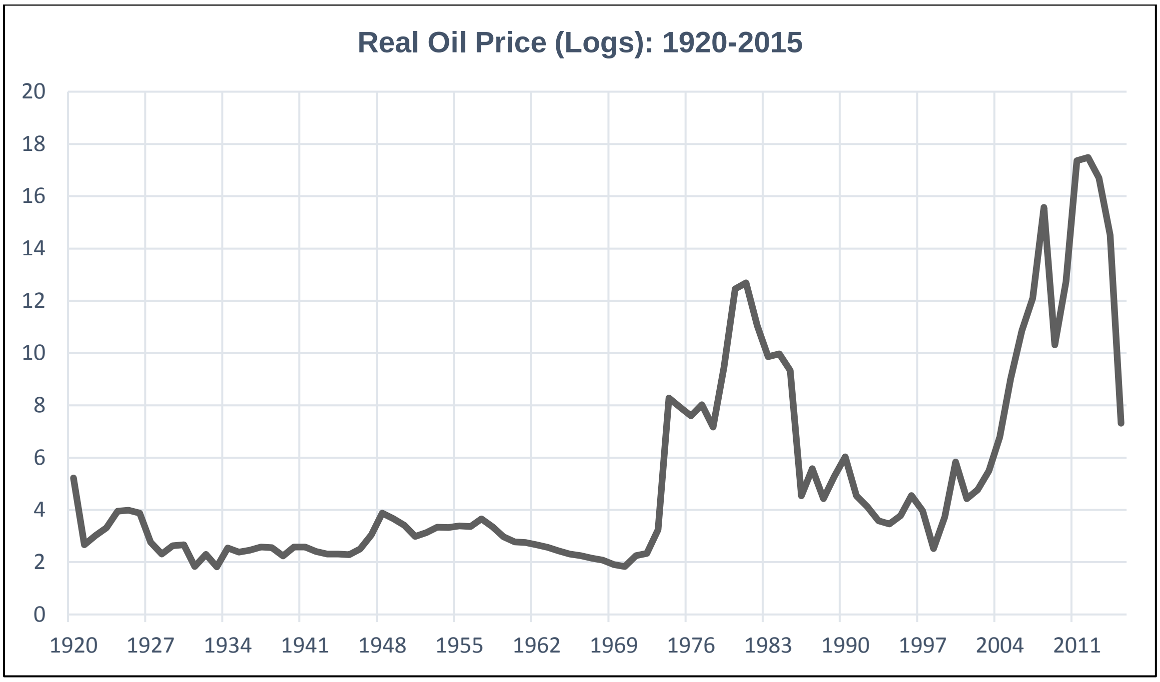
[11] Real private investment initially declines as a result of the shock, but as non-oil real output increases it eventually rises to remain higher than the historical level.

fades out to stabilise below its historical level, and generates an increase in the demand for real balances. Sáez and Puch (2004), on the other hand, calibrate a dynamic stochastic general equilibrium (DSGE) model for the Venezuelan economy using data for the period 1950-1995. This is a model for a small open economy in which oil revenues are introduced to the system as a pure rent transferred from abroad. A positive oil price shock in this theoretical framework has an expansionary effect on non-oil output, consumption, investment and the trade balance as long as preferences are assumed to follow the Greenwood-Hercowitz-Huffman (GHH) specification. The expansionary effects of oil price shocks on both real and monetary variables are also documented in Bárcenas, Chirinos and Plagiacci (2011) where a generalised dynamic factor (GDF) model is estimated for the period 2004-2010. The model encompasses 116 macroeconomic variables and analyses the effects of monetary, fiscal and oil price shocks in the short-run. A finding of the paper is that a rise in the price of oil, in addition to increased aggregate demand, also expands domestic production and lowers interest rates and prices. Finally, asymmetric effects of oil price shocks have been analysed in Mendoza and Vera (2010) who estimated a non-linear VAR model for Venezuela using the scaled oil price changes specification for the time period 1984:II-2003:III. Accordingly, the study found that oil price shocks have a positive and significant impact on real output, and it is claimed that there is empirical evidence supporting the presence of non-linear effects, specifically real economic activity seems to be more responsive to unexpected price increases than to decreases.

III. **Methodology and Empirical Results**.

This section shows the impacts of oil price shocks on selected macroeconomic variables from Venezuela. Figure 1 displays the evolution of the real price of the Venezuelan crude oil barrel in logarithmic terms for the period 1920-2015.[12]

Figure 1



The figure illustrates some well-known features in the behaviour of oil prices over time; the average real price of oil for the Venezuelan barrel increased from $2.81 during the period 1920-1970 to $7.85 in the period 1971-2015. Similarly, the sample standard deviation changed from 0.67 to 4.25 for the aforementioned periods. As documented in Dvir and Rogoff (2010) during the periods 1861-1878 and 1973-2009 oil prices were considerably more persistent and volatile than in the years 1878-1973, these variations in persistence and volatility are associated with altering factors that modified the prevailing conditions in the supply and the demand for oil. Dvir and Rogoff (2010) argue that the oil demand conditions during the periods 1861-1878 and 1973-2009 were dominated by processes of intense industrialisation in countries that have nowadays become important engines of the global economy such as the U.S.A., Japan, Taiwan, South Korea and China. On the other hand, the supply side of the oil market during these periods was characterised by the presence of important constraints to the continued access to oil due to the monopoly of railroads in transportation (1861-1878), and to OPEC's capacity to control access to easily-exploitable oil reserves (1973-2009).

In this study the effects of real oil price changes on the economic activity in Venezuela for the periods 1920-1970 and 1984-2015 will be analysed separately. The two periods are distinct not

[12] Real oil prices are computed by dividing the nominal price of oil in a given year by the ratio of the US Consumer Price Index (CPI) in that year to the CPI in some "base" period.

only in terms of the shifting conditions in the international energy market, but also as a result of significant structural changes experienced in the Venezuelan economy. For example, during the period 1920-1970 the production of crude oil was essentially a private sector enterprise where state intervention was limited to the provision of special hydrocarbon contracts and concessions to the oil companies in order to conduct exploration, development and/or production activities in the country. Whereas during the period 1984-2015 the activities in the industry were mainly under the control of the Venezuelan state-owned company PDVSA[13]. Similarly, macroeconomic conditions were significantly different during the two periods. The Venezuelan economy during the period 1920-1970 was characterised by exhibiting relatively high rates of economic growth and prices were stable; the annual average rate of growth for real GDP per-capita and CPI during this period were 5.2 percent and 1.5 percent, respectively. By contrast, from 1984 to 2015 economic growth was weak and price instability prevailed; the annual average rate of growth for real GDP per-capita and CPI were 0.6 percent and 35 percent, respectively.

The Impact of Oil Price Shocks in the Period 1921-1970.

Granger non-causality tests.
In this part of the paper the links in the causal chain between the real oil price and the Venezuelan economy are evaluated through a series of Wald tests, and impulse respond functions employing bivariate vector autoregression (VAR) models.[14] The data employed for the period is annually recorded in Baptista (2006). The chosen macroeconomic variables are the log-differences of real output, real aggregate demand components, a price variable (the GDP deflator), the real exchange rate, and a measure of the money supply (M2). Similarly, real oil prices are entered as first-differences of the log-levels. Given the prominent role of the oil sector in the economy, the real GDP of the oil sector is analysed separately from the GDP of other economic sectors. Formally, the estimated models are given by

$$\begin{aligned} \Delta y_t &= b_{10} + \sum_{i=1}^{p} b_{11,i}\Delta y_{t-i} + \sum_{i=1}^{p} b_{12,i}\Delta op_{t-i} + \varepsilon_{1,t} \\ \Delta op_t &= b_{20} + \sum_{i=1}^{p} b_{21,i}\Delta y_{t-i} + \sum_{i=1}^{p} b_{22,i}\Delta op_{t-i} + \varepsilon_{2,t} \end{aligned} \qquad (1)$$

where Δy_t and Δop_t denote the first-differences of the log of the macroeconomic variable of interest and the log of real oil price, respectively. The term $\varepsilon_t \sim (0, \Sigma)$ is an uncorrelated white noise process. The null hypothesis is $H_0 : \Delta op \nrightarrow \Delta y$, which implies $H_0 : b_{12,i} = 0 \;\; i = 1,...,p$. Failing to reject the null hypothesis, H_0, indicates that the rate of growth of the real oil prices do not Granger cause the rate of growth of the macroeconomic variable of interest. The *p*-values of

[13] The oil industry in Venezuela was nationalised in 1976.
[14] The restriction to bivariate models was imposed in order to estimate more reliable VARs using relatively short sample periods.

the Granger non-causality tests for the log-differences macroeconomic indicators are presented in Table 1.[15]

Table 1

Predictability from the Real Price of Oil to Selected Real Aggregates, *p*-Values (1921-1970)

Variables	**H_0**	**Serial correlation [a]**	**Normality [b]**
ΔOil Output	0.343	0.123	0.002**
ΔNon-Oil Output	0.815	0.037*	0.005**
ΔConsumption	0.520	0.932	0.422
ΔGovernment	0.729	0.233	0.749
ΔInvestment	0.217	0.029*	0.286
ΔExports	0.713	0.130	0.001**
ΔImports	0.357	0.036*	0.021*
ΔPrices	0.587	0.207	0.746
ΔER	0.307	0.247	0.273
ΔM2	0.019*	0.606	0.000**

Notes: (a) Lagrange multiplier test of residual serial correlation; (b) Based on a test of skewness and kurtosis of residuals; * and ** statistically significant at 5 and 1 percent level, respectively.

The tests reveal that the real activity variables such as the real GDP growth for both the oil and the non-oil sector, and the real aggregate demand components did not exhibit any unusual behaviour as a result of changes in the real oil prices. A similar case can be made for the inflation rate, and the rate of growth of the real exchange rate where real oil prices growth do not seem to be statistically informative about the future course of these variables. Nevertheless, there seems to be statistical evidence of unusual behaviour in the rate of growth of the money supply (M2) succeeding changes in the oil price rate of growth. Overall the rate of growth of the real crude oil prices has predictive power on very few economic variables. [16] It is important, however, to interpret these results cautiously as the small sample properties of an *F*-test are poor when the residuals do not follow a Gaussian process[17]. This seems to be a matter of concern for several variables including the money supply (M2) equation as indicated by the normality test.

