Kirsten Roach

A Structural Analysis of Oil Price Shocks on the Jamaican Macroeconomy

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 a deterioration in domestic macroeconomic variables.

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

JEL classification: E31, E32, Q43.

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1. INTRODUCTION

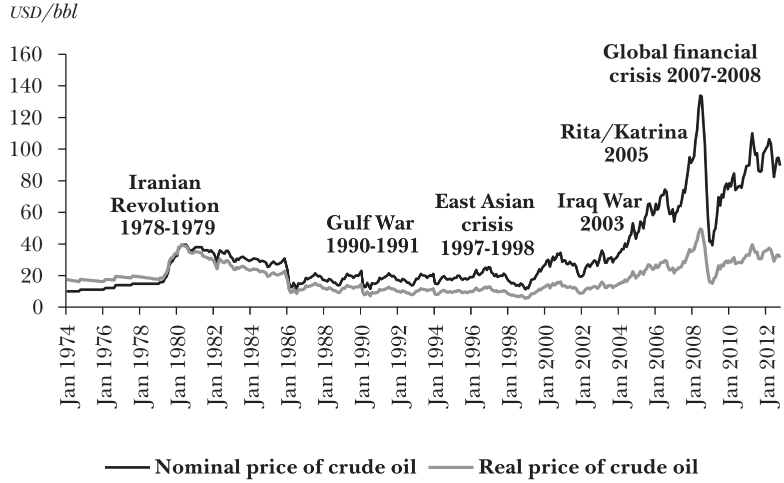
Researchers and policymakers have invariably had an intrinsic interest in commodity price movements owing to their correlation with major macroeconomic events. This interest has emerged since the 1970s when significant fluctuations in crude oil prices triggered an ongoing examination of the impact of 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 and 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 1990-1991, the Asian crisis in 1997-2000, and the global financial crisis in late 2008 have preceded increases in oil prices (see Figure 1). 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 by affecting 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 a third 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 relation 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

Figure 1

NOMINAL VS REAL PRICE OF WTI CRUDE OIL



Source: Bloomberg L.P.

account balance, and interest rates. It is anticipated that a disaggregation of the oil price shocks would help inform policy by providing a better understanding of exactly how specific spikes in oil prices influence Jamaica's key macroeconomic variables. As aggregate demand shocks are typically associated with global economic expansion, these shocks are expected to have a positive albeit lagged impact on the Jamaican economy whereas oil-specific demand shocks emanating from speculative behavior should have adverse implications for Jamaica. While previous studies such as Burger et al. (2009) have explored the effects 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, reflecting the favorable impact of this shock on Jamaica's real output in response to gains in overall global trade. Conversely, oil-specific demand shocks and oil supply shocks would likely result in a deterioration in domestic macroeconomic variables, particularly inflation in the case of the former, largely due to increased speculation associated with this type of shock. The remainder of the paper is organized as follows. Section 2 presents stylized facts. Section 3 reviews 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.

2. STYLIZED FACTS

As previously outlined in Section 1, oil plays an integral role in the Jamaican economy. In effect, fuel imports represented the largest contributor to total imports during the period 2004-2013 (see Figure 2), averaging 33% of imports. Jamaica's heightened demand for crude oil can be attributed to its use as an input in the domestic production process and electricity generation[1].

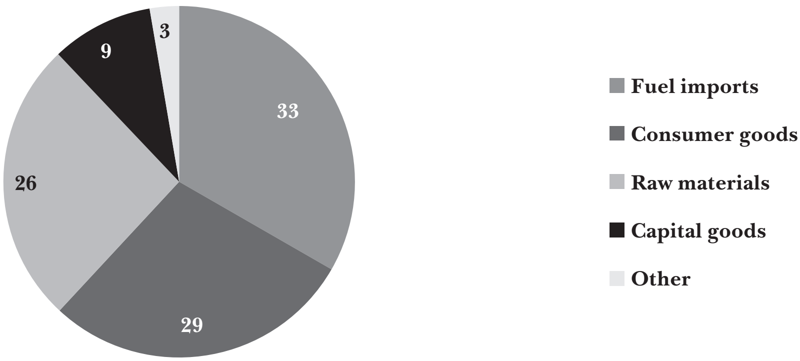
The Petroleum Corporation of Jamaica (PCJ) and bauxite companies are the primary importers of fuel in Jamaica. The PCJ purchases crude oil in accordance with the PetroCaribe Energy Accord and imports and distributes oil derivatives such as liquid petroleum gasoline (LPG), automotive diesel oil, and kerosene[2]. Notwithstanding the agreement, the West Texas Intermediate (WTI) oil price represents the relevant international benchmark for Jamaica. Thus, changes in the WTI

[1] In terms of the remaining categories, 29%, 26% and 9% of imports for that period accounted for imports of consumer goods, raw materials (excluding fuel), and capital goods, respectively.

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

Figure 2

JAMAICA'S MAJOR IMPORTS BY END USE
(2004-2013 average)
Percentage



Source: Bank of Jamaica.

oil price result in similar adjustments to domestic fuel prices (see Figure 3). Given the strong co-movement between WTI oil prices and Jamaica's current account deficit, an increase in WTI oil prices in 2008, for example, led to a widening of the trade deficit due to the impact of higher prices on the country's fuel bill (see Figure 4).

