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EXTERNAL CAPITAL STRUCTURES AND OIL PRICE VOLATILITY

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ABSTRACT

We assess the extent to which a country's external capital structure can aid in mitigating the macroeconomic impact of oil price shocks. We study two Caribbean economies highly vulnerable to oil price shocks, an oil-importer (Jamaica) and an oil-exporter (Trinidad and Tobago). From a risk-sharing perspective, a desirable external capital structure is one that, through international capital gains and losses, helps offset responses of the current account balance to external shocks. We find that both countries could alter their international portfolio to provide a more effective buffer against such shocks.

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1. Introduction

Oil-dependent economies, whether importers or exporters, are particularly exposed to large and volatile shocks associated with oil price fluctuations. The macroeconomic impact of these shocks is pervasive, encompassing the government's budget process and balance sheet, as well as private-sector production and consumption decisions. Insuring against the impact of energy price shocks directly through futures or over-the-counter derivative contracts is difficult, as the typical maturity of available instruments is either too short or the insurance is too costly for small, below-investment-grade economies. It is therefore useful to think about additional insurance and risk-sharing mechanisms that can enhance the set of available (and tradable) financial instruments.

A country's external capital structure (the composition of foreign assets and liabilities by instrument, currency, and maturity) can mitigate or exacerbate the impact of external shocks. For instance, foreign currency exposure may turn an otherwise benign real exchange response to an oil price shock into a negative financial shock with undesirable contractionary effects. Similarly, the maturity structure and instrument composition of foreign assets and liabilities (i.e., debt versus equity or particular sectors of world equity markets as opposed to others) may significantly affect the response to energy price and other external shocks.

In this paper we examine how, in two countries that are strongly impacted by oil price fluctuations (Jamaica and Trinidad and Tobago), the external capital structure did in the past—and can in the future—mitigate the repercussions of oil shocks. We explore questions related to three aspects of the external capital structure: its characteristics, its role in adjustment to oil price shocks, and possible future modifications. What are the characteristics of the existing external capital structure? Is there a substantial currency mismatch? What is the role of the external capital structure in the adjustment to oil shocks? Does it aid in the international sharing of the risk oil shocks pose, or does it hinder risk sharing? How can the existing capital structure be modified to ameliorate the transmission of oil shocks? The main findings are as follows.

- *Characteristics of External Capital Structures*. Trinidad and Tobago does not have a currency mismatch, as its foreign currency assets exceed its foreign currency liabilities. In contrast, Jamaica has a substantial currency mismatch, with large dollar liabilities unmatched by dollar assets or export revenues. This basic fact about Jamaica's external capital structure is important to keep in mind.
- *Role of the External Capital Structure in Response to Oil Price Shocks*. In both countries there is little evidence that the existing capital structures help mitigate the impact of oil shocks.[1] To be sure, in some cases the countries' international portfolios are such that reactions of the current account balances are partially offset by profits or losses on international positions. But there is much scope for improvement.
- *Possible Future Modifications to External Capital Structures*. The international portfolios of both countries can be altered in ways that would ameliorate the impact of oil shocks. For Jamaica, the currency composition of official reserves could be shifted toward currencies that tend to do well when the oil price increases. Identifying which currencies will be positively correlated with the oil price in the future is difficult; in the recent past, the euro, Canadian dollar, and Norwegian krone performed well when oil prices increased. For Trinidad and Tobago, increased exposure to foreign assets that are negatively correlated with the oil price could mitigate the impact of oil price shocks on its external accounts. One way this could be attained is by investing some of the assets in its oil stabilization fund in transportation equities of advanced economies.

[1] This is contrary to the Kilian et al. (2009) finding for broad aggregates of oil exporting and importing countries.

We note at the outset a caveat. Part of our analysis depends on having accurate time series of capital gains and losses on international positions. But time series of the capital gains component of a country's international investment position generally do not exist; see Curcuru et al. (2008) and Curcuru et al. (2009) on difficulties inherent in creating such time series for the United States. In this study we estimate capital gains series as the difference between changes in the net foreign asset position and the current account balance, as is common in the literature. However, without actual data on international capital gains we have no way of knowing that the resulting time series are accurate. Finer analysis awaits better quality data on the gains and losses on international investment positions.

The rest of the paper is organized as follows. Section 2 provides some basic economic indicators for each economy. Section 3 describes and analyzes the current capital structure of Jamaica and Trinidad and Tobago using the most recent data available, with an eye toward identifying potential currency mismatches. In section 4 we empirically investigate the impact of oil shocks on external accounts. The time series results are interpreted with a particular focus on any evidence of international risk-sharing. In section 5 we discuss ways in which each country's capital structure could be altered. We present our conclusions in section 6.

2. Basic indicators of the importance of oil in each economy

We chose for this study two Caribbean countries that have a high degree of trade openness and whose economies are dependent, in different ways, on the world oil market. Basic indicators show that Jamaica and Trinidad and Tobago (henceforth TT) are potentially vulnerable to oil market swings.

For Jamaica, much of its persistent current account deficit, which has averaged roughly 10 percent of GDP over the past decade, owes to oil imports. When oil prices were very low (for example, in 1998), oil contributed only about 25 percent to the overall trade deficit. However, in years with more elevated oil prices the contribution of oil to Jamaica's trade deficit often exceeded 50 percent (top panel of figure 1). Moreover, Jamaica receives, in effect, a double penalty; not only does its trade deficit worsen when oil prices surge, but its currency also tends to depreciate against the U.S. dollar (bottom panel of figure 1), potentially exacerbating the impact of adverse oil shocks on its economy through adverse balance sheet effects that could outweigh any traditional expenditure switching effect of the depreciation. Finally, at least recently, when the Jamaican dollar depreciated, its spreads also widened (figure 2).

The economy of TT, an oil exporter, is also intimately linked to the oil market. As the oil portion of the trade balance increases, so does overall GDP (figure 3); the correlation between the two series is a strikingly high 0.92. Moreover, dollar-based oil prices have translated almost directly into TT$ revenues; while the TT$ is a floating currency, it has fluctuated little vis-à-vis the U.S. dollar over the past decade (figure 4).[2] Spreads in TT are largely in line with, if not a little lower than, overall EMBI spreads, and as such increased sharply in the last quarter of 2008 (figure 5).

3. Existing capital structures and currency mismatches

In this section we present information on each country's external capital structure and evaluate potential currency mismatches.

