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A Structural Analysis of Oil Price Shocks on the Jamaican Macroeconomy

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Abstract

This paper utilizes Structural Vector Autoregression models to examine the impact of oil price shocks on key Jamaican macroeconomic variables over the period 1997:01 - 2012:06. The results indicate that oil price shocks largely do not have a permanent effect on the Jamaican economy. Furthermore, the findings suggest that an oil shock emanating from an increase in global aggregate demand generally precedes an improvement in the domestic economy while demand shocks associated with precautionary holdings of oil (oil-specific demand shocks) and oil supply shocks generally result in deterioration in domestic macroeconomic variables. Although most of the shocks dissipate within four quarters, appropriate policy measures aimed at containing inflation expectations should be implemented within the short-term to prevent a deviation from the monetary authority's targets.

Keywords: Oil price, vector autoregressions, oil demand shocks, oil supply shocks

JEL classification: E31, E32, Q43

[1] The views expressed in this paper are not necessarily those of the Bank of Jamaica.

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1. Introduction

Researchers and policy makers have invariably had an intrinsic interest in commodity price movements owing to their correlation with major macroeconomic events. This interest has emerged since the 1970s when significant fluctuations in crude oil prices triggered on-going examination of the impact of oil price shocks on macroeconomic variables. Arguably, global macroeconomic volatility and stagflation during the 1970s and 1980s have been largely attributed to oil supply shocks (Baumeister et al 2010). These shocks were triggered by major political or economic events such as the Iranian Revolution in 1979 and the collapse of the Organization for the Petroleum Exporting Countries (OPEC) in 1986. Since then, other shocks such as the invasion of Kuwait in 1990/91, the Asian crisis in 1997-2000 and the global financial crisis in late-2008 have preceded increases in oil prices (see Appendix **Figure 1a**). While much of the early literature suggested that spikes in fuel prices primarily resulted from oil supply disruptions, more recent studies indicate that the demand for oil has significantly fomented a large portion of the uptick in oil prices since the 1970s (Kilian, 2009).

Research has revealed that sharp increases in the real price of oil have had an impact on the global business cycle through productivity levels and the level of real interest rates in the economy. For Jamaica, oil remains the most important raw material in various production processes. As a result, the oil bill has accounted for approximately 31.3 per cent of the total value of imports over the past ten years. Given the importance of oil in the production process, volatility in oil prices has major implications for domestic price stability and other macroeconomic variables. Against this background, an assessment of the relationship between these shocks and the macroeconomic variables in the Jamaican economy is warranted.

This paper therefore seeks to examine the impact of oil shocks on key Jamaican macroeconomic variables including real GDP, inflation, the nominal exchange rate, the current account balance and interest rates. While previous studies such as Burger et al (2009) have explored the impact of oil shocks on Jamaica's external capital structures, this paper seeks to broaden the scope to include the impact on domestic macroeconomic variables. The shocks explored in this paper registered varied outcomes based on the type of disturbance. In particular, the results suggest that an oil shock emanating from an increase in aggregate demand is likely to contribute to an improvement in the domestic economy while oil-specific demand shocks and oil supply shocks would likely result in a deterioration in domestic macroeconomic variables. In this regard, the paper recommends the prompt implementation of monetary policy measures to support the impact of aggregate demand shocks and to offset the negative effects of oil specific demand and oil supply shocks.

The remainder of the paper is organized as follows: Section 2 presents stylized facts. Section 3 discusses a review of the literature on oil price shocks and the macroeconomy. Section 4 presents the data considerations and methodology while empirical results are discussed in Section 5. Concluding remarks and policy recommendations are presented in Section 6.

1.1 Trends in the Oil Market

Crude oil, despite its non-renewable characteristics, has been increasingly lauded as a vital resource for energy generation. While natural gas and other sources of alternative energy have become progressively popular in recent years, crude oil continues to dominate world energy demand. Notably, countries of the Organization for Economic Cooperation and Development (OECD) demand more crude oil when compared to non-OECD countries (see **Appendix Figure 2a**). Over the period 2002 – 2011, crude oil consumption by the OECD countries accounted for approximately 57.5 per cent of total world consumption. In particular, the United States of America (USA), a member of the OECD, has been the largest oil-consuming economy, accounting for approximately 21.5 per cent (18.8 million barrels per day (bpd)) of crude oil consumption in 2011. China, a non-OECD country and the second largest consumer after the USA, accounted for 10.2 per cent (8.9 million bpd) of global oil demand during the same period. Demand from OECD countries has, however, shown a trend decline while demand from non-OECD countries has consistently increased over the review period (see **Appendix Table 1a**). The contrasting trend of oil demand between the OECD and non-OECD countries indicates the impact of the rise in fuel demand from China and other major emerging markets over the years whereas the declining trend in fuel demand by the OECD countries suggests the gradual usage of alternative means of energy by some advanced economies. According to estimates by the Energy

Information Administration (EIA), between 1980 and 2011, world oil consumption grew by 38.5 per cent to 87.4 million bpd, primarily due to increased fuel consumption in China.[2]

Consistent with the rise in fuel consumption, global supplies of crude oil have also increased over the years. Supplies grew by 36.1 per cent to 87.1 million bpd in 2011 from 64.0 million bpd in 1980 (see **Appendix Figure 3a**). Much of this increase reflected improved technological innovations which have facilitated more efficient oil production and thus an expansion in supplies. OPEC represents the largest source of global oil production, supplying 42.8 per cent of the market in 2011 (see **Appendix Table 2a**). However, based on projections by the International Energy Agency (IEA), by 2020, the USA is expected to become the world's largest oil-producing country ahead of Saudi Arabia, the top oil-producer in 2012. This projected surge in oil and gas production in the USA has been attributed to upstream technologies that release light tight oil and shale gas resources. In this regard, US oil imports should record a persistent decline resulting in North America becoming a net oil exporter by 2030.[3]

Crude oil is categorized based on its grade and origin.[4] With respect to its origin, oil is placed into "streams" and is in turn priced in accordance with a 'benchmark' grade *inter alia* West Texas Intermediate (WTI) for North American oil and Brent Crude oil, produced in Europe, Africa and the Middle East. Dubai is the benchmark for Middle East oil supplied to the Asia-Pacific region.

As it relates to the domestic market, the Petroleum Corporation of Jamaica (PCJ) and bauxite companies are the primary importers of fuel in Jamaica. The PCJ purchases crude oil in accordance with the PetroCaribe Energy Accord and imports and distributes oil derivatives such

[2] The augmented demand for fuel in China stemmed from the accelerated pace of growth in that economy. In its 2012 publication of the World Energy Outlook (WEO), the International Energy Agency (IEA) projected that global energy demand will rise by more than one-third over the period 2012 to 2035, broadly influenced by an anticipated 60.0 per cent rise from China, India and the Middle East. The IEA also projects a marginal increase in energy demand from OECD countries, reflecting growth in consumption of natural gas and renewable oil in lieu of some crude oil, coal and nuclear energy consumption. Notwithstanding the growth in low carbon sources of energy, fossil fuels should remain the main source of energy.

[3] Tight oil is a petroleum play that entails light crude oil contained in petroleum-bearing formations of relatively low porosity and permeability (shales). It uses the same horizontal well and hydraulic fracturing technology (the propagation of fractures in a rock layer as a result of the action of a pressurized fluid) used in recent boom in production of shale gas.

[4] The grade of oil consists of its relative weight, sulphur content namely 'sweet' or 'sour' and its viscosity such as 'light', 'intermediate' or 'heavy'.

as liquid petroleum gasoline (LPG), automotive diesel oil and kerosene.[5] Notwithstanding the arrangement, the prices paid for these products are linked to their US Gulf Reference Prices, which is the WTI price (see **Appendix Figure 4a**).

2. Literature Review

Studies on the relationship between oil price shocks and macroeconomic variables have been widespread.[6] Hamilton (1983), in his seminal paper, highlighted that a sharp increase in crude oil prices was a precursor to seven of the eight post-war US recessions, particularly during the 1948-72 period, based on the statistical significance of the correlation between oil shocks and real GDP. He proposed three hypotheses: (1) recessions coinciding with oil price increases occurred by a mere coincidence (2) the correlation resulted from an endogenous explanatory variable which generated both the oil price increases and the recessions and (3) an exogenous increase in the price of crude petroleum prompted some of the recessions in the United States before 1973. The paper concluded that the third hypothesis can be substantiated. That is, the timing, magnitude, and/or duration of a portion of the recessions predating 1973 would have yielded an alternative outcome in the absence of the oil price increase or fuel supply shortfalls.