[15] The lag order (p) was set equal to one.

[16] A block non-causality test for the null hypothesis that the coefficients of the lagged values of the rate of growth of the real oil price in the block of equations in a seven-variable VAR(1) model was also conducted. The test statistic was 5.35 with associated *p*-value of 0.5. The variables included in the VAR were the real GDP for both oil and non-oil sector, real exchange rate, GDP deflator, real wage, M2 and real oil price.

[17] Hamilton (1983, pp. 241) argues that the rejection of the null hypothesis in conducting an F-test with non-normal error terms can be either the result of significant coefficients or poor small-sample properties of the test. Moreover, he emphasises that even in the case of normal residuals the test only holds asymptotically.

Testing for symmetry.

As was mentioned earlier, a common view in the extant literature is that the effects of oil price shocks on macroeconomic aggregates are asymmetric. Empirical evidence has been found supporting the view that while oil price increases are detrimental for output growth, oil price decreases do not show a significant correlation with the real economy. In this part of the study a series of symmetry slope-based tests are presented in order to determine whether or not there is empirical evidence supporting this view for the case of the Venezuelan economy. The first test is the traditional approach developed by Mork (1989), where a predictive regression of the growth rate of the relevant economic variable on lagged increases and decreases oil prices is estimated. Formally,

$$\Delta y_t = a_0 + \sum_{j=1}^{p} a_j \Delta y_{t-j} + \sum_{j=1}^{p} b_j^+ \Delta op_{t-j}^+ + \sum_{j=1}^{p} b_j^- \Delta op_{t-j}^- + \varepsilon_t \tag{2}$$

H1: $b_1^+ = ... = b_p^+ = 0$; H2: $b_1^- = ... = b_p^- = 0$; H3: $b_j^+ = b_j^-$, j=1,…,*p*

where the real oil price changes, Δop_t, are introduced through the censored variables Δop_t^+ and Δop_t^- defined as

$$\Delta op_t^+ = \begin{cases} \Delta op_t & \text{if} \quad \Delta op_t > 0 \\ 0 & \text{if} \quad \Delta op_t \le 0 \end{cases} \quad \text{and} \quad \Delta op_t^- = \begin{cases} \Delta op_t & \text{if} \quad \Delta op_t < 0 \\ 0 & \text{if} \quad \Delta op_t \ge 0 \end{cases} \tag{3}$$

Asymmetric effects are tested by means of a Wald test (H_1, H_2 and H_3) with an asymptotic χ_p^2 distribution.

The second methodology is the test developed by Lee *et al.* (1995), where oil price shocks are scaled by a measure of oil price volatility. In this approach oil prices are modelled using an AR(p)-GARCH(p,q) in order to obtain estimates of both the oil price shocks and conditional variances. Formally,

$$\Delta op_t = a_0 + \sum_{j=1}^{p} a_j \Delta op_{t-j} + e_t \qquad e_t \mid I_{t-1} \sim N(0, h_t) \tag{4}$$

and

$$h_t = \gamma_0 + \sum_{i=1}^{q} \gamma_i e_{t-i}^2 + \sum_{j=1}^{p} \gamma_j h_{t-j} \tag{5}$$

The scaled oil price shock increases (SOPSI) and the scaled oil price shock decreases (SOPSD) are defined as $SOPSI_t = \max(0, \hat{e}_t / \hat{h}_t^{1/2})$ and $SOPSD_t = \min(0, \hat{e}_t / \hat{h}_t^{1/2})$, respectively. These variables are then used in a predictive regression model like equation (6) in order to conduct joint hypothesis tests. Formally,

$$\Delta y_t = a_0 + \sum_{j=1}^{p} a_j \Delta y_{t-j} + \sum_{j=1}^{p} b_j^{+} SOPSI_{t-j} + \sum_{j=1}^{p} b_j^{-} SOPSD_{t-j} + \varepsilon_t \tag{6}$$

H4: $b_1^{+} = ... = b_p^{+} = 0$; H5: $b_1^{-} = ... = b_p^{-} = 0$; H6: $b_j^{+} = b_j^{-}$, j=1,…,*p*

Finally, the last of the slope-based tests for symmetry under consideration is based on Hamilton (1996, 2003) non-linear transformation of the net energy price increase. The fitted regression model for the test is formally written as

$$\Delta y_t = a_0 + \sum_{j=1}^{p} a_j \Delta y_{t-1} + \sum_{j=1}^{p} b_j \Delta op_{t-j} + \sum_{j=1}^{p} g_j \Delta op_{t-j}^{+,net} + \varepsilon_t \tag{7}$$

H7: $g_1 = ... = g_p = 0$

where the "net oil price increase", $\Delta op_t^{+,net}$, is defined as (a) zero, and (b) the amount by which (the log of) energy prices in period t, op_t, surpass the maximum value over a pre-determined time period, op_t^{*} (e.g. the previous three years). Given the likely recessionary effects of real oil price decreases for a net oil-exporting country like Venezuela, a test on the "net oil price decrease" (NOPD) is also contemplated in the study. Formally,

$$\begin{aligned} \Delta op_t^{+,net} &= \max\{0, op_t - op_t^{*}\} \\ \Delta op_t^{-,net} &= \min\{0, op_t - op_t^{\circ}\} \end{aligned} \tag{8}$$

where op_t° stands for the minimum value over the predetermined time period.

The results of the different symmetry tests of the effects of oil price changes on the Venezuelan macroeconomic variables are presented in Table 2. The lag order for the predictive regression models was set to one (*p*=1). For the scaled real oil price shocks methodology the log-difference of the real oil price was modelled as an univariate AR(0)-GARCH(1,1). Finally, in the calculation of the net oil price increase (decrease) the pre-determined time period was set to three years.

Table 2
Slope-Based Symmetry Tests of the Response to Oil Price Changes, *p*-values (1921-1970)

Variables	Mork (1989)			Lee, Ni and Ratti (1995)			Hamilton (1996,2003)	
	H_1	H_2	H_3	H_4	H_5	H_6	H_7	H_8
ΔOil Output	0.436	0.706	0.702	0.413	0.855	0.621	0.788	0.952
ΔNon-Oil Output	0.666	0.316	0.436	0.960	0.298	0.472	0.531	0.493
ΔConsumption	0.504	0.845	0.677	0.495	0.952	0.639	0.111	0.995
ΔGovernment	0.701	0.948	0.797	0.942	0.920	0.919	0.831	0.663
ΔInvestment	0.976	0.366	0.494	0.999	0.249	0.586	0.611	0.741
ΔExports	0.452	0.839	0.510	0.355	0.732	0.406	0.761	0.841
ΔImports	0.756	0.716	0.997	0.377	0.691	0.715	0.728	0.977
ΔPrices	0.287	0.824	0.356	0.988	0.885	0.928	0.094	0.934
ΔER	0.469	0.110	0.165	0.767	0.568	0.602	0.187	0.296
ΔM2	0.618	0.053	0.563	0.158	0.313	0.601	0.609	0.803

Note: * and ** statistically significant at 5 and 1 percent level, respectively.

Table 2 shows that macroeconomic variables do not exhibit asymmetric responses to energy price changes. Under the traditional approach developed by Mork (1989) only the growth rate of money (M2) presents weak evidence of an asymmetric response as the null hypothesis of no statistically significant coefficients cannot be rejected for the oil price increases while for the oil price decreases the null can be rejected at 10% significant level. However, the marginal significance level for the pairwise equality of coefficients test (H_3) indicates no significant differences between the effects of real oil price increases and decreases. According to the methodology proposed by Lee et al. (1995) there is no evidence of asymmetric effects for any of the macroeconomic variables under study. Finally, the Hamilton's non-linear transformation of the net real oil price seems to suggest that there is weak evidence of asymmetric effects only for prices as the coefficient of the net oil price *increase* is statistically significant at a 10 percent level. The sign of the coefficient of the lag term is positive indicating real net oil price increases positively affect prices in the economy. It is worth noticing that the response of the rate of growth of money supply (M2) to the net real oil price decreases is not significantly different from zero, therefore, this approach does not corroborate the results obtained in the Mork (1989)'s symmetry test for M2.

Impulse Response Functions.
As indicated by Sims (1980, p.20) estimated VARs "are difficult to describe succinctly" so a more comprehensible view of the influence of oil price shocks on the economy can be observed through the moving-average representation of the autoregressive lag polynomial of the estimated bivariate regressions. Formally, given the bivariate linear model

$$Y_t = AY_{t-1} + E_t \tag{9}$$

where Y_t is a 2×1 random vector, A is a 2×2 matrix, and E_t is a 2×1 vector of random disturbances, the moving-average representation is then given by

$$Y_t = \sum_{i=0}^{\infty} A^i E_{t-i} \tag{9}$$

which is employed to obtain both impulse-response functions and forecast error variance decompositions.

The most commonly used impulse-response function in the economic literature was developed by Sims (1980, 1981). This form of impulse-response function allows the time profile of a random variable, which has been hit by a shock in a particular time period, to be obtained. The methodology computes the difference between the realisations of a random variable under alternative scenarios; one realisation assumes that during the period t and t+n the variable has been hit by a shock at time t, while in the second realisation no shock on the variable has taken place during the period. Although it is a popular approach to assess the effects of a shock on a random variable, the methodology faces important drawbacks. For example, quite often the impulse response function is sensitive to the ordering of the variables in the VAR model, and also the method is not appropriate in the case of non-linear dynamical systems.[18] A methodology that circumvents these problems is the *Generalised Impulse-Response Function* (GI) developed by Koop, Pesaran and Potter (1996), which is the adopted approach in this study. A general formalisation of the GI is a realisation of a random variable defined as

$$GI_Y = (n, E_t, \Omega_{t-1}) = E[Y_{t+n} \mid E_t, \Omega_{t-1}] - E[Y_{t+n} \mid \Omega_{t-1}] \quad \text{for} \quad n = 0,1,\ldots \tag{10}$$

where E stands for the conditional mathematical expectation taken to the VAR model, and Ω_{t-1} is the information set available to forecast. Table 3 and Figure 2 show the accumulated responses and impulse-responses with their corresponding two standard error bands for the preferred (linear) VAR models of the selected macroeconomic variables, respectively.