The destabilizing potential of currency mismatches is well understood, so we will not discuss it in detail here. Briefly, a mismatch in the currency denomination of credit flows and debt

[2] Note that while in nominal effective terms the TT$ has been depreciating since 2002, in real CPI-based terms (not shown) the TT$ has been appreciating since 2004.

stocks creates a vulnerability that has been linked to the increased likelihood and severity of financial crises. For example, if a country borrows heavily in foreign-currency-denominated debt, a currency depreciation would immediately and severely worsen government and private balance sheets and greatly increase debt repayment burdens. Firms would in turn reduce investment, generating pressure for further currency depreciation.[3]

3.1 The Currency Mismatch Measure

We use as a summary measure the Goldstein and Turner (2004) Aggregate Effective Currency Mismatch (AECM), which compares measures of foreign currency debt to the ability to service the debt via export revenue. The currency mismatch measure requires information on a country's foreign assets and liabilities as well as the currency composition of its debt components. For foreign assets and liabilities, we focus on bonds, deposits, and loans—the items that matter most for the assessment of potential currency mismatches—although we also present information on other assets and liabilities (notably, portfolio equity and FDI). For debt, we are most interested in ascertaining the extent to which it is denominated in foreign currencies. The greater share of debt that is foreign currency denominated, the greater are the potential currency mismatch and vulnerability to negative shocks.

AECM is calculated as follows:

(1) $AECM = (NFCA / XGS) * (FC\%TD)$, if $NFCA<0$,

$AECM = (NFCA / MGS) * (FC\%TD)$, if $NFCA>0$,

[3] The link between the contractionary effect of currency crises and the initial currency mismatch has been emphasized in both theoretical and empirical literature. See for instance, Goldstein and Turner (2004), Krugman (1999), Jeanne and Zettelmeyer (2002), Schneider and Tornell (2004), and Aghion et al. (2004).

where *NFCA* is net foreign currency assets (specifically, those related to bonds, deposits, and loans), *XGS* is exports of goods and services, *MGS* is imports of goods and services, and *FC%TD* is foreign currency debt as a percentage of total debt (expressed as a percent).[4]

AECM is formulated as a shorthand measure of a country's vulnerability to a large currency depreciation. Typically the focus is on net foreign currency debtors (*NFCA*<0), who in a currency crisis would face the possibility of rising debt burdens. An increasingly negative *NFCA* combined with greater reliance on foreign currency debt signals a more vulnerable currency mismatch. Note that a positive *NFCA* is scaled by imports, but when negative *NFCA* is scaled by exports (because a depreciation generates a positive boost to exports, which should somewhat offset the adverse balance sheet effect). Finally, as specified in (1), if *NFCA* is positive then so is AECM, indicating a situation in which a depreciation of the domestic currency would generate positive balance sheet effects.

As defined in equation (1) the AECM has no upper or lower bounds. That said, in Goldstein and Turner (2004), in a sample of 22 emerging markets over the 1994-2002 period, the AECM measure generally falls in the -40 to +80 range, except for Argentina's extreme AECM values. In 2002 the AECM was -310 for Argentina, negative but less extreme for countries like Brazil (-33) and Turkey (-41), moderately positive (between 0 and +10) for many Asian emerging market countries (but not for the Philippines), and sizeable and positive for the commodity exporters Venezuela and Peru.[5] AECM will be a larger negative value (depicting a worse currency mismatch)

[4] We follow Goldstein and Turner (2004) and calculate *NFCA* as the sum of cross-border BIS deposits and international reserves net of liabilities to BIS banks, international bonds and multilateral loans outstanding. Note that FDI and portfolio equity are excluded from *NFCA*, which is not dissimilar from their treatment in Lane and Shambaugh (2009) measures of the currency composition of international positions.

[5] As an example of an AECM calculation, consider 2002 information for Brazil. It had an *NFCA* of -$75 billion, supported by annual exports of roughly $69 billion. Thus, *NFCA/XGS* was -1.1. Compounding that was foreign-currency debt ratio (FC%TD) of about 31 percent. Multiplying *NFCA\XGS* by 31 yields the AECM of -33.

when *NFCA* is a larger negative value, exports are smaller, and the percentage of foreign currency-denominated debt is larger.

3.2 Jamaica's External Capital Structure

Table 1 summarizes 2005-2008 data on Jamaica's capital structure. Panel (A) provides details on foreign assets and liabilities. We focus on bonds, deposits, and loans, but for completeness we also include data on equities and FDI. Over this four-year period Jamaica's increasingly negative net foreign asset (NFA) position surpassed negative 100 percent of GDP. Jamaica's foreign assets have been stable (albeit with modest growth in FDI assets and portfolio equity assets); the large and growing negative NFA position owes to rapidly growing foreign liabilities (a doubling of cross-border bond and bank debt, with noteworthy increases in international bond issuance and international liabilities to BIS reporting banks), with both private and public sectors having increased their foreign borrowing.[6] FDI liabilities, which account for roughly half of Jamaica's foreign liabilities, have also risen, albeit not at the rate of bond and bank debt growth.

In panel (B) we provide information on the level and composition of total debt liabilities based on data reported by the Bank of Jamaica. *Domestic* public sector debt outstanding has been relatively stable in recent years and is denominated mostly in domestic currency, with the portion that is US$-denominated falling from 17 percent in 2005 to 12 percent in 2008. The proportion of floating-rate debt has increased significantly, reaching 62 percent of the domestic public debt as of December 2007. Adding in public sector liabilities from panel (A), including multilateral loans, *total* public sector debt liabilities, at 121 percent of GDP, is very high by international standards.

[6] Based on the underlying bond issuance data, 80 percent of the outstanding international bonds are denominated in U.S. dollars, with the remaining 20 percent denominated in euros.

With a large amount of public sector floating-rate debt, the government budget is exposed to significant interest-rate risk. For example, in the recent global financial crisis, Jamaican spreads rose dramatically, widening even relative to the EMBI Global benchmark (figure 2). Increased risk aversion by global investors has translated into higher borrowing costs for all emerging markets, and especially those with high debt levels (such as Jamaica). The combination of a large debt burden and floating rate securities could thus prove problematic.

Although Jamaica's *domestic* public sector debt is denominated primarily in Jamaican dollars, the rise in *external* debt (liabilities from panel (A)) has resulted in an increasing reliance on foreign currency borrowing. Combined with strong domestic credit growth (a third of which is in foreign currency), this has resulted in an increase in the share of total liabilities denominated in foreign currency from 49 percent at the end of 2005 to an estimated 57 percent in September 2008.

Jamaica's AECM is negative and deteriorating (panel (C)), signaling an increasingly dangerous currency mismatch. Its AECM for 2007 is sizeable not because exports are small (they are large at roughly 50 percent of GDP), but because the *NFCA* is large and negative (at almost -40% of GDP) and 54 percent of its debt is foreign-currency denominated. Jamaica, with a large and growing negative foreign exchange exposure on top of a large and growing debtor position, is vulnerable to significant depreciations of the Jamaican dollar versus the U.S. dollar.

3.3 Trinidad and Tobago's External Capital Structure

Table 2 summarizes data on TT's capital structure over the 2005-2008 period.[7] TT's overall NFA position is negative, but over the past four years has improved, largely due to the high oil prices (panel (A)). Growth in foreign assets has been driven by international reserves (including accumulations in the oil stabilization fund) and cross-border bank deposits. A large proportion of

[7] Data on TT's debt structure are not always readily accessible. Unless otherwise noted, data are from the BIS-IMF-OECD-World Bank External Debt Hub.

external liabilities is FDI. Excluding FDI, which we do when computing AECM, TT is considered a net creditor in foreign currency.