While Hamilton (1983), (1996) and Bernanke et al. (1997) support the exogeneity of the major increases in the price of oil, research has demonstrated that there is insufficient evidence to give credence to this school of thought (see Kilian (2008, 2009, 2010); Peersman and Robays (2009); Baumeister et al. (2010)). In particular, Kilian (2008) focused on the exogeneity of oil shocks since 1973 with a view to ascertaining the means by which shortfalls in oil production resulting from wars and other exogenous political events in OPEC countries affect oil prices, US real GDP growth and US CPI inflation. He determined that increases in oil price generally resulted in a significant contraction in US GDP five quarters subsequent to the shock and that only a miniscule proportion of the observed oil price shock resulted from exogenous disruptions to oil supplies during crisis periods. In addition, the results indicated that a sharp rise in US CPI occurred three

[5] The PetroCaribe agreement is preferential arrangement between Venezuela and 13 Caribbean islands for the purchase of oil. Jamaica has been purchasing oil under this facility since 2005.

[6] See (Barsky and Kilian (2002, 2004) and Kilian (2008, 2009, 2010).

quarters after the exogenous oil supply shock in contrast with the commonly held view of a sustained increase in inflation.

Against this background, Kilian highlighted in 2009 that the impact of oil price shocks on the real price of oil was due to the origin of the shock. In particular, oil price shocks were decomposed under the assumption of endogeneity of the price of oil. It entailed a structural decomposition of the real price of crude oil into three categories namely (1) crude oil supply shocks, representing sharp increases in oil prices emanating from disruptions to crude oil production; (2) aggregate demand shock, reflecting increases in oil price driven by expansion in global economic activity and (3) oil-specific demand shocks, resulting from higher precautionary demand primarily due to concerns regarding near-term shortages in oil supply during periods of political unrest. In his analysis, Kilian asserted that a rise in oil prices was largely influenced by positive global aggregate demand shocks as well as increased precautionary demand for oil in lieu of the actual supply disruptions. The paper estimated the relationship between these shocks and the real price of oil and concluded that the type of oil shock determined the impact of higher oil prices on US real GDP and CPI inflation which also had implications for the design of national energy policy frameworks.

Baumeister et al. (2010) examined a set of industrialized economies to determine the economic consequences of oil shocks as defined by Kilian (2009) & Peersman and Van Robays (2009). Their main findings indicated that oil demand shocks associated with global economic activity resulted in a temporary increase in real GDP for all economies subsequent to an increase in oil price. Contrastingly, oil-specific demand shocks were revealed to contribute to a temporary decline in real GDP.[7] Furthermore, their findings suggested that, in the context of an adverse oil supply shock, net oil-importing economies all encountered a permanent contraction in real GDP while the impact was insignificant or positive for oil-exporting economies. The results for the pass-through to inflation were varied among oil-importing economies. Notwithstanding, the results indicated that the pass-through to inflation in an oil-importing economy was contingent on second-round effects largely reflected in upward movements in wages while the pass-through in an oil-exporting economy was limited largely in the context of the appreciation of the effective

[7] Aggregate demand shocks are associated with an expansion in global economic activity while oil-specific demand shocks represent a demand shock specific to the oil market whereby growth in precautionary demand for fuel would result from increased fears of future fuel supply shortages.

exchange rates following an oil supply shock. The paper also revealed reduced vulnerability to oil shocks in the case of economies with a favourable net energy position.

Other studies have sought to examine the relationship between oil shocks and the current account in oil-importing/exporting countries. In the case of Turkey, an oil-importing economy, Ozlale (2010) used a structural vector autoregression (SVAR) model to assess the impact of oil price shocks on the current account deficit. The results showed that the current account deficit to GDP ratio increased gradually in response to an oil price shock within the first three months before declining, which indicated a significant effect of oil price shocks in the short-run. Similarly, the discussion in Chuku et al. (2011) utilized an SVAR over the period 1970 to 2008 to assess the relationship between oil price shocks and current account dynamics in Nigeria, an oil exporter and importer. Oil price shocks were shown to have a significant positive effect on current account deficits for Nigeria but this only obtained in the short-run. As such, the policy implications for the garnering of benefits associated with oil price shocks on the Nigerian economy included increased emphasis on reserve-augmenting strategies, lax monetary policy and heightened international financial integration.

In relation to the Caribbean, Burger et al. (2009) examined the potential for a dampened impact of oil price shocks on external accounts via a country's external capital structure.[8] The economies analyzed were highly vulnerable to oil price shocks, particularly an oil-importer such as Jamaica and an oil-exporter, Trinidad and Tobago. The findings demonstrated that Jamaica's external capital structure possessed many vulnerabilities in the context of a high debt-to-GDP ratio as well as substantial negative foreign exchange exposure. Against this background, Burger et al. (2009) recommended that Jamaica should adjust the composition of its net international reserves (NIR) portfolio with a view to stimulating capital gains in the event of adverse oil market shocks.[9] In this regard, the paper suggested the adoption of an official reserves portfolio that is positively correlated with oil prices.[10] Conversely, Burger et al. (2009) indicated that although Trinidad and Tobago's capital structure was not vulnerable to currency fluctuations, there was still scope to mitigate the impact of oil shocks on the external accounts by hedging against the macroeconomic

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[8] External capital structure can be defined as the composition of foreign assets and liabilities according to instrument, currency and maturity.

[9] Capital gains are the differences between changes in the net foreign asset position and the current account balance.

[10] For example, the official reserves portfolio could be positively correlated with the currencies of oil exporting countries such as Norway and Canada in order to increase capital gains from oil price shocks.

effects of such shocks. Thus, Trinidad and Tobago could augment capital gains amid oil shocks by modifying the structure of its NIR portfolio to incorporate an increased exposure to foreign assets that have a negative correlation with movements in oil prices.

3. Methodology & Data Considerations

Using the methodology of Kilian (2009), the impact of oil price shocks on the Jamaican economy was estimated via two main steps. The first step involved the examination of movements in the real price of crude oil in order to determine the underlying demand and supply shocks that affect the crude oil market. This step will be outlined in section 3.1. The second step encompassed the estimation of the response of Jamaican macroeconomic variables to these shocks as demonstrated in section 3.2.

3.1 Determining the underlying demand and supply shocks that affect the crude oil market

In undertaking the first step highlighted above, a multivariate structural vector autoregression (SVAR) model was estimated utilizing monthly data over the sample period 1997:01–2012:06 for the vector time series, z_t = $(\Delta prod_t \, , \, rea_t \, , \, rpo_t)'$ where $\Delta prod_t$ represented the per cent change in the production of crude oil globally, rea_t was a measure of global real economic activity in industrial commodity markets and rpo_t was the real price of crude oil with rea_t and rpo_t being expressed in logs. The term global "real economic activity" refers to an index of real economic activity which influences industrial commodity markets and is used in lieu of the broadly understood concept of real economic activity associated with world real GDP or industrial output. The index was adopted largely due to the availability of data at a monthly frequency as well as the failure of measures of value added to capture demand in commodity markets.[11] The oil data was garnered from the US Energy Information Administration (EIA) and the IEA. The real price of oil is measured by the nominal refiner acquisition cost of imported

[11] Of note, this measure of crude oil prices represents the best proxy for the free market global price of imported crude oil in the literature. See Kilian (2009) for a full discussion of the rationale and construction of this index.

crude oil deflated by US CPI, which is widely used in the literature. Data on Jamaican macroeconomic variables were obtained from the Bank of Jamaica's database.

The model utilized a lag length of 2 months based on the criteria selection [sequential modified LR test statistic (LR), Final Prediction Error (FPE), Akaike information criterion (AIC) and Hannan Quinn information criterion (HQ)], to which the SVAR representation of the model consisting of a vector of serially and mutually uncorrelated structural innovations, ε_t, may be seen below:

$$A_0 z_t = \propto + \sum_{i=1}^{2} A_i \; z_{t-i} + \varepsilon_t \quad (1)$$

The structural innovations were generated from imposing exclusion restrictions on A_0^{-1}. Fluctuations in the real price of oil were underpinned by three structural shocks: ε_{1t}, which captured crude oil supply shocks, ε_{2t}, which denoted aggregate demand shocks and ε_{3t}, which represented a demand shock specific to the oil market. The latter was geared towards capturing shifts in precautionary demand for fuel that coincided with increased concerns regarding the availability of future oil supplies.

Under the assumption that z_t will respond to shocks to each variable in the vector, additional restrictions were imposed. In terms of the restrictions on A_0^{-1}, it was assumed that:

(1) $a_{12} = 0$ and $a_{13} = 0$ which impose the restrictions of no response from crude oil production to aggregate demand shocks and oil-specific demand shock, respectively, within the same month. This is on the premise that there are high costs associated with an adjustment to oil production and as such an increase in the supply of crude oil is only expected to be significantly influenced by a persistent rise in demand.