Table 3
Accumulated Response to a One-Standard Deviation Oil Price Innovation (1921-1970)

Variables	1 year	3 years	5 years	10 years
ΔOil	-0.003	0.002	0.004	0.004
ΔNon-Oil	0.048	0.063	0.068	0.070
ΔConsumption	0.080	0.079	0.079	0.079
ΔGovernment	0.009	0.015	0.017	0.019
ΔInvestment	0.128	0.163	0.172	0.174
ΔExports	-0.017	-0.018	-0.018	-0.018
ΔImports	0.128	0.145	0.147	0.148
ΔPrices	0.050	0.052	0.052	0.052
ΔER	-0.031	-0.034	-0.035	-0.035
ΔM2	0.035	0.037	0.037	0.037

As reflected in the accumulated responses in Table 3, most macroeconomic variables typically react positively to a shock in the real oil price equation with the exception of exports and the real exchange rate. The negative response of the real exchange rate goes with conventional wisdom as an increase in the price of oil is expected to appreciate the currency of a net-exporting oil country. By contrast, the result for exports might look counter-intuitive, although the response is considerable more muted. It is also possible to observe that in absolute terms investment and imports show a relatively high response to a positive shock to real oil prices changes. Nevertheless, a look at the responses relative to the variable's standard deviation show that the strongest reactions to an oil price shock are exhibited by investment, output in the non-oil sector, imports and prices.

Figure 2 displays the typical behaviour of the macroeconomic variables of interest over a period of 10 years after a shock equivalent to a one standard error innovation in the equation for the growth rate of real oil price. The impulse-responses show that most macroeconomic variables typically respond positively to an oil price shock, although in some cases the estimated response is imprecise as indicated by a broad confident band, and not statistically significant from zero. Hence, output in the non-oil sector, consumption, investment, imports, prices and money increase during the first year after the shock; most of these variables return gradually to the long-run equilibrium value –the effects are not long lasting for consumption and prices as

[18] As discussed in Potter (1994) impulse-response functions in non-linear dynamic models are dependent on the history of the variable and the magnitude of the shock.

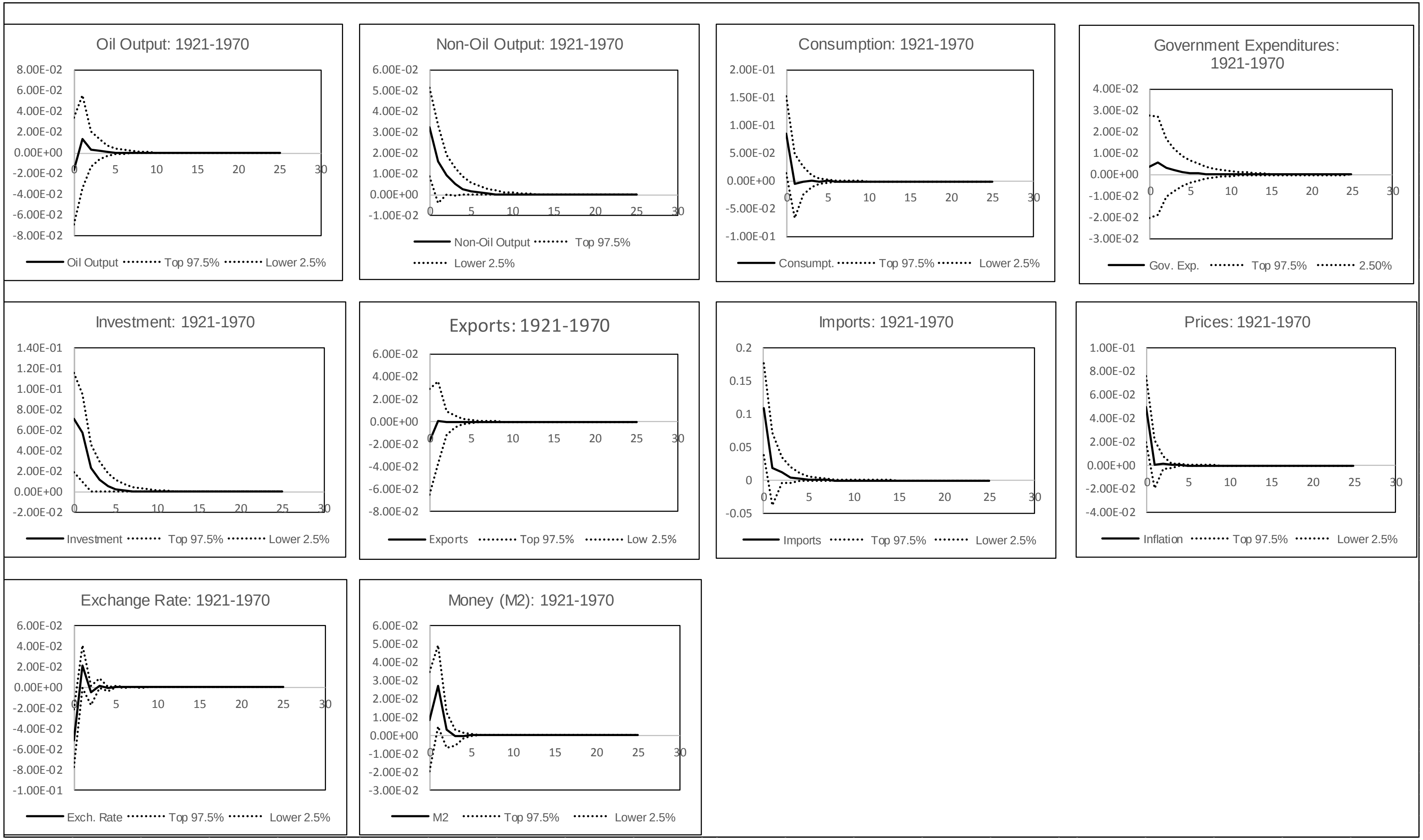
these variables drop sharply after one time period. The effect of a shock on the real exchange rate is negative and significant indicating an appreciation of the currency after a positive oil price shock. On impact the strongest responses in terms of the variable's standard deviation are experienced by the real exchange rate, prices and imports, while the most persistent effects are recorded for investment, output in the non-oil sector and the real exchange rate. The money supply shows its strongest response a year after the shock. Finally, output in the oil sector, government expenditures and exports display minor responses to an oil price change.[19]

A main finding in the studies conducted on the effect of oil price shocks on oil-exporting countries, such as Husain, et al. (2008), is that the effect of oil price changes on non-oil output seems to work through a fiscal policy channel. Nevertheless, in the case of Venezuela during the period 1921-1970 government spending exhibits a small and not statistically significant response to oil price changes. In order to analyse this issue further an estimation of a three-variable VAR model with government spending as an exogenous variable was conducted (not shown here); the modified framework enables one to assess whether the impact of oil price shocks operates directly on the economy rather than through the fiscal channel. Although the estimated impulse-response of the three-variable VAR registers a slightly lower response on impact and less persistence, the short-run dynamic described by the variable is very similar to the impulse-response presented in Figure 2. Consequently, the result could be arguably interpreted as evidence that the effect of changes in the price of oil on the economy operates mainly through a "confidence effect" rather than through the fiscal policy channel as discussed in Vaez-Zadeh (1991).

[19] The response of output in the oil sector is expected as oil production is most likely to be constrained by capacity in the short-run.

Figure 2

Responses to One Standard Error Shock in the Oil Price Equation (1921-1970)



Forecast Error Variance Decomposition

Estimates of the forecast error variance decomposition for the preferred (linear) specifications are presented in this part of the paper. These statistics shows how much of the unanticipated changes of the macroeconomic variables are explained by shocks to the oil price equation. For comparative purposes, the statistics have been also estimated for bivariate VAR models with variables commonly considered important sources of business cycle fluctuations such as government purchases or changes in the quantity of money rather than the real price of oil. Table 4 provides the fraction of the horizon step ahead forecast error variance of the row variable explained by a shock to the oil price/government expenditure/money equation.

Table 4

Estimated Variance Decomposition at 1, 3, 5-period Horizon (1921-1970)

Variables	**Oil Price (%)**			**Government Expend. (%)**			**Money (%)**		
	1 Year	3 Year	5 Year	1 Year	3 Year	5 Year	1 Year	3 Year	5 Year
ΔOil	1.12	1.10	1.10	13.99	21.0	22.48	2.62	2.98	3.01
ΔNon-Oil	18.81	18.66	18.64	34.06	39.60	40.75	5.0	6.0	6.11
ΔConsumption	11.90	11.84	11.84	2.24	2.75	2.85	14.83	14.82	14.82
ΔGovernment	0.44	0.49	0.50	-	-	-	2.58	2.30	2.25
ΔInvestment	21.68	22.17	22.20	23.02	26.14	26.72	3.38	1.10	0.21
ΔExports	1.11	1.09	1.09	12.29	18.46	19.68	0.654	0.873	0.881
ΔImports	20.96	20.75	20.74	22.96	28.45	29.54	5.94	7.55	7.58
ΔPrices	29.49	29.47	29.47	0.23	0.33	0.36	0.89	0.90	0.90
ΔER	36.09	36.27	36.27	0.90	0.91	0.92	1.45	1.46	1.46
ΔM2	8.02	8.10	8.10	3.58	3.87	3.91	-	-	-

Based on the results obtained from the estimation of the forecast error variance decomposition it is possible to observe that oil price fluctuations seem to be an important source of volatility in some of the macroeconomic variables of interest. This is particularly true for variables such as the real exchange rate, inflation, investment and imports. In relation to real output in the non-oil sector, the contribution of oil price changes to the short-run fluctuations of this variable is not negligible (19%) though. Hence, the result is in line with findings obtained in other studies on net oil-exporting countries like the U.K. and Norway, where oil price shocks play a significant role explaining short-run fluctuations in these economies (see Jiménez-Rodríguez and Sánchez, 2005, p.p. 223-224). In the case of variables such as prices and the real exchange rate, oil price changes even dominate other sources of fluctuations as government spending and money supply, which explain a considerably lower proportion of the variables' volatility. On the other hand, variables like real output in the oil sector, government expenditures and exports show a low response to oil price changes in the model.