TT's total debt-to-GDP and public debt-to-GDP ratios have improved in recent years (panel (B)). The public debt-to-GDP ratio is currently low by international standards at 17 percent. Much of TT's debt is denominated in foreign currency, mostly the U.S. dollar. However, TT does not suffer from a currency mismatch if one considers that TT's main asset is oil, which trades internationally in U.S. dollars. The TT$, a floating currency, fluctuates little against the U.S. dollar and is largely unchanged over the past decade (figure 4).

TT's *NFCA* is positive ($8.6 billion in 2007) and, hence, so is its AECM. With a positive *NFCA*, from a currency mismatch perspective foreign-currency-denominated debt is not problematic, as a currency depreciation would lead to capital gains on external positions. In other words, TT's positive AECM indicates a long position in foreign currencies (the U.S. dollar in particular), which could be stabilizing even in the face of shocks large enough to require a one-off exchange rate adjustment. TT's long position in foreign exchange is rare for an emerging economy, as net long positions are more common in the advanced economies (Lane and Shambaugh 2009).

4. Oil shocks and external accounts

We measure the effects of oil shocks on each country's external accounts and analyze the macroeconomic impact using the methodology of Kilian et al. (2009). The methodology involves two steps: (i) trace fluctuations in the real price of crude oil to the underlying demand and supply shocks in the crude oil market, and (ii) assess the response of each country's external accounts to these shocks.

4.1 Identifying Oil Demand and Supply Shocks

As in Kilian et al. (2009), following the identification strategy of Kilian (2009) we estimate a structural VAR model based on monthly data for the vector time series z_t, which consists of the percent change in global crude oil production, a suitably detrended measure of global real economic activity in industrial commodity markets, and the real price of crude oil.[8] The monthly model allows for two years worth of lags. The structural VAR representation of the model is

(2) $$A_0 z_t = \alpha + \sum_{i=1}^{24} A_i z_{t-i} + \varepsilon_t ,$$

where ε_t denotes the vector of serially and mutually uncorrelated structural innovations. The structural innovations are derived by imposing exclusion restrictions on A_0^{-1} in $e_t = A_0^{-1}\varepsilon_t$. Fluctuations in the real price of oil are attributed to three structural shocks: ε_{1t}, which denotes shocks to the global supply of crude oil; ε_{2t}, which captures shocks to the global demand for all industrial commodities (including crude oil) that are driven by global real economic activity; and ε_{3t}, which denotes an oil-market specific demand shock.[9] We call these shocks oil supply shock, aggregate demand shock and oil-specific demand shock, respectively.

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[8] Analogous approaches have been employed to study the effect of oil demand and oil supply shocks on U.S. stock markets (Kilian and Park 2008) and to study the relationship between the U.S. retail gasoline market and the global crude oil market (Kilian 2008).

[9] The term global real economic activity used by Kilian et al. (2009) refers to real economic activity that affects industrial commodity markets rather than the usual broader concept of real economic activity underlying world real GDP or industrial output. This distinction is necessary because an increase in value added in the service sector, for example, is likely to have a different effect on global demand for industrial commodities than an increase in manufacturing. Unlike alternative measures of monthly global real activity such as indices of OECD industrial production, this index captures the recent surge in demand for industrial commodities from emerging economies such as China and India. See Kilian (2009) for a full discussion of the rationale and construction of this index. The oil-market specific demand shock is designed to capture shifts in precautionary demand for crude oil that reflect increased concerns

As in Kilian (2009), the assumptions are that (i) oil producers are free to respond to lagged values of oil prices, real activity, and oil production in setting oil supply, but will not respond to oil demand shocks within the same month, given the costs of adjusting oil production and the uncertainty about the state of the crude oil market; (ii) increases in the real price of oil driven by demand shocks that are specific to the oil market will not reduce global real economic activity in industrial commodity markets within the month; and (iii) 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. These assumptions imply a recursively identified model of the form:

$$e_t \equiv \begin{pmatrix} e_{1t}^{\Delta prod} \\ e_{2t}^{rea} \\ e_{3t}^{rpo} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{pmatrix} \varepsilon_{1t}^{oil\ \text{supply}\ shock} \\ \varepsilon_{2t}^{aggregate\ demand\ shock} \\ \varepsilon_{3t}^{oil-specific\ demand\ shock} \end{pmatrix}. \tag{3}$$

This structural model postulates that the real price of oil (conditional on lagged values of all variables) is determined by the intersection of the supply and demand curves for crude oil. Oil demand shocks (which do not shift the oil supply curve) move the demand curve along the supply curve, causing the real price of oil to change. The model also allows for oil supply shocks (e.g., an unexpected oil supply disruption caused by a war or driven by an exogenous political decision) to move the vertical supply curve along the downward-sloping demand curve, again causing the real price of oil to change. All three types of shocks are allowed to affect the real price of oil within a given month. The model further imposes that the shifts in the real price of oil triggered by oil-market-specific demand shocks will not affect global aggregate demand within the same month.

about future oil supply shortfalls and that are by construction orthogonal to the other shocks. For other possible interpretations, see Kilian (2009).

This assumption is consistent with the sluggish response of real aggregates to shocks in oil markets documented in related literature.

The response of the real price of oil to the three structural shocks (ε_{jt}, j=1,2,3) (from Kilian 2009) is reported in figure 6, which is from Kilian et al. (2009). Although all three responses are ultimately transitory, the timing, persistence, and magnitude of the responses vary depending on the source of the shock. An unanticipated increase in oil-market specific demand (such as an increase in precautionary demand for oil) causes an immediate and persistent increase in the real price of oil that is characterized by overshooting; an unanticipated increase in aggregate demand for all industrial commodities causes a delayed, but sustained increase in the real price of oil; and an unanticipated oil supply disruption causes a short-lived increase in the real price of oil within the first year.

In this study we are interested in assessing the effect of these oil demand and oil supply shocks on external accounts. Because international data on external accounts for most countries are available only at annual frequency, whereas the shocks implied by Kilian's (2009) VAR model are measured at monthly frequency, we follow Kilian et al. (2009) and construct annual measures of the shocks by averaging the monthly structural innovations for each year:

$$\hat{\zeta}_{jt} = \frac{1}{12}\sum_{i=1}^{12}\hat{\varepsilon}_{j,t,i}, \quad j = 1,...,3,$$

where $\hat{\varepsilon}_{j,t,i}$ refers to the estimated residual for the jth structural shock in the ith month of the tth year of the sample. Although data for z_t are available as far back as 1973, we lose two years worth of observations in estimating the VAR model. Thus, the resulting annual shock series goes back to 1975.

Figure 7, also from Kilian et al. (2009), plots $\hat{\zeta}_{jt}$, $j = 1,...,3,$ and illustrates that oil price shocks are best thought of as composites of underlying demand and supply shocks. For example, the oil price shock of 1979/80 is the result of the superimposition of three large positive aggregate demand shocks in 1978, 1979, and 1980, a one-time spike in oil-specific demand in 1979 (at the time of the Iranian Revolution, the Iranian hostage crisis and the Soviet invasion of Afghanistan) and an oil supply shock in 1980 (but interestingly not in 1979).