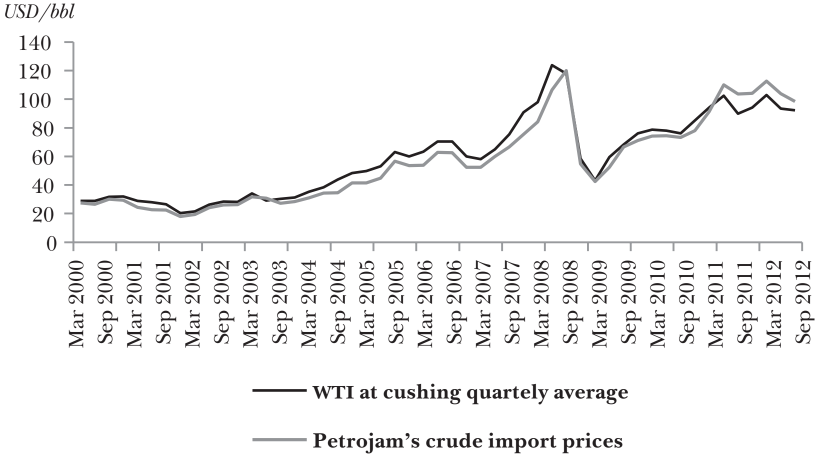
3. LITERATURE REVIEW

Studies on the relation between oil price shocks and macroeconomic variables have been widespread[3]. 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 1948-1972 period, based on the statistical significance of the correlation between

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

Figure 3

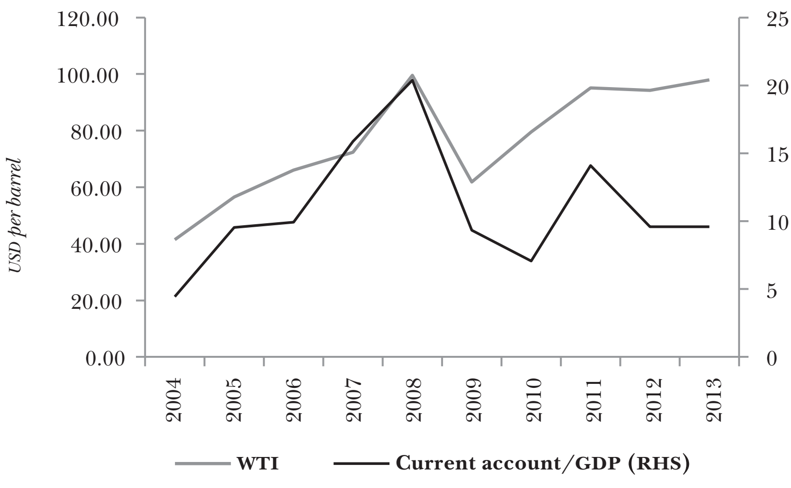
WTI CRUDE OIL PRICES AND PETROJAM'S CRUDE IMPORT PRICES



Source: Bloomberg L.P. and Bank of Jamaica

Figure 4

RELATION BETWEEN WTI OIL PRICES AND JAMAICA'S CURRENT ACCOUNT DEFICIT/GDP RATIO



Source: Bloomberg L.P. and Bank of Jamaica oil shocks and real GDP growth. He proposed three possible hypotheses: *1)* recessions coinciding with oil price increases occurred by a mere coincidence, *2)* the correlation resulted from an endogenous explanatory variable that 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 duration of a portion of the recessions predating 1973 would have been more severe 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 Van Robays, 2009; and Baumeister et al., 2010). In particular, Kilian (2008) focused on the exogeneity of oil shocks since 1973 in order to ascertain how 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 prices 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 the US CPI occurred three quarters after the exogenous oil supply shock, in contrast with the commonly held view that a sustained increase in inflation would occur.

Against this background, Kilian highlighted in 2009 that the impact of oil price shocks on the real price of oil depended on the origin of the shock. In particular, oil price shocks were decomposed under the assumption of the endogeneity of the price of oil. Kilian's approach entailed a structural decomposition of the shocks to 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 shocks, reflecting increases in oil prices driven by an 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 caused 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 relation 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, a finding that 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) and Peersman and Van Robays (2009). Their main findings indicated that oil demand shocks associated with increased global aggregate demand resulted in a temporary increase in real GDP for all economies subsequent to an increase in oil prices. Conversely, oil-specific demand shocks were revealed to contribute to a temporary decline in real GDP[4]. 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 net oil-exporting economies. The results for the pass-through to inflation were varied among oil-importing economies. Notwithstanding this variation, 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

[4] 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 results from increased fears of future fuel supply shortages.

was limited largely in the context of the appreciation of the effective exchange rates following an oil supply shock. The paper also revealed reduced vulnerability to oil shocks in the case of economies with a favorable net energy position.

Other studies have sought to examine the relation between oil shocks and the current account balance in oil-importing and exporting countries. In the case of Turkey, an oil-importing economy, Ozlale and Pekkurnaz (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 that oil price shocks have a significant effect in the short run. Similarly, the discussion in Chuku et al. (2011) utilized a SVAR over the period 1970 to 2008 to assess the relation between oil price shocks and current account dynamics in Nigeria, an oil exporter and importer. Oil price shocks had a significant positive effect on current account deficits for Nigeria in the short run. As such, the policy implications for garnering of the 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 possibility that a country's external capital structure could dampen the impact of oil price shocks on external accounts[5]. 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 is highly vulnerable given the country's high debt-to-GDP ratio and substantial negative foreign exchange exposure. Against this background, Burger et al. (2009) recommended that Jamaica should adjust

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

the composition of its net international reserves (NIR) portfolio with a view to stimulating capital gains in the event of adverse oil market shocks[6]. In this regard, the paper suggested the adoption of an official reserves portfolio that is positively correlated with oil prices[7]. Conversely, Burger et al. (2009) indicated that although Trinidad and Tobago's capital structure was not vulnerable to currency fluctuations, there was still room to mitigate the impact of oil shocks on the country's external accounts by hedging against the macroeconomic 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.