(2) $a_{23} = 0$ which assumes that an increase in the real price of oil emanating from oil-specific demand shocks will not reduce global real economic activity in industrial commodity markets within the month.

Notably, innovations to the real price of oil that cannot be explained by oil supply shocks or aggregate demand shocks must be demand shocks that are specific to the oil market.

The foregoing assumptions yielded a recursively identified model with reduced form errors, $e_t = A_0^{-1}\ \varepsilon_t$ of the form:

$$(2) \qquad e_t = \begin{pmatrix} e_t^{\Delta prod} \\ e_t^{\ rea} \\ e_t^{\ rpo} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{\ oil\ supply\ shock} \\ \varepsilon_t^{\ aggregate\ demand\ shock} \\ \varepsilon_t^{oil-specific\ demand\ shock} \end{pmatrix}$$

3. 2 Estimating the response of Jamaican macroeconomic variables to Oil Price Shocks

An examination of the impact of crude oil demand and supply shocks on the Jamaican economy would necessitate estimations of the relationship between the structural innovations in equation (1) and selected Jamaican macroeconomic variables. In augmenting the study done by Kilian (2009) which only focused on the impact of oil shocks on GDP and inflation, additional macroeconomic variables were included to provide a more holistic analysis of the impact of oil shocks on the Jamaican economy. As a result, the variables under analysis include real GDP (Δy_t), quarterly point-to-point inflation rate (π_t), the quarterly end of period (e.o.p) nominal exchange rate between the US dollar and the local currency (XR_t) the quarterly e.o.p 180-day Treasury Bill yield (IR_t), represented in differences, as well as a measure of Jamaica's external accounts, the current account balance (CA_t) expressed in log differences.[12] In order to facilitate the inclusion of quarterly variables such as real GDP in this analysis as well as maintain the

[12] The 180-day Treasury Bills (T-Bills) yield was utilized in this study as BOJ does not have a policy rate that consistently captures monetary policy actions. For example, in September 2000, BOJ introduced 270 and 360-day tenors with higher margins but did not increase rates. Similarly, in November 2008 BOJ tightened policy by introducing a special 180-day Certificate of Deposit at 20.5 per cent but did not increase rates on its other instruments. Rates on 180-day OMO instruments remained at 15.35 per cent while there was an increase in yields on 180-day T-Bills. There have been also several instances when the longer term rates were increased but the shorter term rates were unchanged. In all instances yields on T-Bills responded to the policy actions. T-bills also capture market sentiment.

identifying assumptions, quarterly shocks were constructed by averaging the monthly structural innovations implied by the VAR model in equation (1) for each quarter:,

$$(3) \qquad \hat{\zeta}_{jt} = \frac{1}{3}\sum_{i=1}^{3} \hat{\varepsilon}_{j,t,i}, \quad j = 1, \ldots, 4$$

Where $\hat{\varepsilon}_{j,t,i}$ is the estimated residual for the *j*th structural shock in the *i*th month of the *t*th quarter of the sample.

These shocks were treated as exogenous based on the identifying assumption of no feedback from $\Delta y_t, \pi_t, XR_t, IR_t$ *and* CA_t to $\hat{\zeta}_{jt}$, j = 1,...,3 within a given quarter. In this context, the dynamic effects of the shocks on Jamaica's real GDP, inflation, exchange rate, interest rate and current account deficit were examined based on quarterly regressions of the form and lag length selection criteria in equations (4-8), respectively:

$$(4) \qquad \Delta y_t = \alpha + \sum_{i=0}^{1} \emptyset_i \hat{\zeta}_{jt-i} + u_t, \quad j = 2, \ldots, 4$$

$$(5) \qquad \pi_t = \delta + \sum_{i=0}^{1} \psi_i \hat{\zeta}_{jt-i} + v_t, \quad j = 2, \ldots, 4$$

$$(6) \qquad XR_t = \beta + \sum_{i=0}^{1} \varphi_i \hat{\zeta}_{jt-i} + w_t, \quad j = 2, \ldots, 4$$

$$(7) \qquad IR_t = \gamma + \sum_{i=0}^{1} \omega_i \hat{\zeta}_{jt-i} + z_t, \quad j = 2, \ldots, 4$$

$$(8) \qquad CA_t = \theta + \sum_{i=0}^{1} \rho_i \hat{\zeta}_{jt-i} + x_t, \quad j = 2, \ldots, 4$$

where u_t, v_t, w_t, x_t, z_t were potentially serially correlated errors while $\hat{\zeta}_{jt}$ was a serially uncorrelated shock. The respective impulse response coefficients were denoted as $\emptyset_i$, ψ_i, φ_i, ω_i and ρ_i.

The equation-by-equation approach shown in equations (4-8), is consistent with the premise that the quarterly shocks $\hat{\zeta}_{jt}$, j = 1,...,3, are mutually uncorrelated. In essence, despite the potential existence of some omitted variable bias, the particularly low contemporaneous correlations between the quarterly shocks and autoregressive residuals of the selected macroeconomic variables permitted the quarterly shocks to be treated as orthogonal or uncorrelated. Notably, low correlations in turn gave credence to the estimation of separate equations for each shock (see Table 3a in Appendix). The equation-by-equation approach was deemed the most parsimonious in assessing the impact of oil shocks on macroeconomic variables. This conclusion is based on an examination of additional investigations by Kilian (2009b) of alternative methodologies comprising the estimation of equivalent equations (4-8) which included current and lagged values of all shocks. To the extent that there was a lack of data availability given the need for five lags for each shock, this alternative approach was found to be unsuitable. Another alternative entailed the addition of lagged dependent variables as regressors in equations (4-8). Since strict exogeneity of $\hat{\zeta}_{jt}$ with respect to each macroeconomic variable was a necessary condition for this alternative, it was found to be infeasible for the purposes of the study as such a condition would eliminate the effects of shocks on the macroeconomic variable (Kilian 2009b,2006a,b,c). In this regard, the equation-by-equation approach was found to be the most viable methodology.

4. Discussion of Results

With the incorporation of the quarterly structural innovations into the five quarterly VAR models as shown in equations (4-8), the results of the impact of the three oil price shocks on macroeconomic variables could be analyzed. These shocks were generated by aggregating the monthly disturbances from equation (1) for each quarter over the sample period 1997:Q1 – 2012:Q2. The Augmented Dickey-Fuller test was employed to verify the existence of a unit root in the variables. The results indicated that all variables, excluding the inflation rate and the interest rates, possessed a unit root as shown in **Table 4a.** Notwithstanding, the results of the stability tests for all variables revealed that no root lies outside of the unit circle, reflecting the satisfaction of the VARs stability conditions (See **Figure 5a**). Further robustness checks on the VARs based on the Portmanteau Tests for Autocorrelations revealed that the residuals were serially uncorrelated (See **Tables 5a-9a)**. The impulse response functions are reported in **Figures 6a** to **10a**.

The impact of both oil demand and supply shocks on real GDP failed to dissipate in the short-term, albeit having a marginal impact on domestic output (see **Figure 6a**). The initial response of real GDP was a contraction under an oil supply shock and an oil specific demand shock. These shocks were mostly statistically insignificant in both cases. However, an aggregate demand shock resulted in an initial expansion in domestic output which was statistically significant at the 5 per cent level. The outcomes were largely consistent with the literature. However, there was a slight deviation in the persistence of an oil supply shock to real GDP possibly reflecting the integral role of oil in the production process of the Jamaican economy. In contrast, though higher oil prices emanate from an aggregate demand shock, other factors including gains from international trade arising from increased global demand can influence the response of real GDP to the oil price shift.[13] In all cases, output returned to a steady state equilibrium after 20 quarters. Additional statistical analysis has shown that over the period 1997-2012, crude oil prices had a weak linear relationship with output in Jamaica, as evidenced in a low positive correlation of 0.1. While most research findings indicate at least a negative correlation between the two variables, the low positive correlation could, however, be attributed to particular factors affecting the local economy. Some of these factors include Jamaica's high inelastic fuel demand which indicates that irrespective of the directional movement in oil prices, Jamaica's dependence on the commodity is necessary for domestic production.