4.2 Estimation of Dynamic Effects

We then estimate the impact of the oil shocks on external balances, as in Kilian et al. (2009). Let y_t denote a stationary macroeconomic aggregate of interest such as the share of the trade balance in GDP. We want to estimate the response of y_t to demand and supply shocks in the crude oil market. We treat the shocks $\hat{\zeta}_{jt}$, $j = 1,...,3,$ as predetermined with respect to y_t, which rules out contemporaneous feedback from y_t to the shocks.[10] This assumption allows us to examine the dynamic effects of the shocks on the dependent variable based on regressions of the form:

$$(4) \qquad y_t = \delta_j + \sum_{i=0}^{h} \psi_{ij} \hat{\zeta}_{jt-i} + u_{jt}, \quad j = 1,...,3,$$

where u_{jt} is a potentially serially correlated error and $\hat{\zeta}_{jt}$ is a serially uncorrelated shock. The parameter h is chosen to coincide with the maximum horizon of the impulse response function to be computed. In practice, we set the maximum horizon of the impulse responses to five years.[11] By definition the impulse response is $dy_{t+1}/d\,\hat{\zeta}_{j,t}$. Differentiation yields that $dy_t/d\,\hat{\zeta}_{j,t-i} = \psi_{ij}$. Under

[10] In contrast, strict exogeneity imposes in addition Granger non-causality from y_t to $\hat{\zeta}_{jt}$. Pre-determinedness and strict exogeneity in our regression framework correspond to the notion of weak and strong exogeneity. For further discussion see Cooley and LeRoy (1985) and Engle et al. (1983).

[11] Given that oil demand may adjust sluggishly to higher oil prices, it would be desirable to know how much external balances adjust at longer horizons, but the short time span of data currently available precludes the required econometric analysis.

stationarity, it follows that $dy_t / d\hat{\zeta}_{j,t-i} = dy_{t+i} / d\hat{\zeta}_{j,t} = \psi_{ij}$. So, to the extent that the oil market is predetermined with respect to macroeconomic aggregates and external accounts, which is a reasonable assumption in our application, a simple OLS regression can be used to consistently estimate the responses of external accounts.

Note however that this equation-by-equation approach is built on the premise that the shock series $\hat{\zeta}_{jt}$ are mutually uncorrelated. Whereas the structural VAR residuals $\hat{\varepsilon}_{jt}$ are orthogonal by construction, the annual shocks $\hat{\zeta}_{jt}$, obtained by aggregating over time monthly estimates, need not be orthogonal. In our application, their correlation is very low, ranging from -0.11 to 0.07, making it reasonable to treat these shocks as orthogonal.

In the empirical analysis we consider the following six measures of each country's external balance:

- Non-Oil Merchandise Trade Balance (TBNO)
- Oil Trade Balance (OILBAL)
- Merchandise Trade Balance (TB) ≡ TBNO + OILBAL
- Current Account (CA) ≡ TB + Service Trade Balance + Income Balance
- Change in Net Foreign Assets (dNFA)
- Capital Gains on Foreign Assets and Liabilities (CAPGAIN) ≡ dNFA + CA [12]

The Net Foreign Assets (NFA) data are from Lane and Milesi-Ferretti (2007), updated through 2007.[13] All other data (including the trade balance, current account, and GDP data) are from the IMF's *World Economic Outlook* database. All external accounts are expressed in current

[12] As CAPGAIN is calculated as the change in the net foreign asset position less the current account balance, it is subject to the caveats raised in Curcuru et al. (2008) and Curcuru et al. (2009). For Jamaica and TT, as well as for almost every country, there is a great need for directly measured—and, hence, presumably more accurate—data on international capital gains.

[13] Note that there is some discrepancy between Jamaica's published IIP data (available from 2005 to 2007) and the Lane and Milesi-Ferretti estimates (available for a much longer time period).

U.S. dollars and, as is conventional, are normalized by nominal GDP for the empirical analysis. Estimation is for the period from 1980 through 2007.[14]

4.3 The Responses of External Balances

Figure 8 shows the responses of external balances to oil shocks. We first discuss the responses of the oil trade balance, non-oil trade balance, and current account (panels (a) and (b)). Then we analyze whether the responses of capital gains are such that they help offset responses of the current account in a way that mitigates movements in the net foreign asset position (panels (c) and (d)).

The responses of external balances to oil-specific demand and supply shocks are constructed from regression model (4). All responses have been normalized such that a given shock implies an increase in the real price of oil. The impulse response functions are framed by one-standard error bands based on estimated OLS standard errors.[15,16]

4.3.1 Trade and Current Account

The estimated responses of oil trade balance, non-oil trade balance, and current account for the three types of oil shocks are shown in panel (a) for Jamaica and panel (b) for TT. Many of the explanations for the estimated responses are intuitive.

For example, for Jamaica any shock that increases the real price of oil has a negative impact on the oil trade balance (first row of panel (a)). Global demand and oil-specific demand shocks have a sustained and significant impact, while the impact of oil supply shocks is short-lived, not

[14] A more detailed description of these aggregates is provided in the data appendix of Kilian et al. (2009).
[15] A correction of the standard errors for autocorrelation and possibly heteroskedasticity could be considered here given the fact that the econometric model omits any dynamics.
[16] In background research work not reported in the paper (but available from the authors), we have used similar methodology to explore the impact of natural disasters and non-fuel commodity price shocks on Jamaica's external accounts. We found no significant effects. Natural disasters data are from EM-DAT: The OFDA/CRED International Disaster Database (http://www.em-dat.net). The alternative non-fuel commodity price series used, including food prices, are from the IMF's IFS database. Finding that these other shocks have limited impact on Jamaica's external accounts need not imply that they are unimportant for Jamaica's welfare and growth, but more likely mean that the methodology used in the paper to assess their impact might not be suitable for those shocks.

surprisingly because the oil price response to the supply shock (figure 6) was short-lived. The responses for the non-oil trade balance are less precise, and thus the responses for the overall current account balance are similar to, but not exactly same as, the responses from the oil trade balance. Overall, we can conclude that demand shocks that raise the real price of oil lead to a deterioration in Jamaica's current account.

For TT, the most precisely estimated responses (those that are significantly different zero) are for the global demand shock (second column of panel (b)). A global demand shock that raises the real price of oil leads to an improvement in not only the oil trade balance but also the non-oil trade balance and, hence, also the current account balance.[17] Responses to other shocks are imprecisely measured and therefore less conclusive.