4. METHODOLOGY AND DATA CONSIDERATIONS

Using the methodology of Kilian (2009), the impact of oil price shocks on the Jamaican economy was estimated via two main steps during the period from January 1997 to June 2012. 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 4.1. The second step encompassed the estimation of the response of key Jamaican macroeconomic variables to the identified structural shocks in Section 4.2. In this context, individual SVAR models were estimated in order to assess the response of the respective macroeconomic variables under study to the shocks.

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

[7] 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.

4.1 Determining the Underlying Demand and Supply Shocks that Affect the Crude Oil Market

In undertaking the first step highlighted above, a multivariate SVAR model was estimated utilizing monthly data over the sample period January 1997 to June 2012 for the vector time series, $z_t = (\Delta prod_t, rea_t, rpo_t)'$ where $\Delta prod_t$ represents the percent change in the production of crude oil globally, rea_t is a measure of global real economic activity in industrial commodity markets, and rpo_t is the real price of crude oil using the WTI benchmark, with rea_t and rpo_t being expressed in logs. The period of study was chosen to encompass the various oil shocks both before and after the 2008 global financial crisis. The assessment period was also determined by the availability of data.

The term global *real economic activity* refers to an index of real economic activity that measures 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. Borrowing from Kilian (2009), this study employs a measure of global real economic activity in commodity markets. This global index comprises dry cargo single voyage freight rates for bulk dry cargoes including grain, oilseeds, coal, iron ore, fertilizer, and scrap metal, compiled by Drewry Shipping Consultants Ltd. The subsequent steps for constructing the index involve deflating the series with the US CPI. The real index was in turn detrended in order to capture cyclical variation in ocean freight rates. This measure 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[8]. The oil data was garnered from the US Energy Information Administration (EIA) and the International Energy Agency (IEA). The real price of oil is

[8] 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.

measured using WTI oil prices deflated by the US CPI. Data on Jamaican macroeconomic variables were obtained from the Bank of Jamaica's database.

The model utilized a lag length of two 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)], for which the SVAR representation of the model consisting of a vector of serially and mutually uncorrelated structural innovations, ε_t may be seen below:

1 $$A_0 z_t = \propto + \sum_{i=1}^{2} A_i z_{t-i} + \varepsilon_t .$$

The structural innovations were generated by imposing exclusion restrictions on A_0^{-1}. Fluctuations in the real price of oil were underpinned by three structural shocks: ε_{1t}, which captures crude oil supply shocks; ε_{2t}, which denotes aggregate demand shocks; and ε_{3t}, which represents a demand shock specific to the oil market. The last of the three was geared toward 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 $a_{13} = 0$, an assumption that imposes the restriction of no response in crude oil production to aggregate demand shocks and oil-specific demand shocks, respectively, within the same month. This restriction is imposed on the premise that there are high costs associated with increasing oil production and as such that only a persistent rise in demand is expected to significantly increase the supply of crude oil.

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 the result of 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 $$e_t = \begin{pmatrix} e_t^{\Delta prod} \\ e_t^{rea} \\ e_t^{rpo} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{oil\ supply\ shock} \\ \varepsilon_t^{aggregate\ demand\ shock} \\ \varepsilon_t^{oil\text{-}specific\ demand\ shock} \end{pmatrix}.$$

4.2 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 necessitated estimations of the relation between the structural innovations in Equation 1 and selected Jamaican macroeconomic variables. This study builds on the work done by Kilian (2009), which only focused on the impact of oil shocks on GDP and inflation, by including additional macroeconomic variables to provide a more holistic analysis of the impact of oil shocks on the Jamaican economy in individual SVAR models aimed at ascertaining the response of the respective macroeconomic variables to each oil price shock. As a result, the variables under analysis include real GDP (Δy_t), the 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[9]. In order to facilitate the inclusion of quarterly variables such as real GDP in this analysis as well as maintain the identifying assumptions, quarterly shocks were constructed by averaging the monthly structural innovations implied by the VAR model in Equation 1 for each quarter:

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

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 Δy_t, π_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, respectively, were examined based on five individual quarterly regressions of the form and lag length selection criteria in Equations 4-8, respectively:

$$\Delta y_t = \alpha + \sum_{i=0}^{1}\phi_i\zeta_{jt-i} + u_t, \text{ j} = 1,\ldots, 3 \text{ (real GDP SVAR)} \tag{4}$$

$$\pi_t = \delta + \sum_{i=0}^{1}\psi_i\zeta_{jt-i} + v_t, \text{ j} = 1,\ldots, 3 \text{ (inflation SVAR)} \tag{5}$$

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9 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% but did not increase rates on its other instruments. Rates on 180-day omo instruments remained at 15.35%, while there was an increase in yields on 180-day T-Bills. There have also been 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.