To sum up, during the period 1921-1970 oil price changes show predictive power only for changes in the money supply (M2) as indicated by the results of the Granger non-causality tests; there is no empirical evidence supporting the view of asymmetric effects of the oil price shocks; and an increase in the real oil price have particularly important positive effects on variables like output in the non-oil sector, investment, imports and prices. While the real exchange rate tends to appreciate as a result of a positive shock to the oil price equation.

The Impact of Oil Price Shocks in the Period 1985-2015.

Granger non-causality tests.

The analysis in this section will be conducted employing the official statistics published by the Central Bank of Venezuela (BCV), which have been recorded quarterly. The study considers statistical tests for the period 1985-2015, and for the sub-periods 1985-1998 and 1999-2015. The scrutiny of the statistical results for the two sub-periods allows one to assess whether the relation between oil price shocks and the economy has been altered because of the significant structural changes that took place in the economy during the sub-period 1999-2015.[20] The *p*-values for the Wald test statistics for Granger non-causality are shown in Table 5. The VAR models were estimated using inter-annual growth rates in order to avoid seasonal effects, and the lag order was set to four (p=4).[21]

Table 5

Predictability from the Real Price of Oil to Selected Real Aggregates, *p*-values (1985-2015)

Variable	H_0 1985-1998	H_0 1999-2015	H_0 1985-2015
ΔOil	0.000**	0.325	0.491
ΔNon-Oil	0.269	0.006**	0.016**
ΔConsumption	0.314	0.011**	0.002**
ΔGovernment	0.698	0.003**	0.058
ΔInvestment	0.227	0.002**	0.008**
ΔExports	0.070	0.027**	0.590
ΔImports	0.328	0.019*	0.019*
ΔPrices	0.145	0.000**	0.000**
ΔER	0.323	0.014**	0.004**
ΔM2	0.011**	0.672	0.122

Note: * and ** statistically significant at 5 and 1 percent level, respectively.

The results for the period 1985-2015 contrast sharply with those obtained for the years 1921-1970 when unusual behaviour in the macroeconomic variables as a result of changes in the real oil prices was only observed for the quantity of money (M2). Oil prices changes seem to play a more prominent role during the period 1985-2015. In particular, variables such as output in the non-oil sector, consumption, investment, imports, prices and the real exchange rate seem to reflect unusual behaviour in their rates of growth succeeding changes in the oil price rate of growth. Similarly, the rate of growth of the real crude oil prices appears to have predictive power on the rate of growth of government expenditure although with a higher level of marginal significance (5.8%). It is also possible to observe that these results are mainly driven by a more significant role of oil price changes in the economy during the sub-period 1999-2015 -during the sub-period 1985-1998 the statistical results show that the real oil price only Granger-cause output in the oil sector and money. Nevertheless, it should be mentioned that some of these results are not robust to the lag order of the VAR. Consistent results are only obtained for variables such as output in the non-oil sector, consumption, government expenditure and prices.

[20] The period 1999-2015 corresponds to a large extent to the government of the left-wing Venezuelan President Hugo Chavez, who introduced important economic reforms oriented to increase state intervention in the economy, and particularly in the oil sector.

[21] Statistical tests for VAR models with 8 lags where computed, which are available from the authors upon request.

Testing for symmetry.

In Table 6 the results of the symmetry tests of the effects of oil price changes on the macroeconomic variables in Venezuela are presented. The lag order for the predictive regression models was set to four (p=4). [22] For the scaled real oil price shocks methodology the log-difference of the real oil price was modelled as an univariate AR(1)-GARCH(1,1). Finally, the pre-determined time period for calculation of the net oil price increase/decrease was set to three years.

In the period 1985-2015 evidence of asymmetric effects of oil price changes seems to be found for variables such as investment and exports. The overall differences between the estimated coefficients for oil price increases and decreases, respectively, according to Mork's asymmetric model are suggestive of asymmetric effects on investment. Similarly, the net oil price increase/decrease specifications show statistically significant correlations with investment growth. Nevertheless, the only result that is not sensitive to the number of lags in the estimated VAR model is the net oil price decrease specification. A stronger case for the presence of asymmetric effects of oil price changes can be found for the variable exports. This variable is significantly correlated with real oil price increases, when the oil price reaches new highs rather than a reversion from a recent decline, as indicated by the low marginal significant level in the net oil price increase specification. This result is robust enough to withstand changes in the lag order of the multivariate time series model.

The statistical tests for the asymmetric effect of oil price shocks during the sub-periods 1985-1998 and 1999-2015 show that only during the former sub-period it is possible to obtain results that are not sensitive to the number of lags in the model. Hence, during 1985-1998 asymmetric effects are shown for variables like output (oil and non-oil sectors), consumption, investment, exports and prices. Nevertheless, the only results that can withstand changes in the lag order of the model are those for the variables output in the oil sector, investment and exports. Positive and negative oil price changes seem to have different effects on output growth in the oil sector according to the scaled specification. While in the case of investment, a statistically significant correlation is found with the net oil price decrease as indicated by the low marginal significant level. Finally, exports seem to respond only to negative oil price shocks based on the scaled specification.

In sum, the statistical tests conducted in this section provide some evidence of asymmetric effects of oil price changes on investment and exports during the whole period 1985-2015. Furthermore, output in the oil sector, investment and exports record asymmetric responses to oil price shocks in the sub-period 1984-1998. While no clear evidence of asymmetric responses to oil price changes are found for the sub-period 1999-2015.

[22] Statistical tests for VAR models with 8 lags are available from the authors upon request.

Table 6
Sloped-Based Symmetry Tests of the Response to Oil Price Changes, *p*-values (1985-2015)

1985-1998

Variables	**Mork (1989)**			**Lee, Ni and Ratti (1995)**			**Hamilton (1996,2003)**	
	H_1	**H_2**	**H_3**	**H_4**	**H_5**	**H_6**	**H_7**	**H_8**
ΔOil	0.417	0.021*	0.628	0.010**	0.008**	0.007**	0.420	0.504
ΔNon-Oil	0.350	0.512	0.287	0.030*	0.129	0.036*	0.773	0.584
ΔConsumption	0.039*	0.309	0.066	0.040*	0.040*	0.033*	0.820	0.435
ΔGovernment	0.073	0.473	0.102	0.310	0.824	0.369	0.488	0.452
ΔInvestment	0.413	0.536	0.578	0.039*	0.845	0.186	0.003**	0.010**
ΔExports	0.904	0.187	0.822	0.220	0.048*	0.091	0.976	0.496
ΔImports	0.301	0.271	0.172	0.501	0.539	0.540	0.641	0.916
ΔPrices	0.005**	0.865	0.054	0.000**	0.376	0.010**	0.391	0.596
ΔER	0.207	0.344	0.284	0.188	0.859	0.553	0.645	0.119
ΔM2	0.418	0.098	0.761	0.033*	0.894	0.479	0.230	0.782

1999-2015

Variables	**Mork (1989)**			**Lee, Ni and Ratti (1995)**			**Hamilton (1996,2003)**	
	H_1	**H_2**	**H_3**	**H_4**	**H_5**	**H_6**	**H_7**	**H_8**
ΔOil	0.813	0.250	0.473	0.512	0.660	0.523	0.507	0.797
ΔNon-Oil	0.752	0.035*	0.683	0.941	0.151	0.705	0.814	0.641
ΔConsumption	0.493	0.021*	0.291	0.585	0.114	0.537	0.337	0.399
ΔGovernment	0.528	0.110	0.941	0.655	0.176	0.578	0.229	0.482
ΔInvestment	0.018*	0.264	0.243	0.261	0.144	0.824	0.129	0.167
ΔExports	0.957	0.009**	0.188	0.493	0.438	0.526	0.020*	0.782
ΔImports	0.816	0.026*	0.318	0.949	0.050*	0.466	0.287	0.535
ΔPrices	0.011**	0.425	0.461	0.127	0.147	0.572	0.133	0.027*
ΔER	0.182	0.667	0.733	0.179	0.233	0.589	0.437	0.990
ΔM2	0.384	0.490	0.434	0.158	0.101	0.278	0.751	0.031*

Table 6. Continued

1985-2015

Variables	Mork (1989)			Lee, Ni and Ratti (1995)			Hamilton (1996,2003)	
	H_1	H_2	H_3	H_4	H_5	H_6	H_7	H_8
ΔOil	0.808	0.217	0.391	0.793	0.762	0.965	0.172	0.882
ΔNon-Oil	0.507	0.113	0.611	0.626	0.309	0.892	0.439	0.323
ΔConsumption	0.123	0.324	0.853	0.231	0.538	0.919	0.423	0.836
ΔGovernment	0.296	0.598	0.804	0.157	0.567	0.266	0.259	0.381
ΔInvestment	0.017*	0.080	0.071	0.034*	0.354	0.455	0.009**	0.003**
ΔExports	0.796	0.132	0.242	0.501	0.655	0.606	0.016*	0.977
ΔImports	0.585	0.065	0.431	0.819	0.128	0.634	0.377	0.411
ΔPrices	0.001*	0.847	0.173	0.001**	0.326	0.210	0.136	0.334
ΔER	0.091	0.589	0.856	0.028*	0.194	0.455	0.299	0.552
ΔM2	0.484	0.308	0.701	0.182	0.648	0.423	0.500	0.174

Note: * and ** statistically significant at 5 and 1 percent level, respectively.