4.3.2 Current Account, Capital Gains, and the Net Foreign Asset Position

To ascertain whether the external capital structures help mitigate the impact of oil price shocks, we focus on the current account, capital gains on international positions, and the NFA position. Theory suggests that in a financially integrated world oil-importing nations should take equity stakes in oil-exporting countries in order to hedge against oil price volatility (see for instance Ghironi et al. 2007). This hedging would allow oil-importing countries to earn capital gains, offsetting the impact of the shock on the oil trade balance and the current account, thereby shielding the NFA from oil prices fluctuations. In our analysis, we ask the following. Does the capital gains path tend to offset the response of the current account in a way that mutes the overall response of external national wealth (the NFA position)?

[17] As Kilian et al. (2009) discuss, under incomplete markets, a surplus in the oil trade balance should lead to a deficit in the non-oil trade balance. However, in the case of the global demand shock, the same shock that drives the oil price up can also drive the non-oil trade balance up if the global demand increase affects other export sectors of the economy. What we thus estimate and observe is the net effect. It is not surprising, therefore, to see that the response of the non-oil trade balance compounds the effect on the oil trade balance.

Panels (c) and (d) show the responses of the current account, capital gains, and the NFA position to oil price shocks. For Jamaica, in one case, global demand shocks, capital gains move in the opposite direction of the current account responses, at least to some extent (panel (c), second row). But overall, shocks that raise the real price of oil tend to negatively impact Jamaica's NFA position, suggesting that for the most part Jamaica's external capital structure is not mitigating the impact of these shocks. For TT, there is some evidence, not overwhelming, that for demand shocks (the middle and bottom rows) the external capital structure mitigates some of the impact on the NFA position (panel (d)).

5. Potential Modifications of the External Capital Structures

In this section we discuss potential portfolio modifications that may help to better hedge against the risks posed by oil price shocks (based on the analysis from Section 4) and external shocks more generally (based on the information from table 1 and 2). We stress that what follows is a cursory analysis that should be seen as illustrative.

5.1 Jamaica

To shield the net foreign asset position in the face of an oil price shock, capital gains should offset current account movements. Because Jamaica's current account balance is strongly affected by oil price changes (top panel of figure 9), to do so the country portfolio (or capital structure) should be strongly and positively correlated with oil prices.

Oil prices have a strong positive correlation with a wide range of assets. One example is oil company stocks or oil-related exchange-traded funds (ETFs); another, perhaps more feasible, is a fund based on a broad equity index of a country that has both substantial oil production and deep equity markets (e.g., Norway or Canada). Given the close link between the oil price and currency movements of oil-exporting countries (Chen and Rogoff, 2003), one concrete way to implement such a portfolio would be to switch part of the official reserve portfolio into these fully convertible currencies.

Jamaica's current capital structure shows its vulnerability to currency fluctuations (table 1). In theory, a country with a procyclical exchange rate could hedge domestic output fluctuations by taking long positions in foreign currencies. This hedging, consistent with Lane and Shambaugh (2010), would provide an *appreciating* foreign asset during domestic economic contractions. Unfortunately, Jamaica—like many other emerging economies—displays no such evidence of access to international risk sharing via this channel. As figure 1 showed, the Jamaican dollar tends to depreciate during troubled macroeconomic times but, at the same time, the data in table 1 indicate that Jamaica has a short position in foreign currency, not the preferred long position.

Given Jamaica's vulnerability to both oil price and exchange rate shocks, it might be able to take advantage of the recent tight positive relationship between the US$/euro exchange rate and oil prices (bottom panel of figure 9). Whether this tight relationship will hold in the future is debatable. If it were to persist, increasing the allocation of euro-denominated assets in its foreign portfolio would help reduce fluctuations in its net foreign asset position and might ameliorate its currency mismatch. More direct ways to address Jamaica's currency mismatch include reducing foreign currency borrowing, increasing trade (greater exports would reduce the magnitude of a negative AECM), and increasing local bond market development (a higher local currency share in total debt reduces the magnitude of the AECM).

5.2 Trinidad and Tobago

While TT's current capital structure shows no substantial vulnerability to currency fluctuations (table 2), the response of capital gains on foreign assets and liabilities (CAPGAIN) to the various oil market shocks suggests that TT's external capital structure can be altered to better shield the net foreign asset position against oil supply and oil-specific demand shocks. For TT, a portfolio that would hedge against the macroeconomic effects of oil shocks would have a strong negative correlation with oil prices, as the current account balance is tightly related to oil prices (top panel of figure 10).

For assets that are negatively related to oil prices, one might consider the U.S. dollar. The U.S. dollar (bottom panel of figure 10) shows, at least in recent years, a tight (negative) relationship with oil prices, but this correlation might not hold in the future. If it does, to limit fluctuations in the net foreign asset position TT might increase its long U.S. dollar position. But holding dollar-denominated assets would not suffice, as the TT$ fluctuates little with the U.S. dollar. Alternatively, assets that might have the same desirable characteristic of being negatively correlated with oil prices include a broad index of transportation stocks and, more directly, exchange traded funds that are constructed to co-move negatively with oil prices.[18]

6. Conclusion

In this paper we have described the external capital structures of Jamaica and TT and analyzed how these structures did in the past—and could in the future—mitigate or exacerbate the impact of external shocks. We examined the capital structures and evaluated potential currency mismatches, and analyzed the response of external accounts to different types of oil shocks.[19]

The analysis of Jamaica's external capital structure highlighted many vulnerabilities due to large and growing negative foreign exchange exposure combined with a large and growing debtor

[18] It is likely that the Heritage and Stabilization Fund tries to manage its portfolio with consideration such as this in mind, although we have no definite way of knowing that.
[19] For Jamaica, we also investigated natural disasters and commodity price shocks, but found that these did not have a systematic and significant impact on its external accounts.

position, much of which is financed by floating rate securities. Our investigation of the impact of oil shocks on external accounts revealed a pattern of capital gains responses to oil shocks that does not mitigate the macroeconomic effects of such shocks. A key consideration going forward is how the composition of Jamaica's (net) international portfolio might be altered so as to create capital gains when there are shocks that increase the real price of oil. One potential way to ameliorate both general vulnerability to currency movements and its response to oil shocks is to change the composition of official reserves toward the euro and oil currencies such as the Norwegian krone and the Canadian dollar.

TT, in contrast, has no evident problem with currency mismatches, as its international assets are larger than its liabilities (excluding FDI). That said, a key consideration going forward is how the composition of TT's (net) international portfolio might be altered in order to generate capital gains when there are negative oil price shocks. Given that the TT$ fluctuates little with the U.S. dollar, one way to mitigate the response to oil shocks is to add assets—such as a leveraged U.S. dollar exchange-traded fund (ETF) or broad indexes of transportation shocks—that might co-move negatively with the price of oil.

The efforts that many oil-exporting countries have put into building oil stabilization funds (such as TT's Heritage Stabilization fund) recognize many of the issues we address. The debate on the establishment of sovereign wealth funds highlights a desire of oil-exporting countries to increase rate of returns from investments in good times. In contrast, we approach these issues by exploring ways to insulate the economy from positive and negative contingencies, both over time and across states of nature.

Finally, we must restate an important caveat. In our analysis of the response of capital gains to oil price shocks we use capital gains series estimated by combining information from IIP and BOP data. Finer analysis awaits better data on capital gains.