6 $$XR_t = \beta + \sum_{i=0}^{1} \varphi_i \zeta_{jt-i} + w_t, \text{j} = 1,\dots, 3 \text{ (exchange SVAR)}$$

7 $$IR_t = \gamma + \sum_{i=0}^{1} \omega_i \zeta_{jt-i} + z_t, \text{j} = 1,\dots, 3 \text{ (interest rate SVAR)}$$

8 $$CA_t = \theta + \sum_{i=0}^{1} \rho_i \zeta_{jt-i} + x_t, \text{j} = 1,\dots, 3 \text{ (current account SVAR)},$$

where u_t, v_t, w_t, x_t, z_t were potentially serially correlated errors while ζ_{jt} was a serially uncorrelated shock. The respective impulse response coefficients were denoted as ϕ_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 1). 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 et al. (2009) 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, 2009). In this regard, the equation-by-equation approach was found to be the most viable methodology.

Table 1

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

5. 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 from the first quarter of 1997 to the second quarter of 2012. 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 (see Table 2). 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 5). Further robustness checks on the VARs based on the portmanteau tests for autocorrelations revealed

Table 2

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)

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

that the residuals were serially uncorrelated (see Tables 3-7). The impulse response functions are reported in Figures 6 to 10 using both the 95% and 68% confidence intervals. Of note, the responses of Jamaica's macroeconomic variables under study to all three shocks were identical irrespective of the confidence bands utilized. Nevertheless, while the majority of the responses were statistically significant based on the 68% confidence interval, most were not for the 95% confidence interval[10].

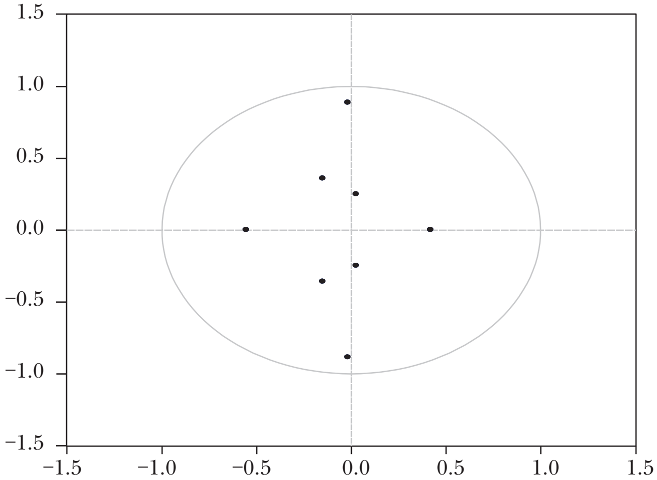
The impact of both oil demand and supply shocks on real GDP failed to dissipate in the short term, albeit having a marginal impact on domestic output (see Figure 6). The initial response of real GDP was a contraction under an oil supply shock

[10] Sims and Zha (1999) endorse the use of 68% confidence intervals for the purposes of impulse responses and argue that "there is no scientific justification for reporting hypotheses at the 5% significance level in every application."

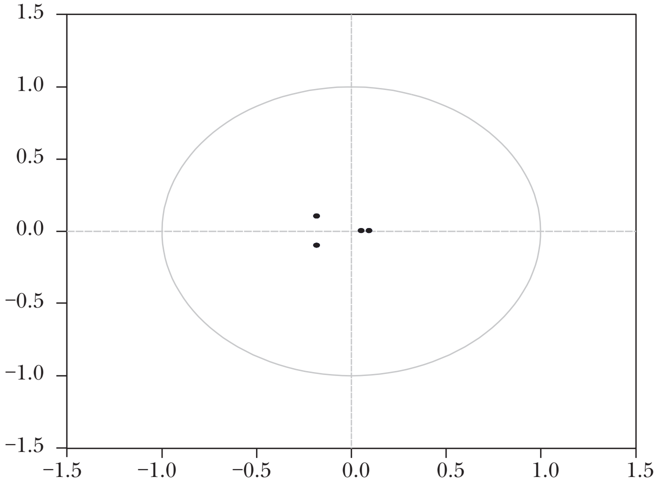
Figure 5

STABILITY CONDITION TESTS

A. REAL GDP[1]



B. INFLATION[1]

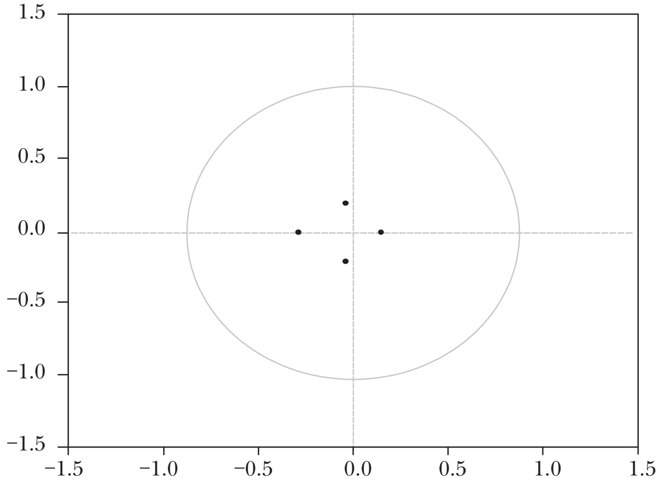


[1] Inverse roots of AR characteristic polynomial.
Sources: Bloomberg L.P. and Bank of Jamaica.