Regarding the response of inflation to an oil supply shock, inflation declined temporarily during the first two quarters with no impact observed thereafter, yielding a statistically insignificant result at the 5 per cent level (see **Figure 7a**). As a result, policymakers need not be concerned about the impact of supply disruptions in major oil producing countries on domestic inflation in the short term. This outcome can be ascribed to the fact that supply disruptions in one area typically result in increased oil production in other regions to compensate for the shortfall. In addition, such disruptions are largely concentrated in the Middle East thereby having a greater influence on Brent crude oil prices in comparison to the benchmark WTI prices. In contrast, an acceleration in inflation was observed in the third quarter, albeit statistically insignificant at the 5

[13] See Baumeister et al. (2010).

per cent level, in relation to the impact of an aggregate demand shock. As a result, the monetary authorities may need to implement temporary price stabilizing measures only in the event of an adverse change in inflation expectations. Oil-specific demand shocks resulted in an initial acceleration in inflation within the first two quarters prior to decelerating by the fourth quarter. This was statistically significant at the 5 per cent level. Again, a temporary impact on inflation is observed indicating the need for possible implementation of short-term monetary policy measures to stem an increase in inflation expectations and further rise in other prices such as wages. The findings were largely consistent with those by Kilian (2009) on the US economy.

In terms of the nominal exchange rate, there was a marginal depreciation following an oil supply shock, although statistically insignificant (see **Figure 8a**). Similarly, an aggregate demand shock engendered depreciation of the domestic currency, particularly within the first two quarters. This shock yielded a statistically significant result at the 5 per cent level. Some investors, based on ignorance of the source of the shock, may initially respond by increasing the demand for foreign currency for portfolio rebalancing. In addition, there could be an expansion in demand for foreign currency for current account transactions as investors increase the input in the production process to meet the growth in external demand. This depreciation, however, dissipates by the third quarter reflecting the impact of the improvements in Jamaica's major trading partners on foreign currency earnings in the domestic economy. This result is consistent with findings from Baumeister et al (2010) where oil-importing countries experienced an initial depreciation of their currencies in the near term followed by a correction thereafter. Similarly, an oil-specific demand shock led to depreciation in the exchange rate within the first two quarters in keeping with uncertainty in the oil market leading to possible hoarding or speculative behaviour by local investors. This impact was, however, found to be relatively small.

Regarding interest rates, the impact of oil price demand and supply shocks was largely consistent with the literature. An increase in market interest rates is expected within the first four quarters of an oil supply and oil specific demand shock (see **Figure 9a**). While the impact was statistically significant in the case of the oil specific demand shock, the converse holds as it relates to the oil supply shock. Arguably, the increase in market interest rates stemming from an oil-specific demand shock could be associated with price stabilizing measures and efforts made by the Central Bank to maintain stability in the foreign exchange market. Similarly, the impact of the shocks emanating from oil supply disruptions on interest rates can be attributed to initiatives to maintain stability of the domestic currency.. In response to an aggregate demand shock, interest rates fell initially but increased by the third quarter. The effect of this shock on interest rates was not significant at the 5 per cent level. The direction of the shock may be due to the effect of improvements in global economic activity and by extension domestic economic activity resulting in a decline in market interest rates within the first two quarters. As the pace of economic activity accelerates, interest rates rise, possibly indicating the need to prevent demand-induced inflationary pressures. As shown in Baumeister et al. (2010), high oil prices stemming from shocks to oil supplies and increases in aggregate demand were characterized by higher interest rates in all net energy-importing economies. Regarding the oil-specific demand shock, interest rates increased to possibly curtail inflationary pressures emanating from this shock.

In relation to the response of Jamaica's external accounts to an oil supply shock, the current account deficit increased within the first two quarters (see **Figure 10a**). This result could be associated with the initial high fuel prices generally associated with reduced supplies of oil which in turn leads to an increase in the value of imports and hence an overall deterioration in the trade balance. As other oil producers augment supplies and some countries cut demand, fuel prices fall which then leads to a reduction in the deficit by the third quarter. In contrast, aggregate demand and oil-specific demand shocks resulted in lower current account deficits within the first two quarters but this impact was reversed by the third quarter. The initial reduction in the deficit may be attributed to the impact of the gains from global economic activity which offset the impact of the higher prices of oil. The responses of the current account deficit to all three shocks were statistically insignificant at the 5 per cent level.

In an effort to delve more deeply into the extent to which each shock contributed to the responses by the respective macroeconomic variables, variance decompositions were conducted (see **Tables 10a-14a)**. [14] With respect to the oil supply shock on real GDP, inflation, exchange rate, interest rate and the current account deficit, variance decompositions indicated that this shock accounted for 4.2 per cent, 4.9 per cent, 0.4 per cent, 0.7 per cent and 2.0 per cent of the movements in each

[14] While impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

variable by the third quarter. Overall, this shock is shown to have the smallest impact but eliminates the trade- off between economic growth and inflation for monetary policymakers since both real GDP and inflation decelerate in response to this shock as shown in the impulse response analysis thereby supporting expansionary monetary policy.

Regarding the aggregate demand shock on real GDP, inflation, exchange rate, interest rate and the current account deficit, the respective variance decompositions highlighted that this shock contributed to 10.5 per cent, 0.7 per cent, 26.0 per cent, 4.0 per cent and 1.5 per cent of movements by the third quarter. Despite the results from the impulse response which suggest an eventual acceleration in inflation, the variance decomposition indicates the negligible importance of the shock to inflation and the current account deficit which increases the scope for policy makers to implement growth inducing strategies in the short-run.

As it relates to the oil demand shock, variance decompositions demonstrated that 5.2 per cent, 8.5 per cent, 1.6 per cent, 6.0 per cent and 2.0 per cent of movements in real GDP, inflation, exchange rate, interest rate and the current account deficit can be attributed to this shock within the first three quarters. The relatively high importance of the shock to inflation increases the scope for policy makers to implement price stabilizing policies. The temporary fall in economic activity in combination with the rise of consumer prices create a trade-off for monetary policy-makers.

The results of this study were comparable to those of Baumeister et al. (2010) on oil-importing and oil-exporting countries including the Euro area and other advanced economies as well as Kilian (2009) with respect to the US economy. While Kilian (2009) solely looked at the impact of shocks on real GDP and inflation, Baumeister et al. (2010) incorporated a more fulsome analysis of the impact of oil shocks on macroeconomic variables including real GDP, inflation, interest rates and exchange rates. Notably, neither of these studies analyzed the impact of shocks on the current account. The initial responses of real GDP were consistent across all of these studies. Interestingly, Baumeister et al. (2010) found that net oil and non-oil energy-importing economies underwent a permanent fall in real economic activity as a result of an oil supply shock while in the Jamaican case explored in this study, a recovery was observed after a year which can be attributed to Jamaica's inelastic demand for oil. The findings for the response of inflation were largely comparable with those by Kilian (2009) on the US economy, particularly as it relates to the positive response of inflation to an oil-specific demand shock while the results for Baumeister et al. (2010) varied for oil-importing countries. In a context where oil-importing countries experienced an initial depreciation of their currencies and a correction thereafter, the results for the exchange rate response was mostly in line with findings from Baumeister et al (2010). In like fashion to this study, the results as indicated by Baumeister et al. (2010) were such that high oil prices stemming from shocks to oil supplies and increases in aggregate demand were characterized by higher interest rates in all net energy-importing economies. In sum, the impulse responses were largely in keeping with key studies on the impact of oil shocks on the macroeconomy.

5. Conclusion

Given the exposure of the Jamaican economy to oil price shocks, an analysis of the impact of these disturbances on the major macroeconomic indicators was deemed important. In addition, recognizing that increases in oil prices could stem from either demand or supply related developments, the shocks were decomposed in an effort to understand the impact of various oil shocks on the Jamaican economy and its implications for monetary policy.

Consistent with the literature, the effects of the shocks on the macroeconomic variables of the Jamaican economy varied in accordance with the type of shock. Changes in oil prices stemming from increased global aggregate demand generally led to an improvement in domestic macroeconomic variables. However, higher oil prices emanating from a shock to global crude oil supplies or from a perceived threat to future oil supplies (leading to speculative demand) would result in an overall deterioration in Jamaica's economy. Of note, the impact of oil price shocks on the Jamaican macroeconomy largely failed to exhibit permanent effects. This could be associated with the relative dependence on oil, reflected in Jamaica's fairly inelastic demand for the product. Notably, the results point to the fact that if appropriate policy measures fail to be implemented in the short-term, it could result in a deterioration in selected macroeconomic indicators which could lead to a permanent negative impact on the overall economy. Against this background, the paper recommends that monetary policy initiatives aimed at curtailing the adverse effects of oil specific demand and oil supply shocks be implemented if the policy objectives are threatened. Expansionary monetary policy is recommended in the case of an oil supply shock in order to stimulate domestic output while price stabilizing policies are recommended following an oil-specific demand shock. Policy actions should also be implemented to augment the impact of an aggregate demand shock. In this regard,growth inducing policies should be implemented in the event of an AD shock in order to augment the impact on real GDP but is contingent on policy objectives being pursued in terms of the trade-off between growth and price stability. Given the conclusions, it would be useful to study the impact of price shocks to agricultural raw materials on the domestic macroeconomic variables to determine if the results hold for all imported raw materials.