References

Aghion, P., P. Bacchetta, and A. Banerjee, 2004. “A Corporate Balance-Sheet Approach to Currency Crises”. *Journal of Economic Theory,* Vol. 119 (November), pp. 6–30.

Bank of Jamaica, 2007. “Financial Stability Report”.

Central Bank of Trinidad and Tobago, 2008. *Statistical Digest*. Volume VII No. 1.

Chen Y. and K. Rogoff, 2003. “Commodity currencies”. *Journal of International Economics* 60(1): 133-160.

Cooley, T.F., and S. LeRoy, 1985. “Atheoretical Macroeconometrics: A Critique”. *Journal of Monetary Economic* 16: 283-308.

Curcuru, S., T. Dvorak, and F. Warnock, 2008. “Cross-Border Returns Differentials”. *Quarterly Journal of Economics* 123: 1495–1530.

Curcuru, S., C. Thomas, and F. Warnock, 2009. “Current Account Sustainability and Relative Reliability”. NBER International Seminar on Macroeconomics 2008.

Engle, R. F., D. F. Hendry, and J.-F. Richard, 1983. "Exogeneity". *Econometrica* 51, 277-305.

Ghironi, F., J. Lee, and A. Rebucci, 2007. “The Valuation Channel of External Adjustment”. NBER WP 12937.

Goldstein, M., & Turner, P., 2004. *Controlling Currency Mismatches in Emerging Markets*. Washington, DC: Institute for International Economics.

Jeanne, O., and J. Zettelmeyer, 2002. “‘Original Sin,’ Balance Sheet Crises, and the Roles of International Lending”. IMF Working Paper 02/234 (Washington: International Monetary Fund).

Kilian, L., 2009. “Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market”. *American Economic Review*, 99(3): 1053-1069.

Kilian, L., 2008. “Why Does Gasoline Cost So Much? A Joint Model of the Global Crude Oil Market and the U.S. Retail Gasoline Market”. mimeo, Department of Economics, University of Michigan, http://www.personal.umich.edu/~lkilian/ paperlinks.html.

Kilian, L., and C. Park, 2008. “The Impact of Oil Price Shocks on the U.S. Stock Market”. *International Economic Review* (forthcoming).

Kilian, L., A. Rebucci, and N. Spatafora, 2009. “Oil Shocks and External Balances”. *Journal International Economic,* 77: 181-194.

Krugman, P., 1999. “Balance Sheets, The Transfer Problem, and Financial Crises” in *International Finance and Financial Crises: Essays in Honor of Robert P. Flood, Jr.,* ed. by P. Isard, A. Razin, and A. Rose (Norwell, Massachusetts: Kluwer Academic).

Lane, P.R., and G.M. Milesi-Ferretti, 2007. “The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970–2004”. *Journal of International Economic* 73: 223-250.

Lane, P.R., and J. Shambaugh, 2009. “Financial Exchange Rates and International Currency Exposures”. *American Economic Review* 99(1): 1-30.

Lane, P.R., and J. Shambaugh, 2010. “The Long or Short of it: Determinants of Foreign Currency Exposure in External Balance Sheets”. *Journal of International Economics* (forthcoming).

Schneider, M., and A. Tornell, 2004. “Balance Sheet Effects, Bailout Guarantees and Financial Crises”. *Review of Economic Studies,* Vol. 71 (July), pp. 883–913.

Table 1: Summary Data for Jamaica's Capital Structure
(in millions of U.S. dollars, unless otherwise noted)

	end-05	end-06	end-07	Sept-08
(A) Foreign Assets and Liabilities				
Foreign Assets	**6561**	**7298**	**7511**	
Cross-Border BIS Deposits	2228	2434	2728	2692
International Reserves less Gold	2170	2318	1878	2257
Foreign Direct Investment	1861	1989	2173	
Portfolio Equity	301	557	731	
Foreign Liabilities	**12942**	**15697**	**18347**	
International Bonds	2999	3774	4260	4587
Public Sector	2499	2824	3005	3512
Liabilities to BIS Banks	1294	2448	3345	4885
Public Sector	531	703	1065	1623
Multilateral Loans	1081	1025	940	900
Foreign Direct Investment	7389	8190	9513	
Portfolio Equity	179	259	289	
Net Foreign Assets	**-6381**	**-8399**	**-10837**	
NFA/GDP (%)	-68	-81	-101	
(B) The Structure of Debt				
Domestic Public Sector Debt	7434	7992	7907	8006
Floating rate (%)	49	56	62	*62*
US$-indexed or US$-denominated (%)	17	13	12	*12*
Total Public Sector Debt	11545	12544	12918	14041
Public Debt/GDP (%)	123	121	121	
Private Domestic Bank Credit	2299	2744	3248	3698
Foreign Currency (%)	34	34	34	34
Total Debt	15107	17983	19700	22076
Foreign Currency (%)	49	51	54	57
Total Debt/GDP (%)	161	173	184	
(C) The Currency Mismatch Measure				
NFCA	-976	-2495	-3939	
Exports	3994	4782	4928	
Aggregate Effective Currency Mismatch	-12	-27	-43	

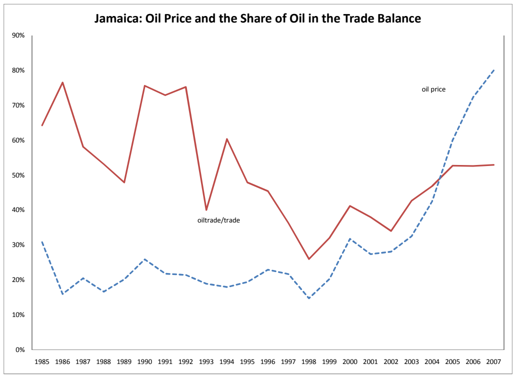
Notes. Data are primarily from the BIS-IMF-OECD-World Bank External Debt Hub, supplemented by Lane and Milesi-Ferretti (2007) and local sources. Domestic public sector debt characteristics are provided by the 2007 Bank of Jamaica Financial Stability Report; we assumed no changes for 2008. The foreign exchange share of private domestic bank credit is based on February 2008 data from the BOJ. Net Foreign Currency Assets (NFCA) and Aggregate Effective Currency Mismatch (AECM) are calculated as defined by Goldstein and Turner (2004) and therefore exclude equity and FDI. Total Debt is estimated as the sum of International Bonds, Cross-Border Liabilities to BIS banks, Multilateral Loans, Domestic Public Sector Debt, and Private Domestic Bank Credit.