Impulse Response Functions

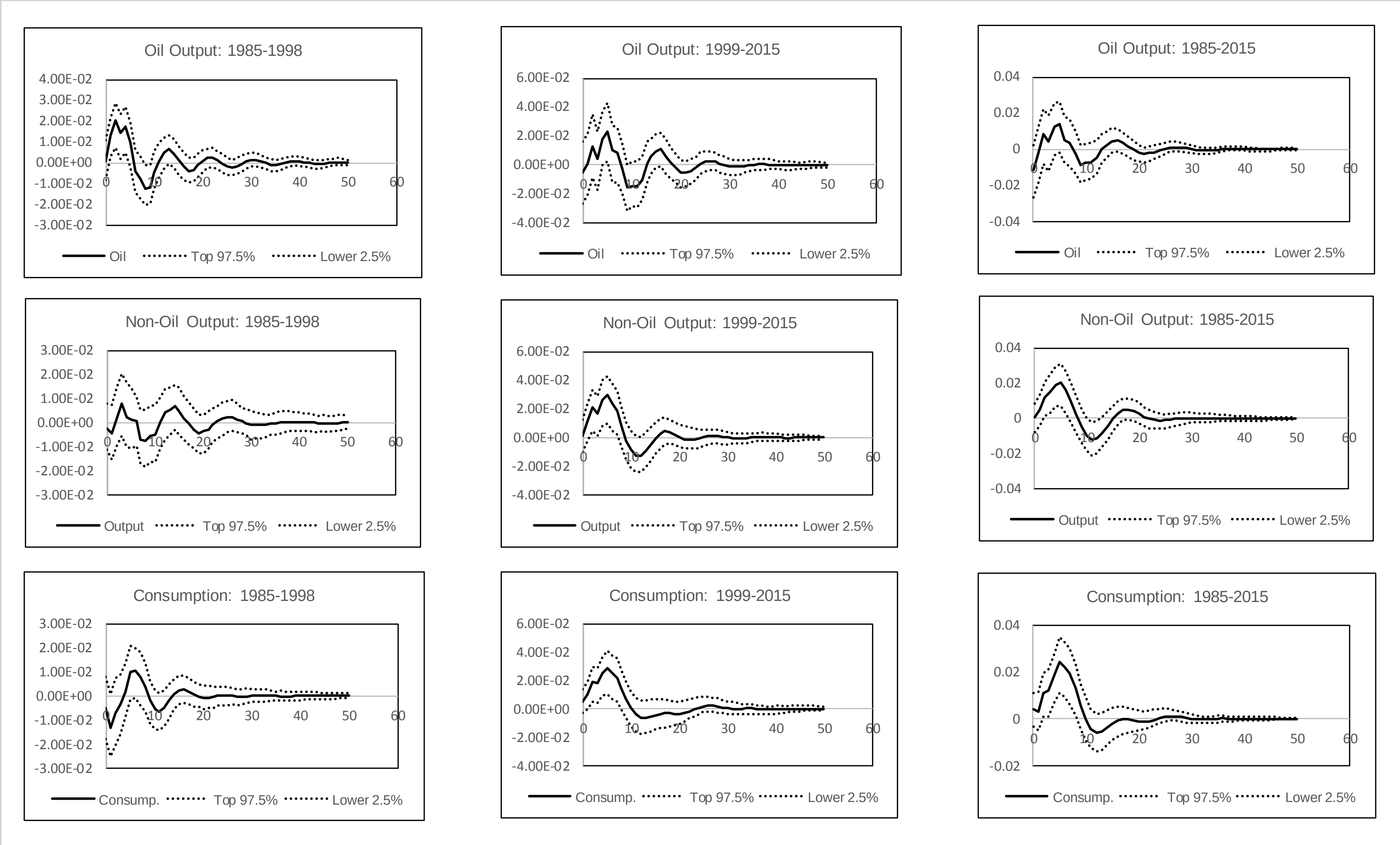
The effects of oil price changes on the economy during the period 1985-2015 as well as for the sub-periods 1985-1998 and 1999-2015 will be analysed in this section. Accumulated responses and impulse-response functions of the effects of a shock on the oil price equation for the macroeconomic variables under study are presented in Table 7 and Figure 3, respectively.

Table 7
Accumulated Response to a One-Standard-Deviation Oil Price Innovation (1985-2015)

Variables	**Period**	4 quarters	6 quarters	8 quarters	10 quarters	12 quarters
	1985-1998	0.066	0.072	0.052	0.035	0.041
ΔOil Output	1999-2015	0.030	0.063	0.069	0.039	0.014
	1985-2015	0.011	0.030	0.031	0.015	0.002
	1985-1998	0.005	0.007	-0.008	-0.018	-0.013
ΔNon-Oil Output	1999-2015	0.077	0.131	0.158	0.148	0.122
	1985-2015	0.051	0.087	0.099	0.084	0.060
	1985-1998	-0.027	-0.006	0.006	-0.002	-0.013
ΔConsumption	1999-2015	0.078	0.131	0.167	0.174	0.164
	1985-2015	0.049	0.095	0.127	0.132	0.122
	1985-1998	-0.051	-0.015	-0.013	-0.035	-0.047
ΔGovernment	1999-2015	0.129	0.207	0.239	0.225	0.204
	1985-2015	0.040	0.099	0.118	0.103	0.084
	1985-1998	-0.063	-0.039	-0.078	-0.119	-0.111
ΔInvestment	1999-2015	0.088	0.305	0.442	0.413	0.295
	1985-2015	-0.009	0.124	0.189	0.151	0.075
	1985-1998	0.035	0.044	0.032	0.021	0.027
ΔExports	1999-2015	0.046	0.089	0.111	0.077	0.042
	1985-2015	0.007	0.033	0.043	0.030	0.014
	1985-1998	-0.019	0.059	0.062	0.008	-0.038
ΔImports	1999-2015	0.244	0.374	0.385	0.309	0.248
	1985-2015	0.145	0.258	0.267	0.191	0.118
	1985-1998	0.249	0.220	0.223	0.245	0.246
ΔPrices	1999-2015	-0.058	-0.206	-0.342	-0.435	-0.527
	1985-2015	0.053	-0.065	-0.154	-0.176	-0.163
	1985-1998	-0.273	-0.208	-0.146	-0.140	-0.170
ΔER	1999-2015	-0.290	-0.255	-0.188	-0.174	-0.197
	1985-2015	-0.279	-0.231	-0.153	-0.125	-0.148
	1985-1998	0.119	0.164	0.157	0.119	0.091
ΔM2	1999-2015	-0.010	0.004	0.014	0.013	0.009
	1985-2015	0.034	0.061	0.065	0.050	0.035

The accumulated responses to a one-standard-deviation shock to the oil price equation presented in Table 7 show that the effects of the shock on the macroeconomic variables are mostly positive for the whole period 1985-2015, with the exception of the real exchange rate and prices. On the other hand, the sign of the effect is robust to changes in the sample period only for output in the oil sector, exports and the real exchange rate. The table also provides evidence of an economy more responsive to changes in the price of oil during the sub-period 1999-2015 than during the years 1985-1998 as the responses to an oil price shock for most variables are considerable higher during the former period –a clear exception is the quantity of money.

Figure 3
Responses to One Standard Error Shock in the Oil Price Equation (1985-2015)



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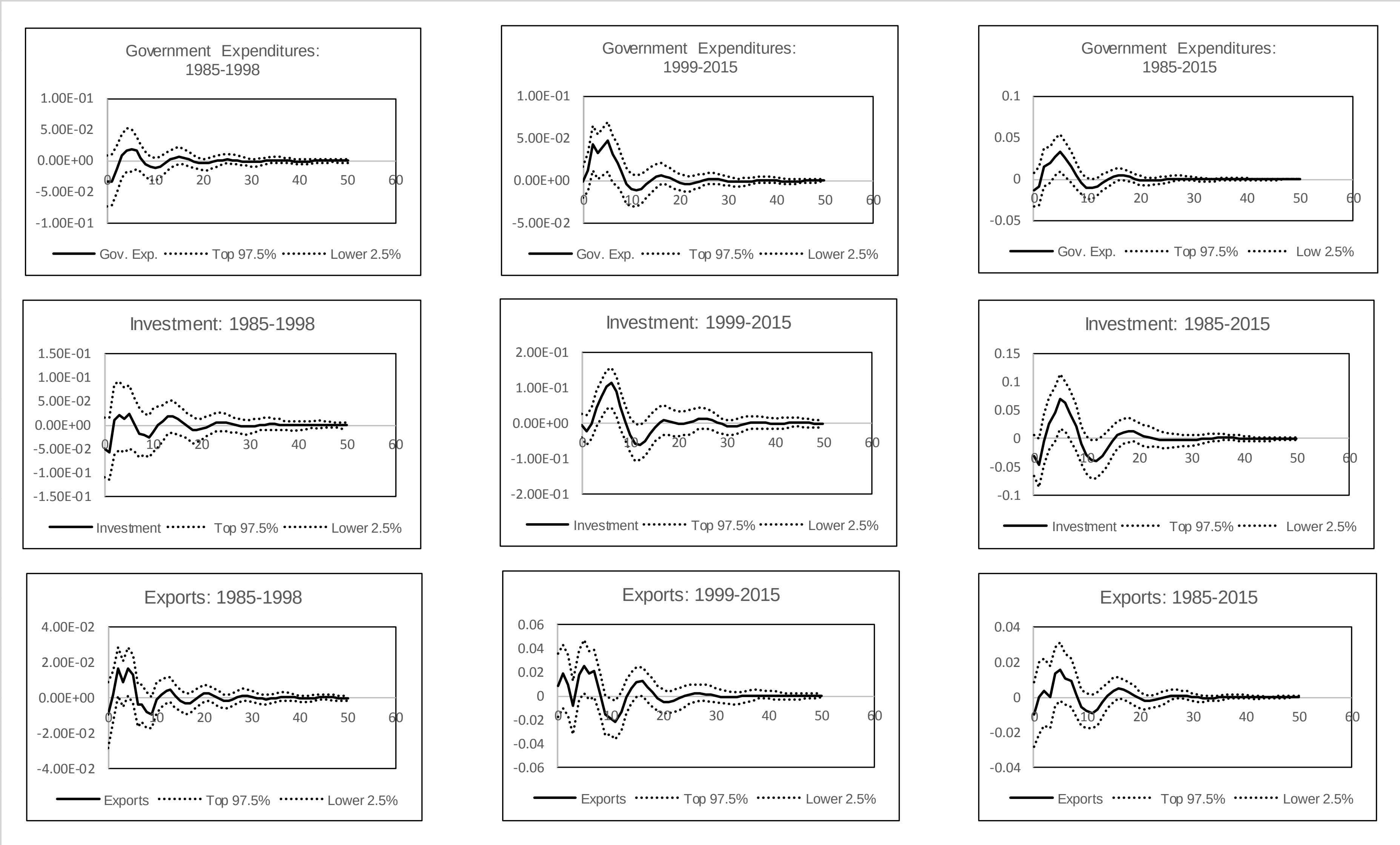