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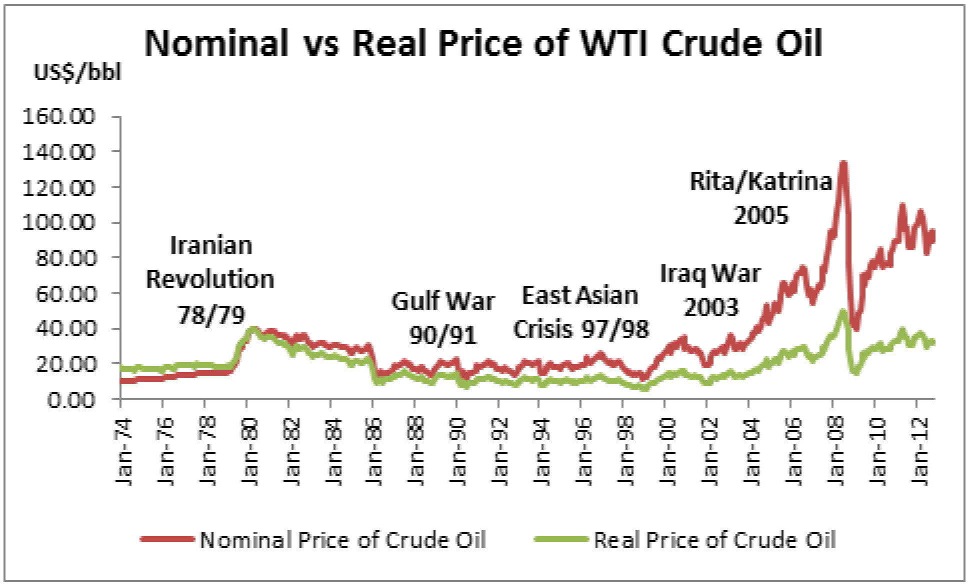
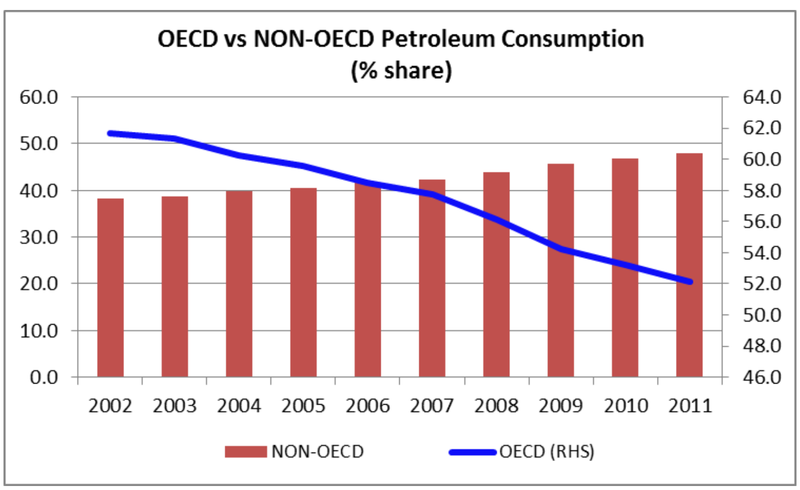
Appendix

Figure 1a



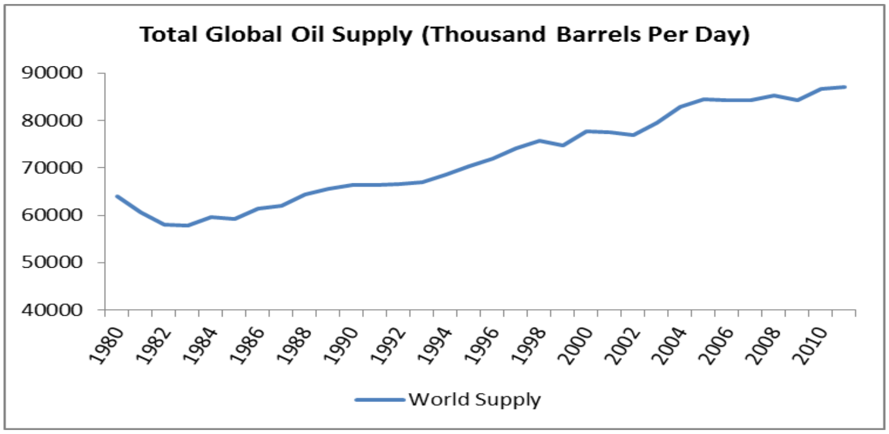
Source: Bloomberg

Figure 2a



Source: Energy Information Administration

Figure 3a



Source: Energy Information Administration

Table 1a: Top Oil-Consuming Countries: Consumption (Thousand Barrels per day) & Share of Global Consumption in 2011

United States	18,835	21.5%
China	8,924	10.2%
Japan	4,464	5.1%
India	3,426	3.9%
Saudi Arabia	2,986	3.4%
Brazil	2,793	3.2%
Russia	2,725	3.1%
Germany	2,400	2.7%
Canada	2,259	2.6%
South Korea	2,230	2.6%

Source: Energy Information Administration

Table 2a: Top Oil-Producing Countries: Production (Thousand Barrels per day) & Share of Global Production in 2011

OPEC	30,122	42.8%
Russia	9,943	14.1%
Saudi Arabia	9,311	13.2%
United States	5,659	8.0%
China	4,080	5.8%
Iran	3,576	5.1%
Western Europe	3,195	4.5%
Venezuela	2,881	4.1%
Kuwait	2,659	3.8%
Iraq	2,653	3.8%
United Arab Emirates	2,565	3.6%

Source: OPEC

Figure 4a

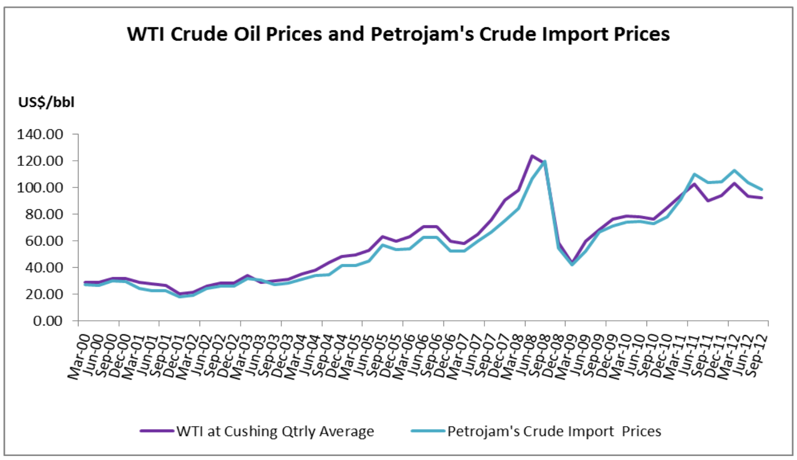


Table 3a: Contemporaneous correlation of quarterly shocks with Autoregressive Residuals for selected Jamaica macroeconomic variables

	Oil Supply Shock	Aggregate demand shock	Oil-specific demand shock
Real GDP	0.009	0.395	0.135
Inflation	-0.320	0.176	-0.161
Exchange Rate	-0.218	0.273	0.307
Interest Rate	-0.118	0.095	0.056
Current Account	0.150	0.082	0.204

Table 4a: Unit Root Tests

(Augmented Dickey-Fuller t-statistic)

	Level		**1st difference**		**Degree of Integration**
	T-Statistic	P-value	T-Statistic	P-value	
Real GDP	-2.5622	0.1068	-19.2779	0.0000	I(1)
Inflation Rate	-5.5254	0.0000	-	-	I(0)
Exchange Rate	-1.0604	0.7258	-4.8191	0.0002	I(1)
Interest Rate	-8.0892	0.0000	-	-	I(0)
Current Account	-2.6428	0.0902	-13.1600	0.0000	I(1)

Lag lengths in the ADF regressions were chosen by the Bayesian information criterion.
Asymptotic critical values are: 1 percent, -3.51; 5 percent, -2.89; 10 percent, -2.58