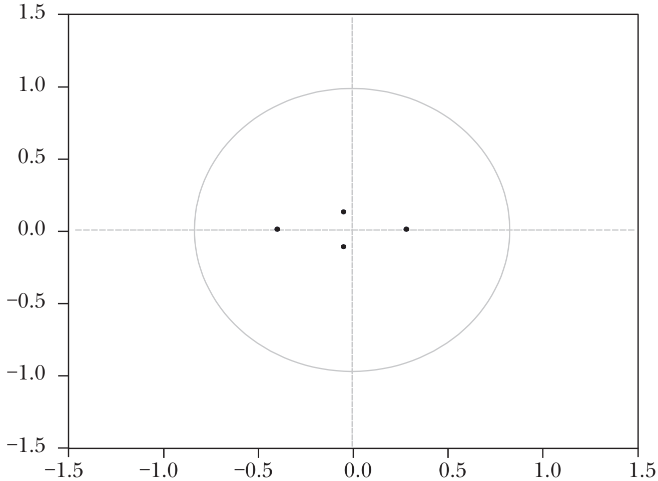
Figure 5 (cont.)

STABILITY CONDITION TESTS

C. EXCHANGE RATE[1]



D. INTEREST RATE[1]

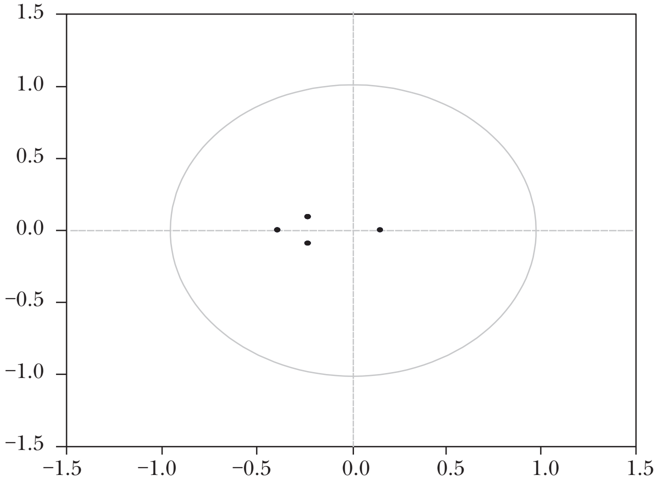


[1] Inverse roots of AR characteristic polynomial.
Sources: Bloomberg L.P. and Bank of Jamaica.

Figure 5 (cont.)

STABILITY CONDITION TESTS

E. CURRENT ACCOUNT[1]



[1] Inverse roots of AR characteristic polynomial.
Sources: Bloomberg L.P. and Bank of Jamaica.

Table 3

REAL GDP AUTOCORRELATION TEST
VAR residual portmanteau tests for autocorrelations

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

Notes: [1]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 4

INFLATION AUTOCORRELATION TEST

VAR Residual Portmanteau Tests for Autocorrelation

Lags	*Q-stat*	*Prob.*	*Adj. Q-stat*	*Prob.*	*df*
1	11.86208	NA[1]	12.06313	NA[1]	NA[1]
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

Notes: [1]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 5

EXCHANGE RATE PORMANTEAU AUTOCORRELATION TEST

Lags	*Q-stat*	*Prob.*	*Adj. Q-stat*	*Prob.*	*df*
1	10.94135	NA[1]	11.12680	NA[1]	NA[1]
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

Notes: [1]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 6

INTEREST RATE PORMANTEAU AUTOCORRELATION TEST

Lags	*Q-stat*	*Prob.*	*Adj. Q-stat*	*Prob.*	*df*
1	9.720715	NA[1]	9.885473	NA[1]	NA[1]
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

Notes: [1]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 7

CURRENT ACCOUNT PORMANTEAU AUTOCORRELATION TEST
VAR residual portmanteau tests for autocorrelations

Lags	*Q-stat*	*Prob.*	*Adj. Q-stat*	*Prob.*	*df*
1	9.425405	NA[1]	9.585158	NA[1]	NA[1]
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

Notes: [1]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.

and an oil-specific demand shock. However, both shocks were mostly statistically insignificant at the 5% level. In contrast, an aggregate demand shock resulted in an initial expansion in domestic output that was statistically significant at the 5% level. Notably, the responses of real GDP to all three shocks are significant using the 68% confidence interval. 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[11]. Additional statistical analysis has shown that over the period 1997-2012, crude oil prices had a weak linear relation with output in Jamaica, as evidenced by the 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. The result was statistically insignificant at the 5% level but significant using the 68% confidence bands (see Figure 7). As a result, policymakers need not be concerned about the impact of supply disruptions in major oil producing countries on Jamaica's 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 contrast, the impact of an aggregate demand shock led to an acceleration in inflation by the third quarter, albeit statistically insignificant at both the 95% and 68% levels. Oil-specific demand shocks resulted in an initial acceleration in inflation within the first two quarters prior to decelerating by the fourth quarter.