Table 2. Summary Data for Trinidad and Tobago's Capital Structure
(in millions of U.S. dollars, unless otherwise noted)

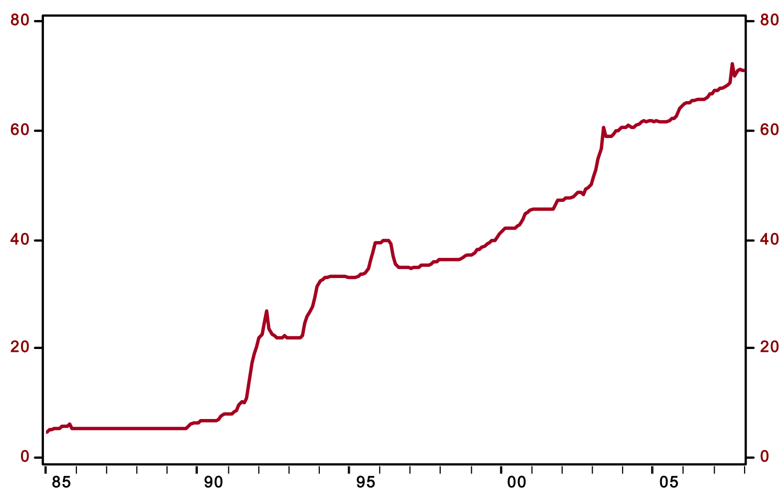
	end-05	end-06	end-07	Sept-08
(A) Foreign Assets and Liabilities				
Foreign Assets	**10871**	**14078**	**16210**	
Cross-border BIS Deposits	4736	5918	7897	9118
Int'l Reserves less Gold	4961	6586	6694	8775
Heritage and Stabilization Fund	871	1396	1759	
Foreign Direct Investment	1158	1556	1600	
Portfolio Equity	15	18	20	
Foreign Liabilities	**19280**	**21226**	**22741**	
International Bonds	2050	2496	2291	2284
Public Sector	682	539	691	684
Liabilities to BIS Banks	3129	2947	3204	3886
Public Sector	91	143	321	439
Multilateral Loans	482	434	438	411
Foreign Direct Investment	13506	15246	16705	
Portfolio Equity	113	102	103	
Net Foreign Assets	**-8409**	**-7148**	**-6531**	
NFA/GDP(%)	-56	-39	-32	
(B) The Structure of Debt				
Domestic Public Sector Debt	1816	1878	2089	2364
Total Public Sector Debt	**3071**	**2994**	**3539**	**3898**
Public Debt/GDP (%)	20	16	17	
Private Domestic Bank Credit	4272	4964	5935	6640
Total Debt	11749	12720	13957	15585
Foreign Currency (%)	48	46	43	42
Total Debt / GDP (%)	78	70	67	
(C) The Currency Mismatch Measure				
NFCA	4036	6627	8658	
Imports	5725	6843	7670	
Aggregate Effective Currency Mismatch	**34**	**45**	**48**	

Notes. Data are primarily from the BIS-IMF-OECD-World Bank External Debt Hub, supplemented by Lane and Milesi-Ferretti (2007) and local sources such as CBTT (2008). Net Foreign Currency Assets (NFCA) and Aggregate Effective Currency Mismatch (AECM) are calculated as defined by Goldstein and Turner (2004) and therefore exclude equity and FDI. Total Debt is estimated as the sum of International Bonds, Cross-Border Liabilities to BIS banks, Multilateral Loans, Domestic Public Sector Debt, and Private Domestic Bank Credit.

Figure 1. Jamaica: Longer-Term Perspective on Oil, Trade, and the Exchange Rate

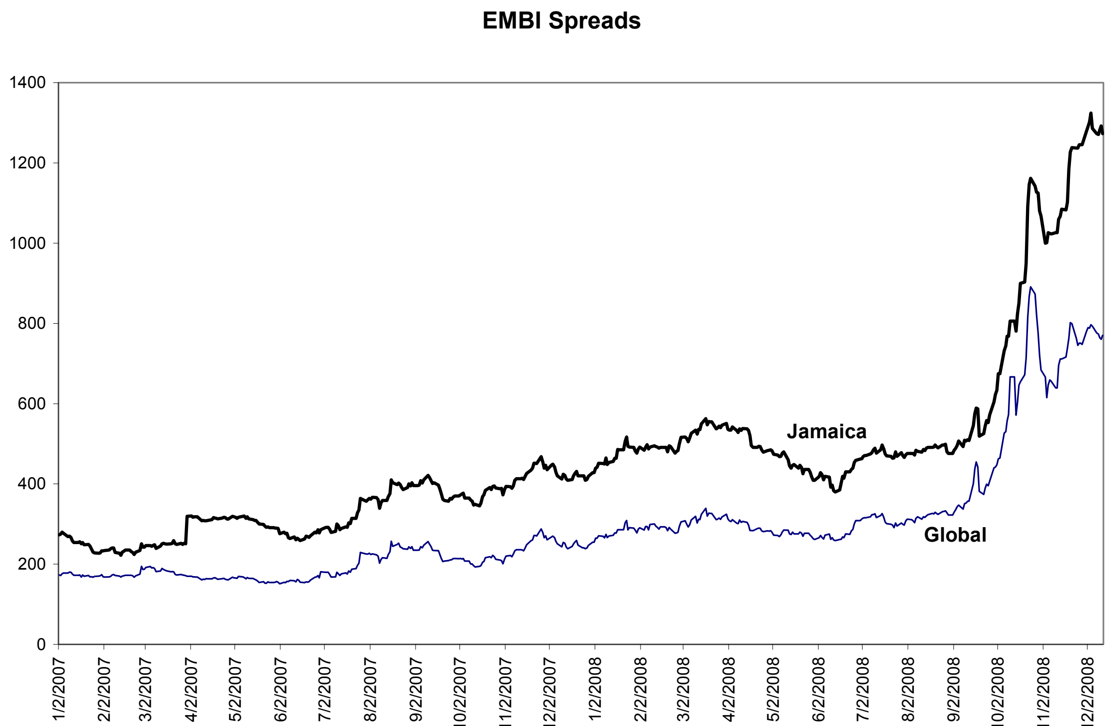


Jamaica: Exchange Rate (J$/US$)