Figure 5a: Stability Condition Tests

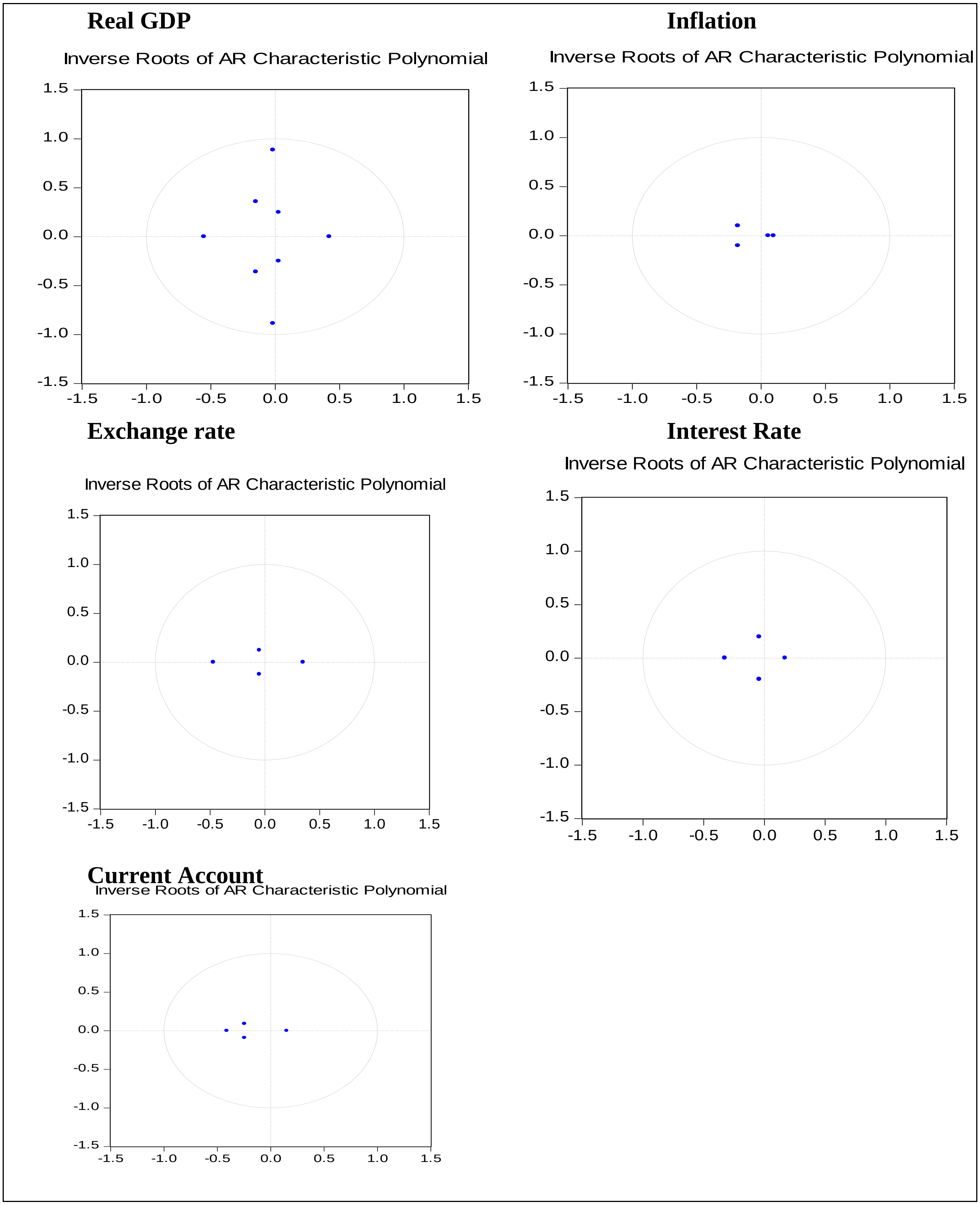


Table 5a: Real GDP Autocorrelation test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 02/12/13 Time: 16:16
Sample: 1997Q1 2012Q2
Included observations: 59

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	8.525442	NA*	8.672433	NA*	NA*
2	17.32332	NA*	17.77901	NA*	NA*
3	37.74929	0.1280	39.29923	0.0961	29
4	52.56783	0.2043	55.19548	0.1419	45

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution
*df and Prob. may not be valid for models with exogenous variables

Table 6a: Inflation Autocorrelation test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 02/12/13 Time: 16:20
Sample: 1997Q1 2012Q2
Included observations: 60

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	11.86208	NA*	12.06313	NA*	NA*
2	26.13026	0.6185	26.82332	0.5812	29
3	44.25690	0.5033	45.90399	0.4345	45
4	62.17170	0.4342	65.09842	0.3361	61

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution
*df and Prob. may not be valid for models with exogenous variables

Table 7a: Exchange Rate Autocorrelation test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 02/12/13 Time: 16:22
Sample: 1997Q1 2012Q2
Included observations: 60

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	10.94135	NA*	11.12680	NA*	NA*
2	30.41066	0.3937	31.26746	0.3529	29
3	48.29284	0.3413	50.09081	0.2785	45
4	64.10392	0.3682	67.03125	0.2780	61

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution
*df and Prob. may not be valid for models with exogenous variables

Table 8a: Interest Rate Autocorrelation test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 02/12/13 Time: 16:27
Sample: 1997Q1 2012Q2
Included observations: 60

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	9.720715	NA*	9.885473	NA*	NA*
2	34.05432	0.2373	35.05817	0.2026	29
3	48.72004	0.3257	50.49576	0.2654	45
4	61.47620	0.4588	64.16308	0.3663	61

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution
*df and Prob. may not be valid for models with exogenous variables

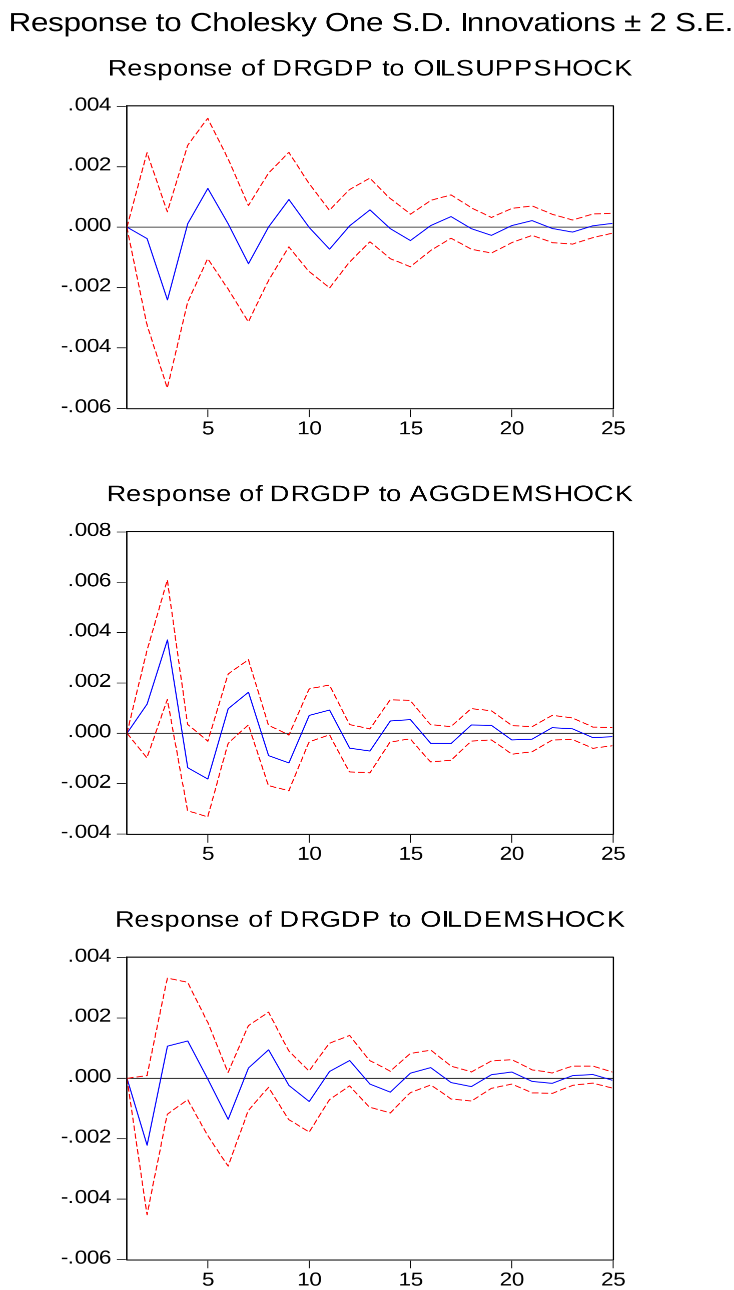
Table 9a: Current Account Autocorrelation test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 02/12/13 Time: 16:24
Sample: 1997Q1 2012Q2
Included observations: 60

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	9.425405	NA*	9.585158	NA*	NA*
2	29.09564	0.4601	29.93367	0.4173	29
3	45.95350	0.4325	47.67879	0.3643	45
4	62.11750	0.4361	64.99737	0.3393	61