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

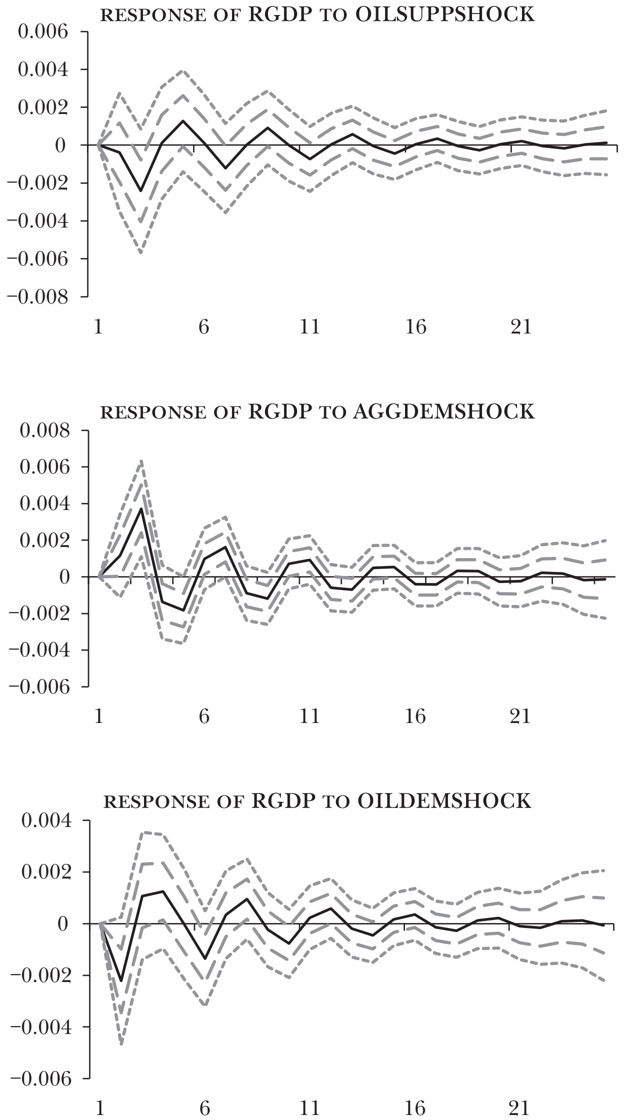
This result was statistically significant at both the 95% and 68% confidence intervals. A temporary spike in inflation indicates the need for the possible implementation of short-term policy measures to stem an increase in other prices such as wages.

In terms of the nominal exchange rate, there was a marginal depreciation following an oil supply shock, although statistically insignificant at both confidence levels under analysis (see Figure 8). Similarly, an aggregate demand shock engendered a depreciation of the domestic currency, particularly within the first two quarters, which was statistically significant at both confidence levels. 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, dissipated by the third quarter, possibly reflecting the impact of the improvements in Jamaica's major trading partners on foreign currency earnings in the domestic economy. Similarly, an oil-specific demand shock led to depreciation in the exchange rate within the first two quarters. This result is in keeping with the notion that uncertainty in the oil market leads to possible hoarding or speculative behavior by local investors. This impact was, however, statistically insignificant at the 5% level but was found to be significant using the 68% confidence interval.

Regarding interest rates, impulse responses indicated an increase in market interest rates within the first four quarters following an oil supply and oil-specific demand shock (see Figure 9). 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 at each level of significance under study. 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% level. Of note, however, the 68% error bands yielded a significant response in the second quarter.

Figure 6

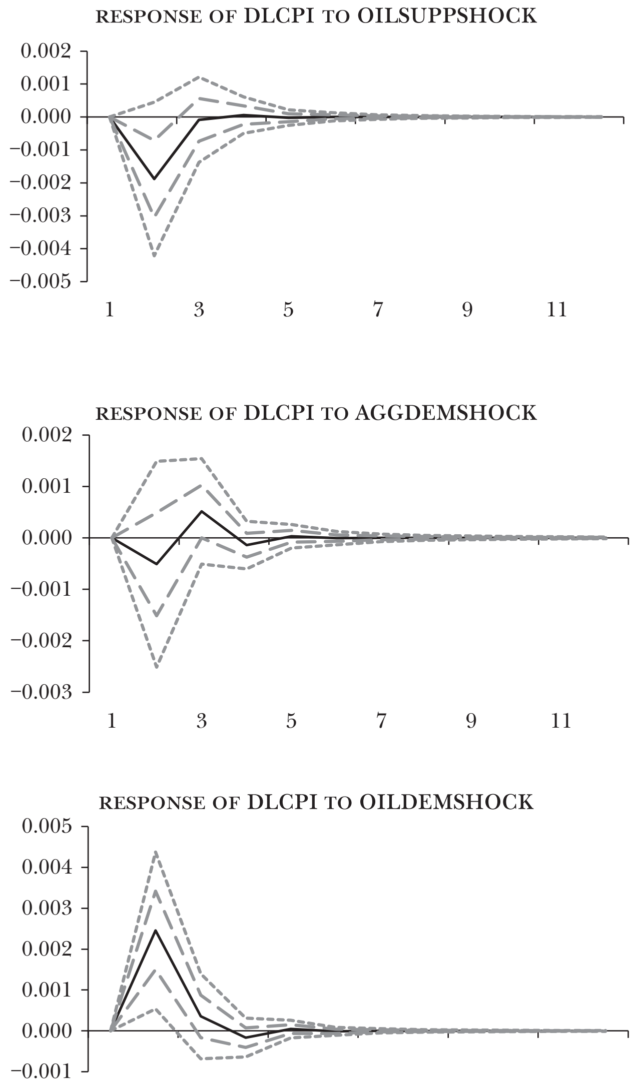
RESPONSE OF REAL GDP TO ONE-STANDARD DEVIATION OIL SHOCKS



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. Dotted lines are 95% confidence intervals while dashed lines are 68% confidence intervals.