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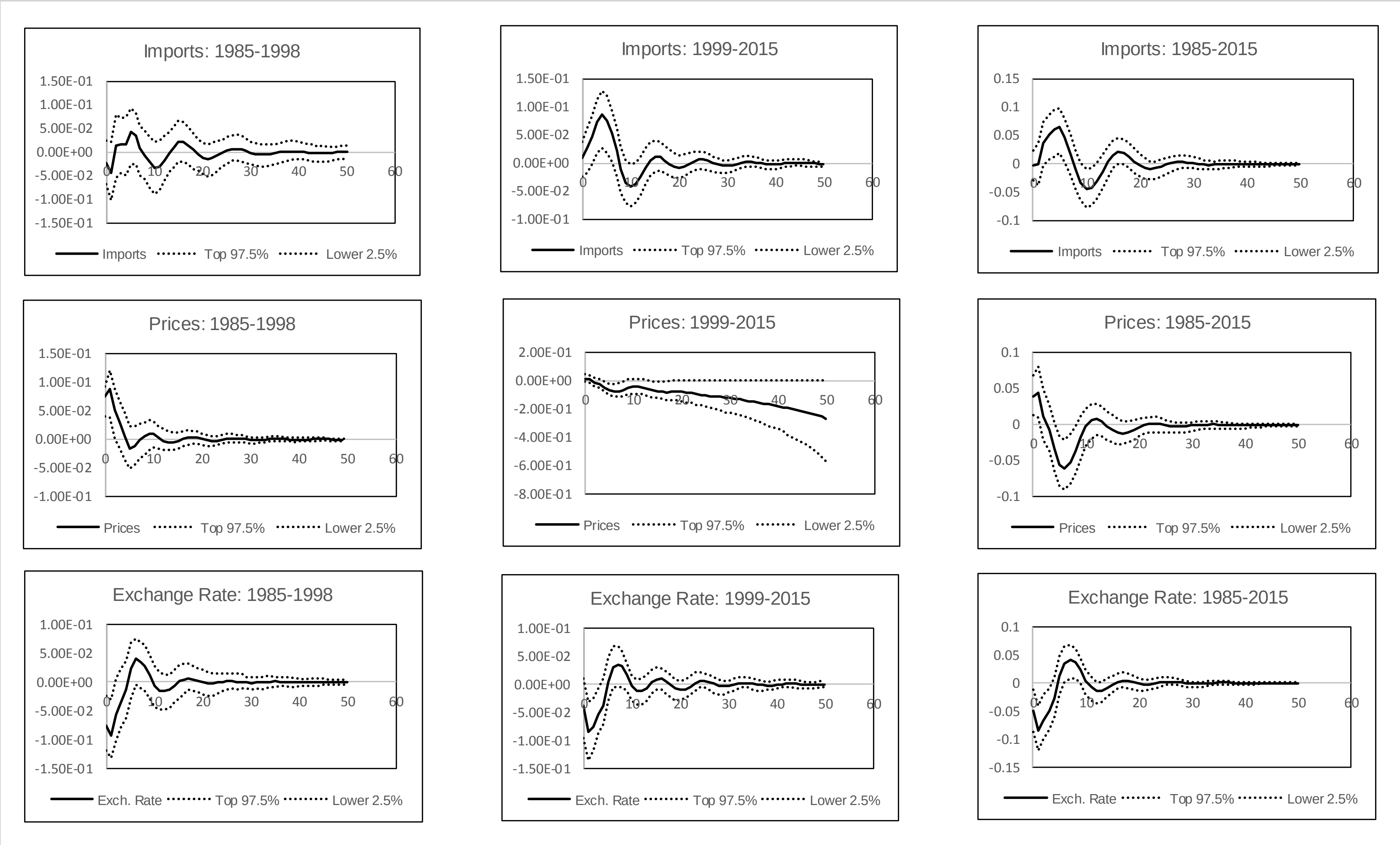
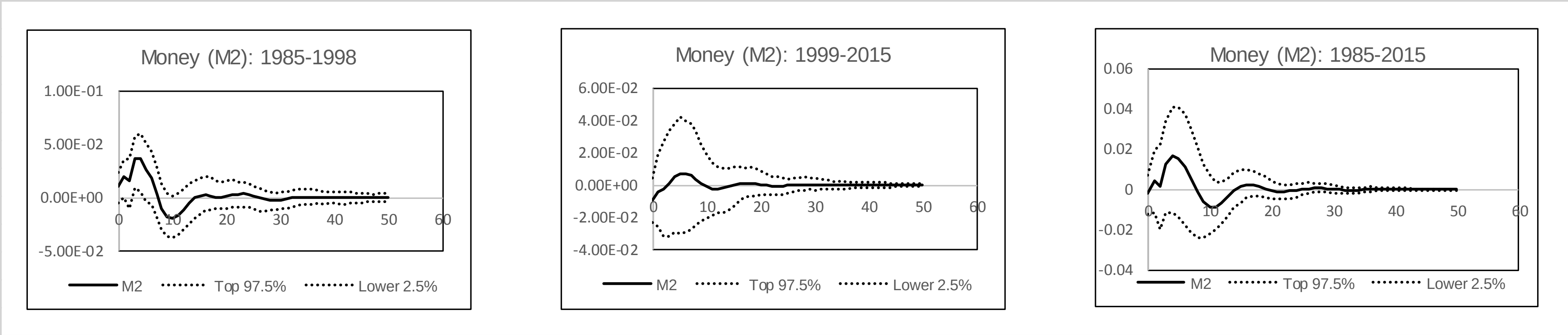


Figure 3. Continued.



Looking at the impulse response functions in Figure 3, it is possible to visualise the short-run dynamic described by the macroeconomic variables as a result of the shock. Although most variables exhibit a positive response to the shock, these effects are statistically significant mainly for the sub-period 1999-2015. Furthermore, for most variables the results found for this sub-period tend to dominate the outcomes obtained for the whole period 1985-2015. Hence, oil price changes have a statistically significant positive effect on variables such as output in the non-oil sector, consumption, government expenditures, investment and imports during the sub-period 1999-2015 as well as for the whole period 1985-2015, reaching a peak five to six quarters after the shock.[23] On the other hand, positive oil price changes have a statistically significant effect on output growth in the oil sector only for the sub-period 1985-1998, reaching a maximum two quarters after the shock. Similarly, positive statistically significant responses for the first sub-period and the whole period are found for prices, which reaches its maximum effect one quarter after the shock.[24] Finally, an increase of the real oil price has a negative effect on the real exchange rate (i.e. an appreciation). This response is statistically significant and robust to changes in the sample period, reaching the highest appreciation one quarter after the shock.

In the previous section, it was found that variables such as output in the oil sector, investment, and exports seem to respond asymmetrically to oil price changes. In particular, it was found that positive and negative oil price shocks seem to have impacts of different magnitudes on output growth in the oil sector according to scaled specification during the sub-period 1985-1998; investment seems to respond to negative oil price changes whenever this variable reaches new lows as reflected by the net oil price measurement during both the sub-period 1985-1998 and the whole period 1985-2015; and exports show an statistically significant correlation to net oil price increases during the entire time span 1985-2015, while in the sub-period 1984-1998 it only records a statistically significant correlation with negative oil price shocks based on the scaled specification. Given that the different models (i.e. linear, asymmetric, scaled and net) are not nested, the fitness of these models will be compared using selection criteria such as the Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (BIC). Table 8 shows these statistics for each econometric specification.

[23] An important difference to the results obtained during the period 1921-1970, output in the non-oil sector shows a no statistically significant response to oil price shocks once government expenditure is introduced into the VAR model. This outcome suggests that for the years 1999-2015 the effects of oil price changes on output work mainly through a fiscal channel.

[24] For the sub-period 1999-2015 the effect on prices is negative and the variable diverges because of the shock. Nevertheless, it is not statistically significant as indicated by the broad confident bands.

Table 8
Relative Performance of the Models (1985-2015)

1985-1998				
Variables	**Linear**	**Asymmetric**	**Scaled**	**Net**
ΔOil	AIC= 98.8359 **BIC= 90.0553**	AIC= 96.5227 BIC= 83.8396	**AIC= 100.8392** BIC= 88.1561	AIC= 79.0389 BIC= 67.4417
ΔInvestment	AIC= -2.2929 BIC= -11.0735	AIC= -4.4205 BIC= -17.1036	AIC= -1.4738 BIC= -14.1569	**AIC= 9.6098** **BIC= -1.9874**
ΔExports	AIC= 66.8854 **BIC= 58.1048**	AIC= 63.8793 BIC= 51.1962	**AIC= 67.4977** BIC= 54.8147	AIC= 48.9091 BIC= 37.3119
1985-2015				
Variables	**Linear**	**Asymmetric**	**Scaled**	**Net**
ΔOil	**AIC= 133.9296** **BIC= 121.3859**	AIC= 132.2147 BIC= 114.0960	AIC= 131.0721 BIC= 112.9534	AIC= 119.0743 BIC= 101.4041
ΔInvestment	AIC= 22.3409 BIC= 9.7972	AIC= 23.1379 BIC= 5.0192	AIC= 22.3306 BIC= 4.2119	**AIC= 31.0448** **BIC= 13.3745**
ΔExports	**AIC= 99.7143** **BIC= 87.1706**	AIC= 98.7556 BIC= 80.6369	AIC= 97.3812 BIC= 79.2625	AIC= 88.9133 BIC= 71.2430

The results presented in Table 8 show that for output in the oil sector the linear model outperforms the other specifications during the period 1985-2015. However, during the sub-period 1985-1998, the linear model only shows best fit according with the BIC while the AIC selects the scaled oil price specification. In relation to investment, the net oil price specification is preferred during both 1985-1998 and 1985-2015. Finally, the results obtained for the variable exports show that the linear model has the best fit during the whole period 1985-2015. Nevertheless, for the sub-period 1985-1998 the AIC selects the scaled oil price shock specification while the BIC favours the linear specification. Figure 4 shows the impulse response functions of the linear and non-linear models for these variables.