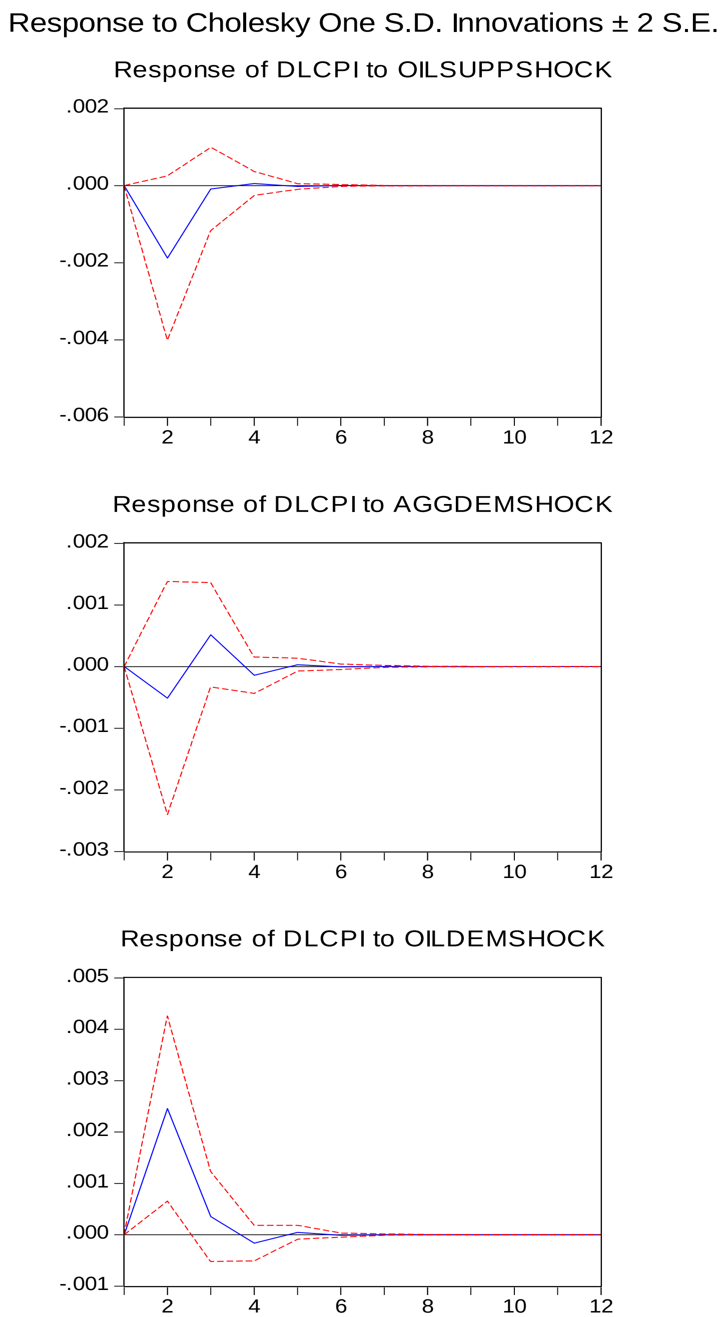
*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution
*df and Prob. may not be valid for models with exogenous variables

Figure 6a: Response of real GDP to One-Standard Deviation Oil Shocks



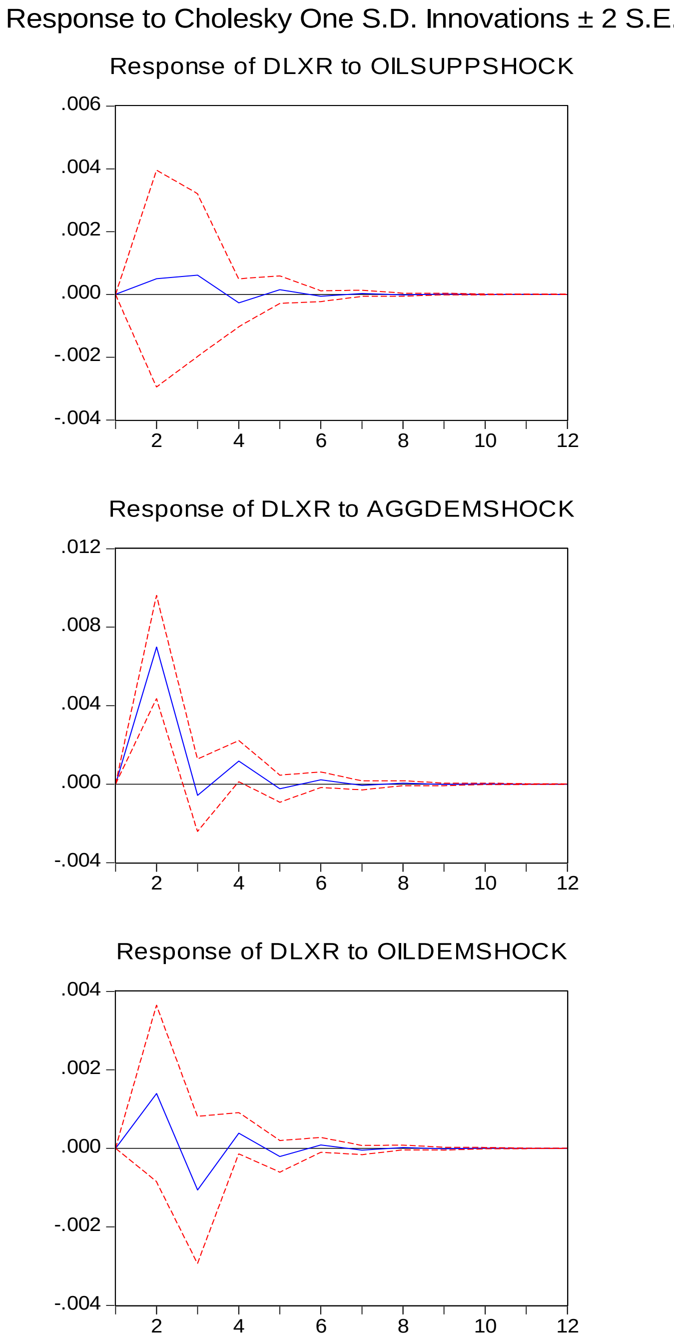
NOTES: Estimates based on a quarterly VAR (2) system in Equation 3. OILSUPPSHOCK, AGGDEMSHOCK, OILDEMSHOCK and DRGDP represent Oil Supply Shocks, Aggregate Demand Shocks, Oil-Specific Demand Shocks and real GDP Growth.

Figure 7a: Response of Inflation to One-Standard Deviation Oil Shocks



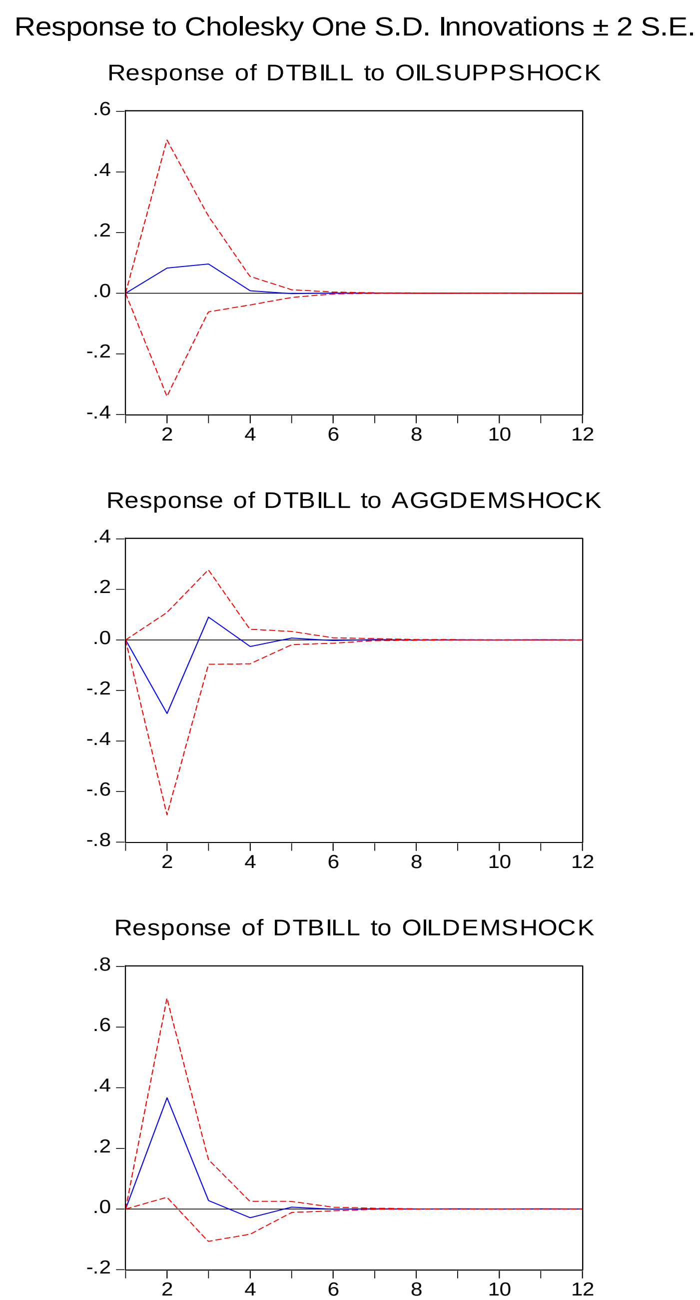
NOTES: Estimates based on a quarterly VAR (1) system in Equation 3. OILSUPPSHOCK, AGGDEMSHOCK, OILDEMSHOCK and DLCPI represent Oil Supply Shocks, Aggregate Demand Shocks, Oil-Specific Demand Shocks and inflation.