Figure 7

RESPONSE OF INFLATION TO ONE-STANDARD DEVIATION OIL SHOCKS

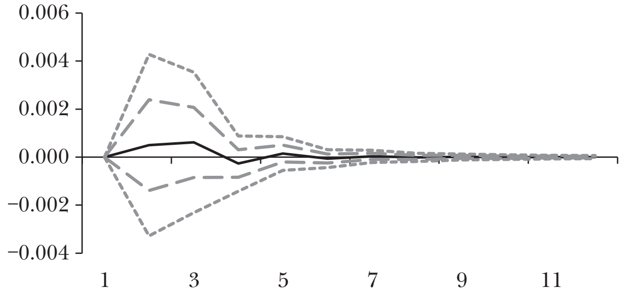


Notes: Estimates based on a quarterly VAR (1) system in Equation 3. OILSUPPSHOCK, AGGDEMSHOCK, OILDEMSHOCK and DLCPI represent oil supply shocks, aggregate demand shocks, oil-specific demand shocks, and inflation. Dotted lines are 95% confidence intervals while dashed lines are 68% confidence intervals.

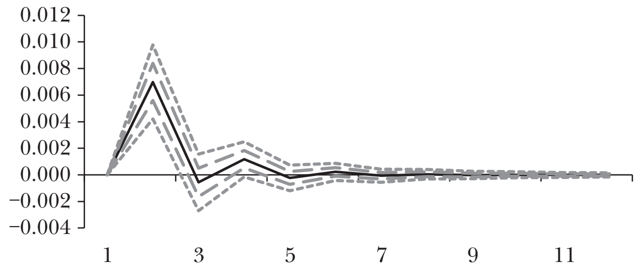
Figure 8

RESPONSE OF EXCHANGE RATE TO ONE-STANDARD DEVIATION OIL SHOCKS

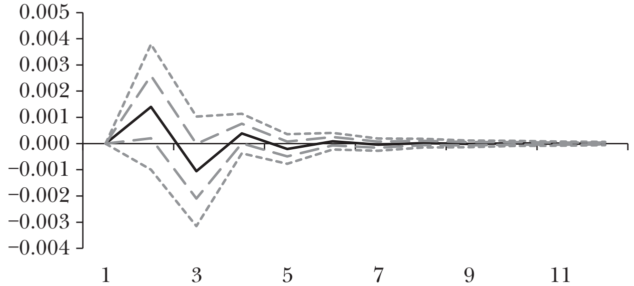
RESPONSE OF DLXR TO OILSUPPSHOCK



RESPONSE OF DLXR TO AGGDEMSHOCK



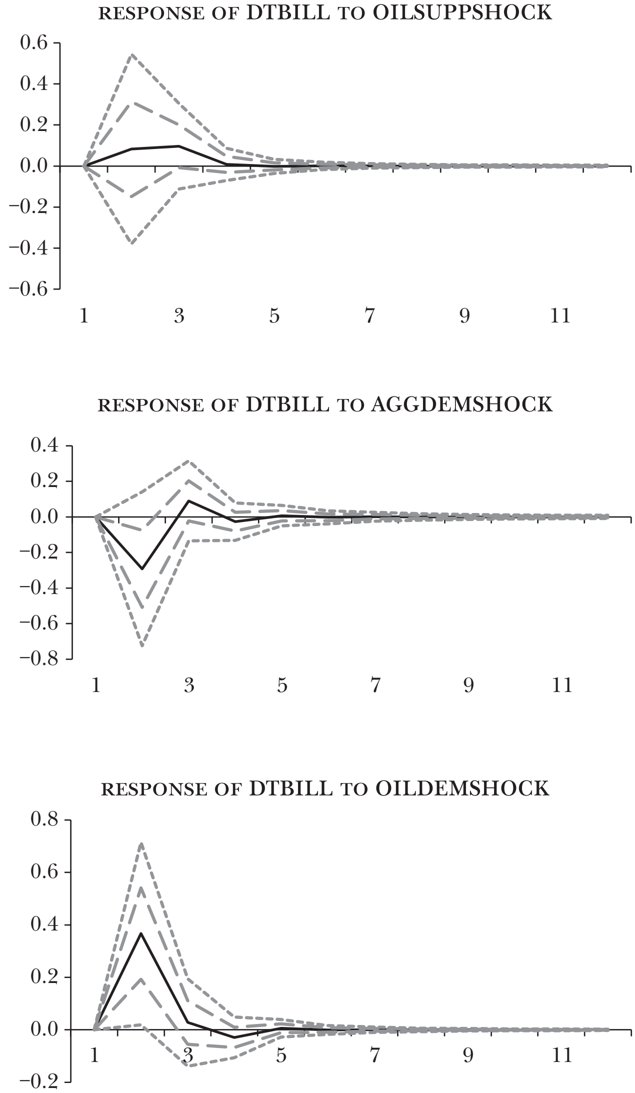
RESPONSE OF DLXR TO OILDEMSHOCK



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. Dotted lines are 95% confidence intervals while dashed lines are 68% confidence intervals.