Figure 4
Responses to One Standard Error Shock in the Oil Price Equation
(Linear and Non-Linear Models: 1985-2015)

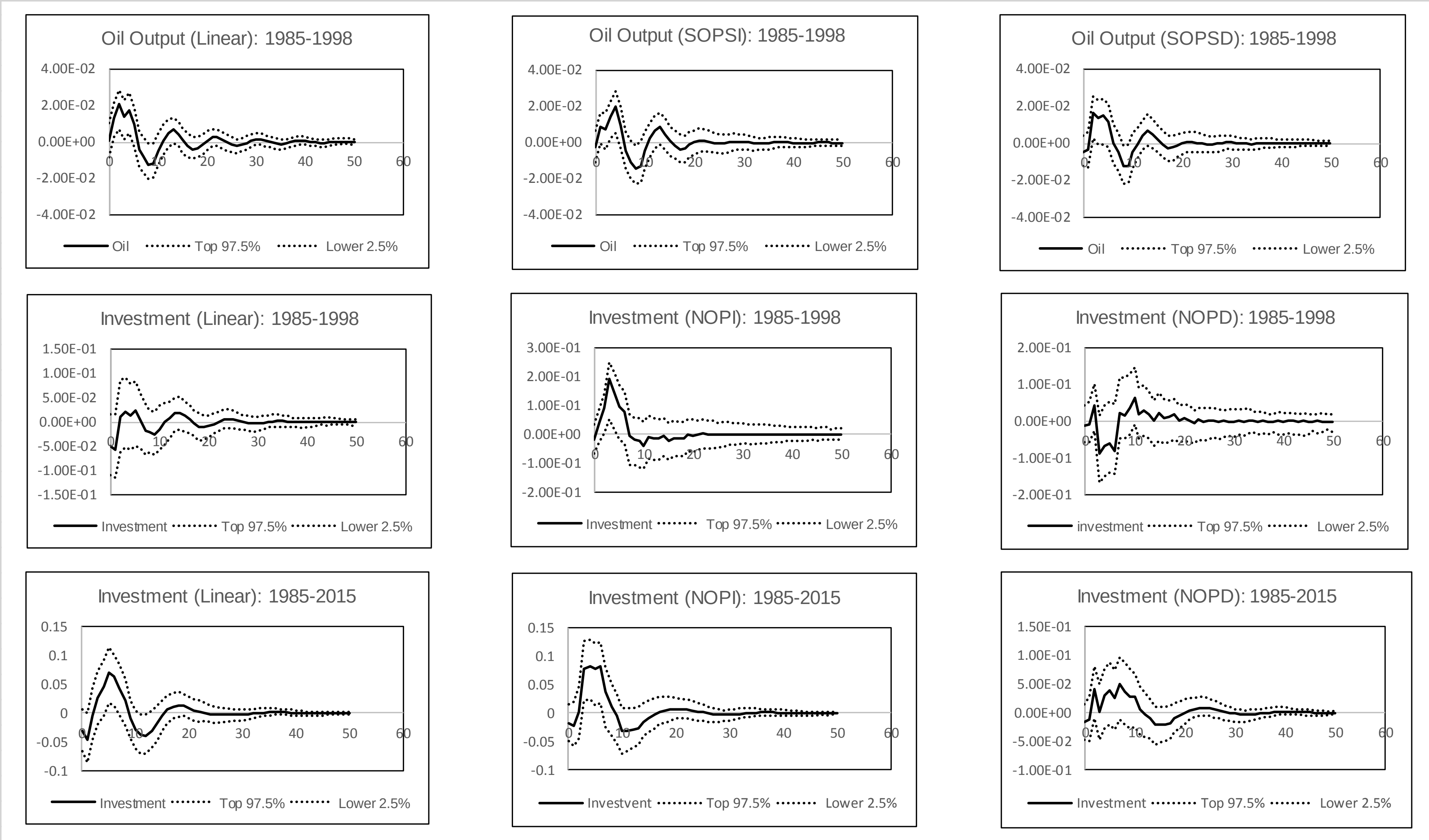
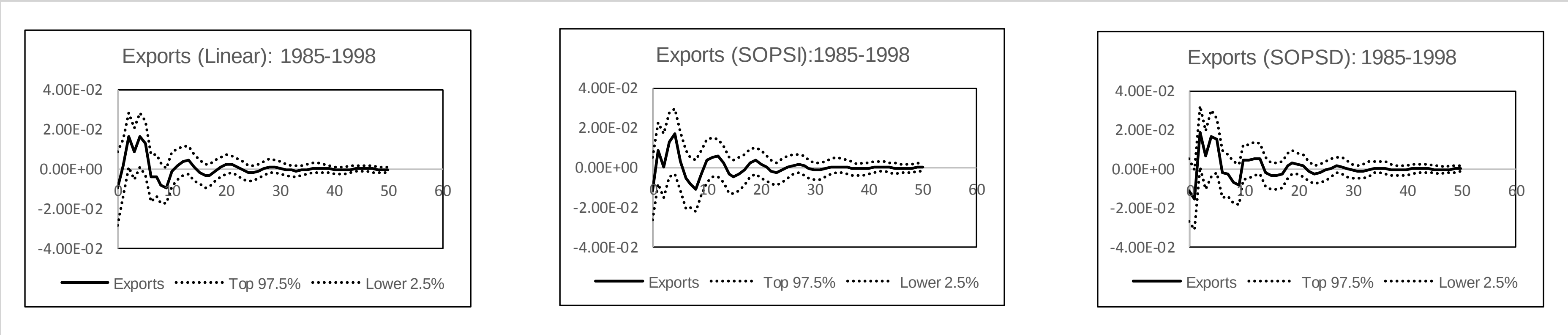


Figure 4. Continued.



Looking at the impulse-response functions for output in the oil sector during the sub-period 1985-1998, it is possible to observe that there are some differences in the response of the variable to positive and negative oil price shocks based on the scaled specification. Output in the oil sector increases because of a positive shock to the real price of oil, reaching a maximum four quarters after the innovation. This response is statistically significant from zero as shown by the confidence bands. Nevertheless, the variable appears to be unresponsive to negative oil price shocks, which is indicated by the broad confidence bands around the impulse-response.

Model specification seems to play a significant role in the response of investment to oil price changes; the linear model suggests a not significant response during the sub-period 1985-1998 while the net oil price specification indicates a positive significant response to an oil price hike, and not statistically significant response to a decrease in the price of oil. A similar response is observed for the whole period 1985-2015, although in this case there is more similarity between the responses obtained for the linear and the net oil price increase model. Surprisingly, investment does not show a statistically significant response to the net oil price decrease measurement during the different the periods under consideration.

Finally, an inspection of the impulse-response functions of exports shows that oil price shocks during 1985-1998 has no statistically significant effect on this variable according to both the linear and the scaled oil price increase/decrease specifications.

Forecast Error Variance Decomposition

This part of the study will assess how important oil price changes are as a source of short-run fluctuations during recent years in the economy of Venezuela. Table 9 presents the forecast error variance decomposition for the period 1985-2015 as well as for the sub-periods 1985-1998 and 1999-2015.

Table 9
Estimated Variance Decomposition at 1, 3, 5-period Horizon (%)

Variable	**1985-1998**			**1999-2015**			**1985-2015**		
	1 Year	**3 Years**	**5 Years**	**1 Year**	**3 Years**	**5 Years**	**1 Year**	**3 Years**	**5 Years**
ΔOil	41.90	50.63	51.73	4.85	14.97	16.89	4.37	8.30	8.88
ΔNon-Oil	3.04	6.20	8.28	24.41	43.24	44.05	14.68	29.25	30.83
ΔCon	7.45	15.79	16.00	28.96	44.57	44.39	14.01	34.45	34.60
ΔGov	9.28	12.35	12.72	24.52	36.81	37.15	7.39	15.91	16.17
ΔInv	5.89	7.22	8.03	12.04	44.93	45.36	6.53	18.91	19.96
ΔExp	14.40	18.53	18.87	6.37	20.32	22.13	2.18	6.61	7.05
ΔImp	4.36	9.42	10.35	25.36	38.06	37.89	11.62	24.78	26.14
ΔPrices	37.08	36.99	36.87	11.98	25.26	26.09	14.44	27.87	28.04
ΔER	33.77	37.68	37.79	25.00	26.90	26.33	27.03	32.22	32.05
ΔM2	22.26	28.09	27.39	0.44	0.74	0.76	1.96	3.61	3.69

A look at the results presented in the table above shows that for the period 1985-2015 changes in the price of oil play a significant role as a source of business cycle fluctuations in the economy. A large proportion of the changes in macroeconomic variables such as output in the non-oil sector, consumption, imports, prices and the real exchange rate seem to be explained by movements in the real price of oil. Nevertheless, the contribution of oil price changes to economic fluctuations can change substantially according to the time span under consideration.

Hence, it is possible to see that oil price changes explain a considerably large proportion of the short-run fluctuations of variables like output in the non-oil sector, consumption, government spending, investment and imports during the sub-period 1999-2015, but not during the years 1985-1998. For example, during the sub-period 1985-1998 oil price changes explain a relatively low percentage of the variation of output in the non-oil sector (3-8%), which contrasts sharply with the proportion obtained during the sub-period 1999-2015 (24-44%). Interestingly, the high percentage during the years 1999-2015 can drop significantly once government expenditure is added as an exogenous variable in the model (13-24%), which is an indication that the effects of unexpected changes in the real price of oil might be operating through the fiscal policy channel. On the other hand, the importance of oil prices as a source of short-run fluctuations in the oil sector real output is considerable higher in the sub-period 1985-1998 than in 1999-2015. This result seems to suggest that during the period that became known as the "Apertura Petrolera" (or New Oil Opening), in which the state-owned oil company promoted a series of joint ventures with foreign oil companies to exploit oil fields previously abandoned by the company, oil price changes played a more prominent role in the determination of the economic activity in the sector -during the period 1999-2015 these commercial agreements were modified reducing the participation of the private enterprises in the industry. These results could reflect the significant structural changes experienced in the country during the period 1999-2015 when a higher state intervention in the economy is observed.