Figure 8a: Response of Exchange Rate to One-Standard Deviation Oil Shocks



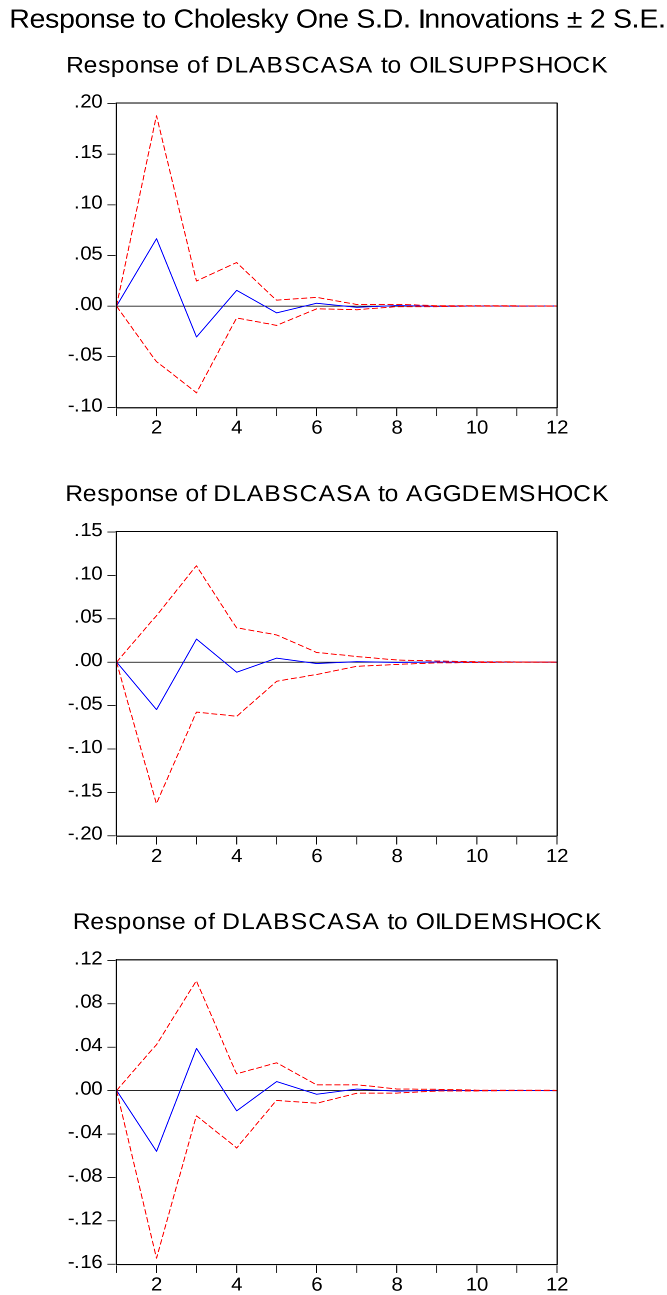
NOTES: Estimates based on a quarterly VAR (1) system in Equation 3. OILSUPPSHOCK, AGGDEMSHOCK, OILDEMSHOCK and DLXR represent Oil Supply Shocks, Aggregate Demand Shocks, Oil-Specific Demand Shocks and the nominal exchange rate.

Figure 9a: Response of Interest Rates to One-Standard Deviation Oil Shocks



NOTES: Estimates based on a quarterly VAR (1) system in Equation 3. OILSUPPSHOCK, AGGDEMSHOCK, OILDEMSHOCK and DTBILL represent Oil Supply Shocks, Aggregate Demand Shocks, Oil-Specific Demand Shocks and the 180-day Treasury Bill interest rate.

Figure 10a: Response of Current Account to One-Standard Deviation Oil Shocks



NOTES: Estimates based on a quarterly VAR (1) system in Equation 3. OILSUPPSHOCK, AGGDEMSHOCK, OILDEMSHOCK and DLABSCASA represent Oil Supply Shocks, Aggregate Demand Shocks, Oil-Specific Demand Shocks and the seasonally adjusted current account deficit.

Table 10a: Variance decomposition of real GDP

Period	S.E.	Real GDP	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock
1	0.009369	100.0000	0.000000	0.000000	0.000000
2	0.009705	93.20463	0.156556	1.419289	5.219524
3	0.011984	81.10716	4.147979	10.52971	4.215156
4	0.012127	79.22231	4.058926	11.56134	5.157421
5	0.013240	79.74182	4.338183	11.59270	4.327297
6	0.013353	78.51046	4.271593	11.93259	5.285358
7	0.013983	78.24095	4.646024	12.23443	4.878598
8	0.014050	77.59154	4.602327	12.51957	5.286565
9	0.014418	77.62504	4.768557	12.56058	5.045823
10	0.014463	77.23827	4.739356	12.72456	5.297810

Table 11a: Variance decomposition of inflation

Period	S.E.	Inflation	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock
1	0.007709	100.0000	0.000000	0.000000	0.000000
2	0.008434	86.18130	4.960546	0.368265	8.489888
3	0.008458	85.70174	4.943022	0.736347	8.618890
4	0.008461	85.64169	4.944264	0.763648	8.650395
5	0.008461	85.63743	4.944630	0.764876	8.653061
6	0.008461	85.63727	4.944652	0.764905	8.653176
7	0.008461	85.63726	4.944653	0.764906	8.653179
8	0.008461	85.63726	4.944653	0.764906	8.653179
9	0.008461	85.63726	4.944653	0.764906	8.653179
10	0.008461	85.63726	4.944653	0.764906	8.653179

Table 12a: Variance decomposition of exchange rate

Period	S.E.	Exchange rate	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock
1	0.010342	100.0000	0.000000	0.000000	0.000000
2	0.013682	72.77623	0.134163	26.04880	1.040805
3	0.013769	72.15912	0.330073	25.89110	1.619711
4	0.013852	71.65637	0.363733	26.30258	1.677315
5	0.013856	71.61108	0.374977	26.31525	1.698693
6	0.013859	71.59109	0.376627	26.33037	1.701910
7	0.013859	71.58838	0.377111	26.33163	1.702883
8	0.013859	71.58751	0.377199	26.33224	1.703057
9	0.013859	71.58736	0.377222	26.33232	1.703103
10	0.013859	71.58732	0.377226	26.33234	1.703112

Table 13a: Variance decomposition of interest rate

Period	S.E.	Interest rate	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock
1	1.431336	100.0000	0.000000	0.000000	0.000000
2	1.508329	90.05159	0.299485	3.741150	5.907780
3	1.515037	89.34945	0.700266	4.060880	5.889403
4	1.515576	89.28714	0.702346	4.088828	5.921682
5	1.515612	89.28372	0.702437	4.090737	5.923102
6	1.515615	89.28345	0.702443	4.090998	5.923106
7	1.515615	89.28342	0.702443	4.091028	5.923107
8	1.515615	89.28342	0.702443	4.091032	5.923108
9	1.515615	89.28342	0.702443	4.091032	5.923108
10	1.515615	89.28342	0.702443	4.091032	5.923108

Table 14a: Variance decomposition of current account deficit

Period	S.E.	Current Account deficit	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock
1	0.436645	100.0000	0.000000	0.000000	0.000000
2	0.484645	95.49759	1.885092	1.273898	1.343424
3	0.494444	94.38356	2.194169	1.514285	1.907980
4	0.496307	94.12907	2.275173	1.557974	2.037782
5	0.496634	94.08317	2.290263	1.564048	2.062518
6	0.496689	94.07540	2.293006	1.564866	2.066730
7	0.496698	94.07414	2.293472	1.564974	2.067418
8	0.496700	94.07393	2.293550	1.564989	2.067529
9	0.496700	94.07390	2.293563	1.564991	2.067547
10	0.496700	94.07389	2.293565	1.564992	2.067550