Figure 9

RESPONSE OF EXCHANGE RATE TO ONE-STANDARD DEVIATION OIL SHOCKS

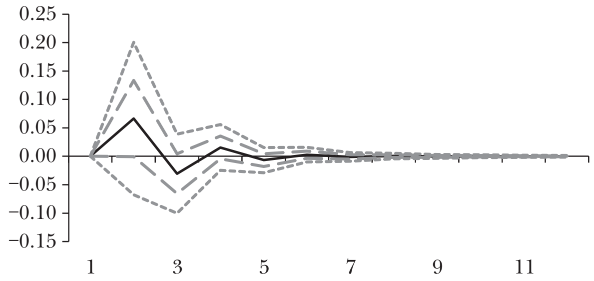


Notes: Estimates based on a quarterly VAR (1) system in Equation 3. OILSUPPSHOCK, AGGDEMSHOCK, OILDEMSHOCK, and DTBILL represent oil supply shocks, aggregate demand shocks, oil-specific demand shocks, and the 180-day Treasury bill interest rate. Dotted lines are 95% confidence intervals while dashed lines are 68% confidence intervals.

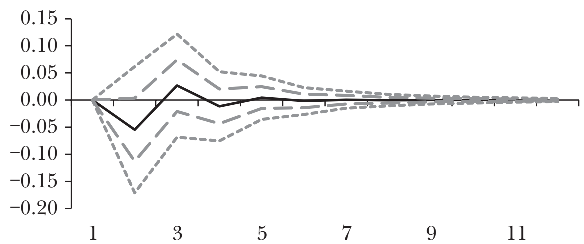
Figure 10

RESPONSE OF CURRENT ACCOUNT TO ONE-STANDARD DEVIATION OIL SHOCKS

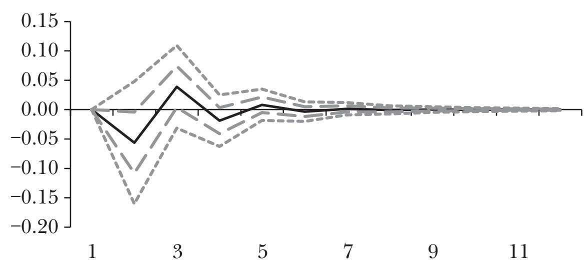
RESPONSE OF DLABSCASA TO OILSUPPSHOCK



RESPONSE OF DLABSCASA TO AGGDEMSHOCK



RESPONSE OF DLABSCASA TO OILDEMSHOCK



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. Dotted lines are 95% confidence intervals while dashed lines are 68% confidence intervals.

As for the response of Jamaica's external accounts to an oil supply shock, the current account deficit increased within the first two quarters (see Figure 10). This result could be associated with the initial high fuel prices generally stemmed from the prospect of reduced oil supplies, 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 the oil supply and aggregate demand shocks were statistically insignificant at the 95% and 68% confidence intervals. However, the response of the current account deficit to an oil-specific demand shock was significant at the 68% confidence interval (see Table 8).

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 9-13)[12]. With respect to the effect of the oil supply shock on real GDP, inflation, the exchange rate, the interest rate, and the current account deficit, variance decompositions indicated that this shock accounted for 4.2%, 4.9%, 0.4%, 0.7%, and 2%, respectively, of the movements in each variable by the third quarter. Overall, this shock is show to have the smallest impact since it accounts for only a small percentage of the variation in the different macroeconomic variables.

[12] While impulse response functions trace the effects of a shock to one endogenous variable on 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.

Table 8

SUMMARY OF IMPULSE RESPONSES

	Real GDP	*Inflation*	*Exchange rate*	*Interest rate*	*Current account deficit*
Oil supply shock	↓	↓	↑	↑	↑
Aggregate demand shock	↑[a]	↑	↑[a]	↑	↓
Oil-specific demand shock	↓	↑[a]	↑	↑[a]	↓

[a] Denotes rejection using the 95% confidence bands.

Regarding the effect of the aggregate demand shock on real GDP, inflation, the exchange rate, the interest rate, and the current account deficit, the respective variance decompositions highlighted that this shock contributed to 10.5%, 0.7%, 26%, 4%, and 1.5%, respectively, 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.

As for the oil-specific demand shock, variance decompositions demonstrated that 5.2%, 8.5%, 1.6%, 6% and 2% of movements in real GDP, inflation, the exchange rate, the interest rate, and the current account deficit, respectively, can be attributed to this shock within the first three quarters. The results suggest the relatively high importance of this shock to inflation in the context of Jamaica's economy.

Table 9

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

Notes: Cholesky ordering- real GDP, oil supply shock, aggregate demand shock, oil-specific demand shock. Standard errors: Monte Carlo (10,000 repetitions).

Table 10

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

Notes: Cholesky ordering- inflation, oil supply shock, aggregate demand shock, oil-specific demand shock. Standard errors: Monte Carlo (10,000 repetitions).

Table 11

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

Notes: Cholesky ordering- exchange rate, oil supply shock, aggregate demand shock, oil-specific demand shock. Standard errors: Monte Carlo (10,000 repetitions).

Table 12

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

Notes: Cholesky ordering- interest rate, oil supply shock, aggregate demand shock, oil-specific demand shock. Standard errors: Monte Carlo (10,000 repetitions).

Table 13

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

Notes: Cholesky ordering- current account deficit, oil supply shock, aggregate demand shock, oil-specific demand shock. Standard errors: Monte Carlo (10,000 repetitions).

6. 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.

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, particularly real GDP. 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) largely resulted in an overall deterioration in Jamaica's economy, contributing to an acceleration in inflation and a potentially higher current account deficit. Of note, the impact of oil price shocks on the Jamaican macroeconomy largely failed to exhibit permanent effects. This finding could be associated with the relative dependence on oil, reflected in Jamaica's fairly inelastic demand for the product. 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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