Extension

The changing effects of the unexpected real oil price fluctuations on the studied macroeconomic variables are better visualised by computing rolling impulse response functions as introduced by Blanchard and Gali (2007). The advantage of this approach is that it allows a gradual change of the effects of oil price shocks on the economy rather than a discrete break in a particular time period. Figure 5 presents the rolling impulse responses using a moving window of 40 quarters with the first window centred in 1991.

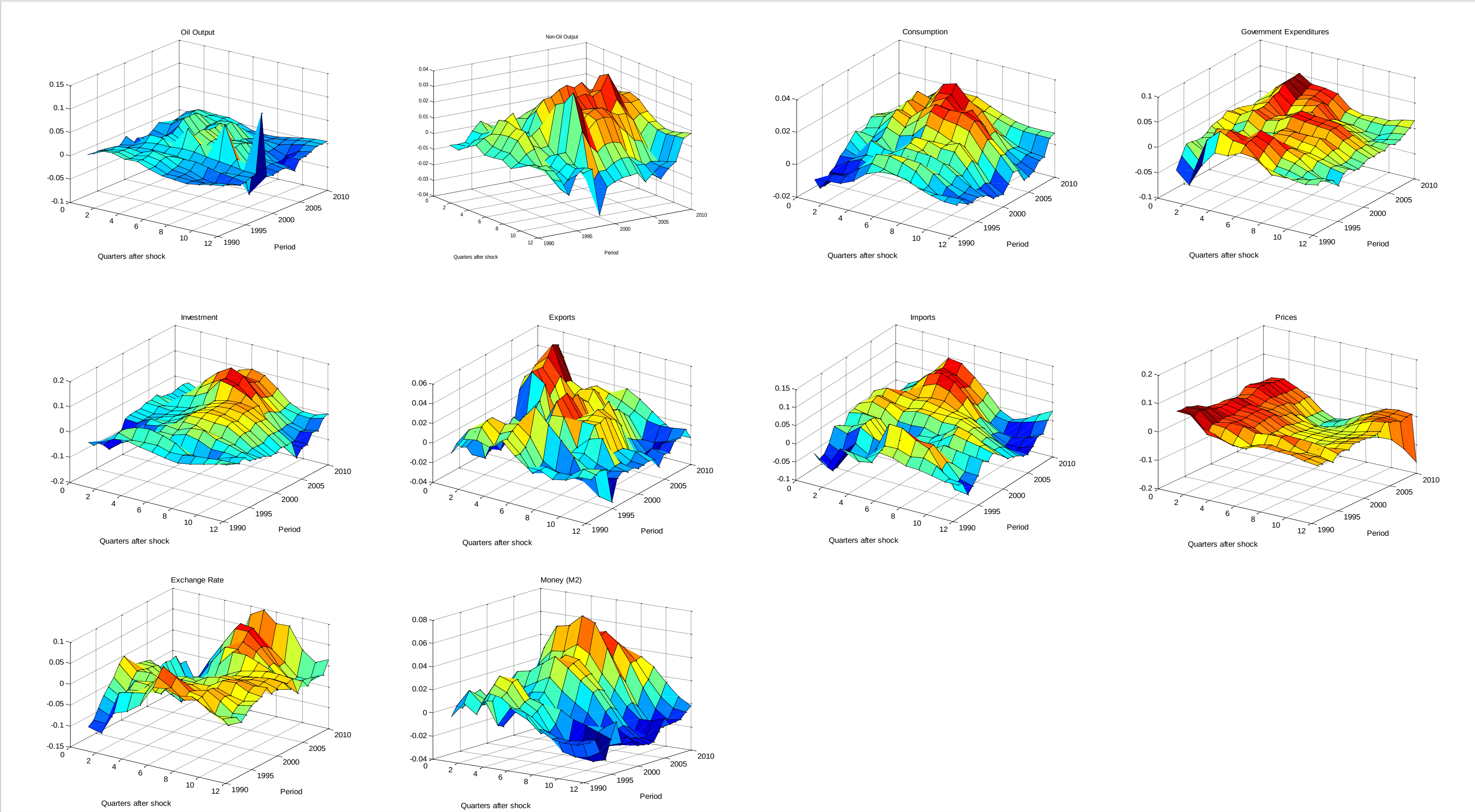
Figure 5 shows that the response of most variables to oil price changes starts to become more pronounced in the late 1990s and the beginning of the 2000s. An important exception to this pattern is output in the oil sector, whose response to an oil price shocks starts to become more muted at the end of the 1990s. Similarly, the real exchange rate shows a relatively flat response (minor appreciation) around the years 1998-2002, however, from the early 2000s it starts exhibiting increasing negative responses to unexpected oil price rises.[25] For most of these variables the increasing response to oil price shocks is not sustained over time though. Variables like output in the non-oil sector, consumption, investment, imports and money growth reach a maximum in the middle of the 2000s to then start becoming less responsive to these shocks. In the case of government expenditures, however, the increasing response to oil price changes continues until the end of the series. Another interesting feature that emerges from analysing the rolling impulse responses is that while the real activity variables like output and most of the aggregate demand component attain a maximum response five to six quarters after the shock, monetary variables such as prices and the real exchange rate are considerably

[25] As can be observed in the graph, before the late 1990s the responses of the real exchange rate to unexpected increases in the price of oil were becoming less pronounced each time.

swifter in reaching the maximum impact, which can only take two quarters to be fulfilled.[26] Finally, the variable exports tend to behave slightly differently as it only start to show an increasing response around the year 2004, but only for a short time span as it begins to exhibit a quitter reaction to the shocks after 2008.

[26] Government expenditures, exports and M2 are clear exceptions to these patterns as the variables reach their highest responses three, two and six quarters after the innovation, respectively.

Figure 5
Rolling Impulse Response Functions (1985-2015)



IV. Conclusions

Oil production has played a prominent role in shaping the economy of Venezuela for more than a century. After being a rural economy based on the production (and export) of a few agricultural products at the beginning of the twentieth century, the development of the oil industry powered the expansion of important economic activities such as manufacturing and commerce in the country. Consequently, the importance of understanding the interaction between the oil industry and the rest of the economy can hardly be overstated; oil production has accounted for near 33 percent of total real GDP in the past, it generates near 98 percent of the total foreign currency available in the country, and it is the most important source of fiscal revenue for the nation with a contribution which has been as high as 70 percent in some years. This empirical study strives to make contributions in the understanding of the relationship between the oil sector and the rest of the economy by examining how unexpected changes in the price of oil have influenced the behaviour of key macroeconomic variables over time in Venezuela.

Clearly, the significance of studying the effects of oil price changes on the economy is not constrained to countries like Venezuela where the oil sector accounts for a relatively large share of the economy. The economic impacts of oil price shocks have long been studied in a large range of developed economies, which are mostly net oil-importing countries, to determine the significance of these shocks explaining short-run fluctuations. The dominant view in the extant literature is that unexpected oil price changes are an important source of business cycle fluctuations, and that the effects of oil price shocks on real output are not symmetric; oil price increases are associated with drops in real economic activity while oil price decreases have been found to be not correlated with output changes. While this has been the empirical findings for most net oil-importing nations, in the case of net oil-exporting countries the evidence suggests that there is a positive linear association between oil price changes and real output. This relationship between oil price shocks and real economic activity is sometimes explained in terms of a fiscal policy mechanism; oil price changes drive fiscal revenues which in turn exacerbate output fluctuations. According to this interpretation of the effects of oil price shocks on the economy, unexpected oil price changes do not have an independent effect in the economic activity (Hussain *et al*., 2008).

In this study the impacts of oil price shocks on real output (oil and non-oil sectors), aggregate demand components, and some monetary variables (prices, real exchange rate and money supply) have been assessed for the periods 1920-1970 and 1984-2015. The distinction between the two periods is important, among other reasons, because of major structural changes that have brought the increasing state intervention in the economy in recent years.

Even though the documented positive association between unexpected oil price changes and real output has been found in Venezuela, the study reveals that such a relationship is far from stable, and that the channels by which the oil price changes are transmitted to the non-oil economy might have been different during the time periods under consideration. Hence, it has been found that a positive shock to the oil price equation increases real output in the non-oil sector during the periods 1920-1970 and 1999-2015, but not statistically significant association is found for the sub-period 1984-1998. Furthermore, there seems to be evidence that the channels by which the oil price changes affect the economy have changed overtime; oil price shocks appear to exert an independent influence on economic activity in the years 1920-1970, while their impact on the economic cycle during the period 1999-2015 seems to come through their effects on government spending. By contrast, real output in the oil sector looks responsive to oil price shocks during the sub-period 1984-1998, which can be associated with the New Oil Opening policy, but not during years 1920-1970 and 1999-2015 when oil production was most likely constrained by capacity and OPEC quotas, respectively.

In relation to the asymmetric effects of oil price shocks, the evidence found in the study suggests that only output in the oil sector and real investment seem to respond asymmetrically to oil price movements during the period 1984-2015 (more precisely during the years 1984-1998); output in the oil sector increases because of a positive shock to the price of oil while being unresponsive to a negative oil price innovation; similarly, investment rises when the price of oil reaches new highs and shows not statistically significant association for oil price decreases. Evidence of an asymmetric response to oil price shocks for output in the non-oil sector was not found, a result that contrasts with evidence presented in previous studies.

Finally, rolling impulse responses indicate that most macroeconomic variables exhibit a more responsive reaction to unexpected changes in the price of oil in the late 1990s and beginning of the twenty first century. This response, however, starts to fade away for most variables after the mid-2000s when the reaction of the variables to the shock becomes significantly more muted -an important exception to this pattern is the dynamic described by government spending, which exhibits significant responses until the end of the period.

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