Source: International Monetary Fund /Haver Analytics

Figure 2. Jamaica: Recent Data on Spreads and the Exchange Rate



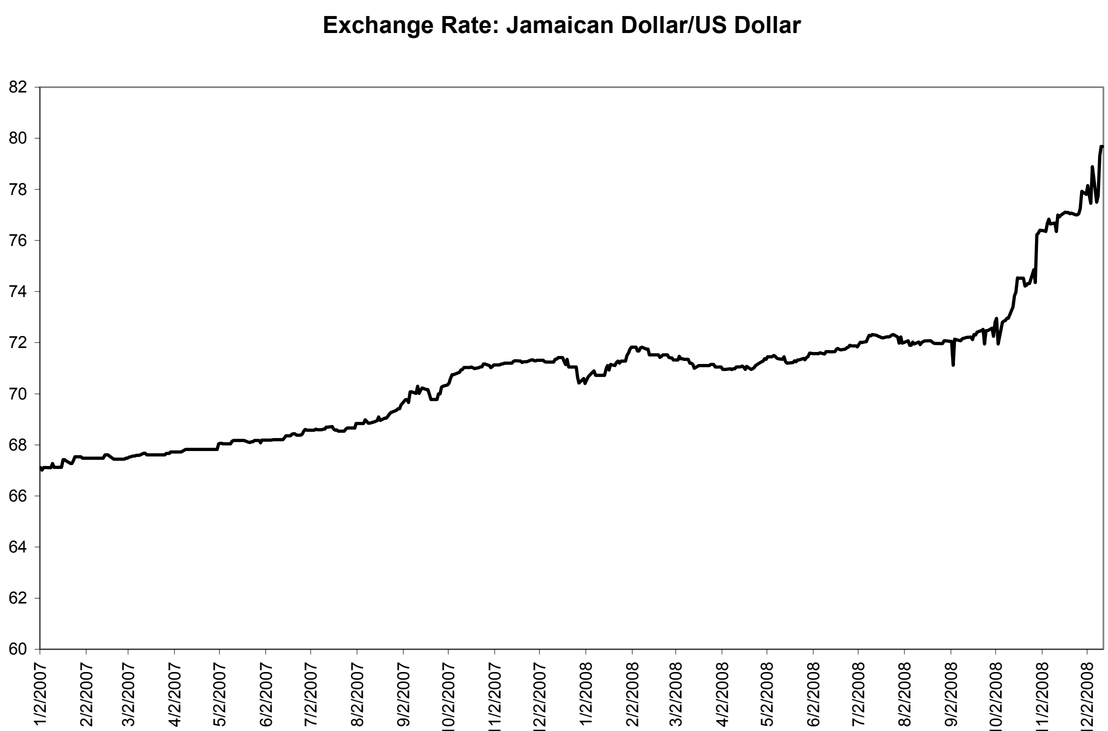


Figure 3. Trinidad and Tobago's Dependence on Oil

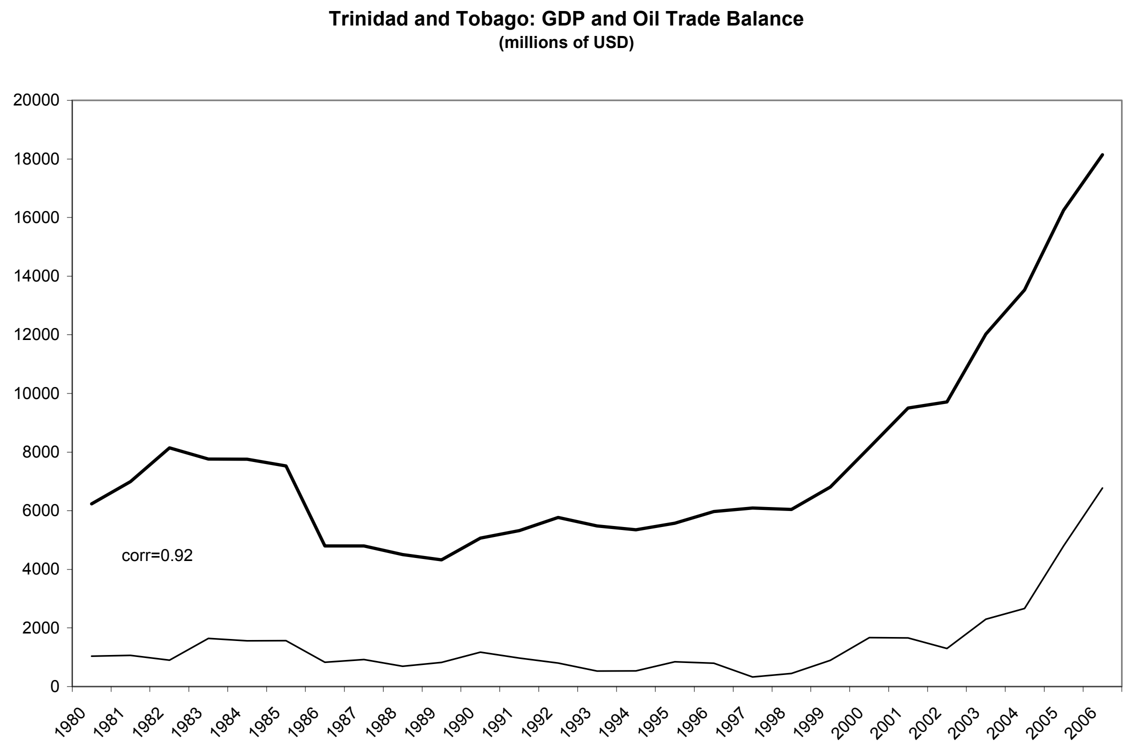
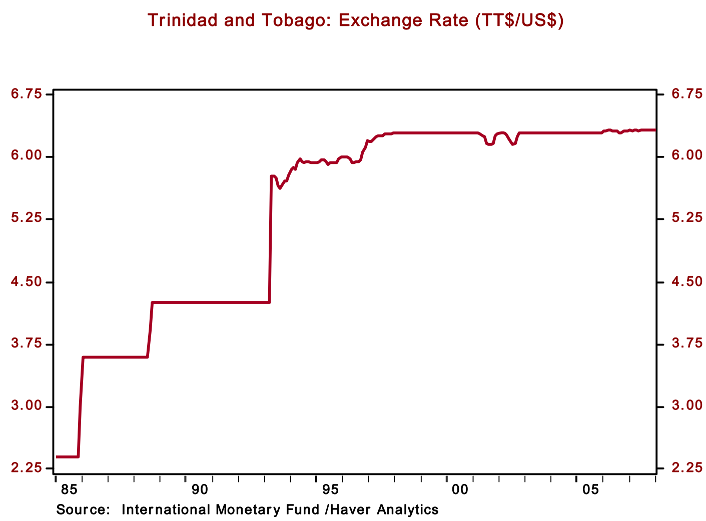


Figure 4. A Longer-Term Perspective on Trinidad and Tobago's Exchange Rate



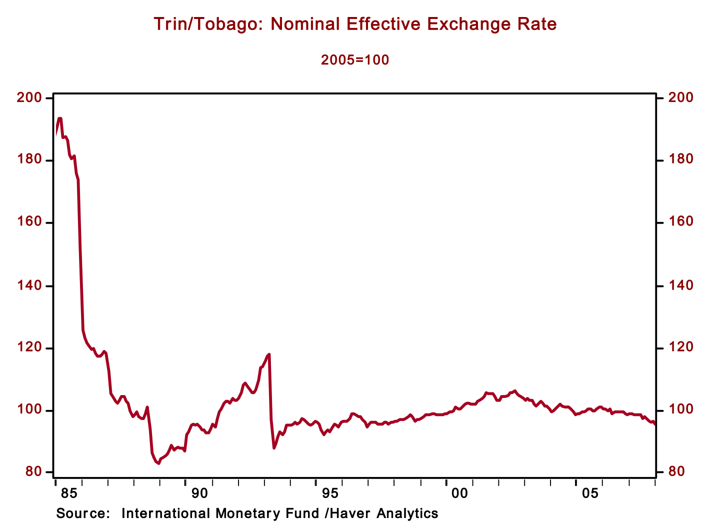
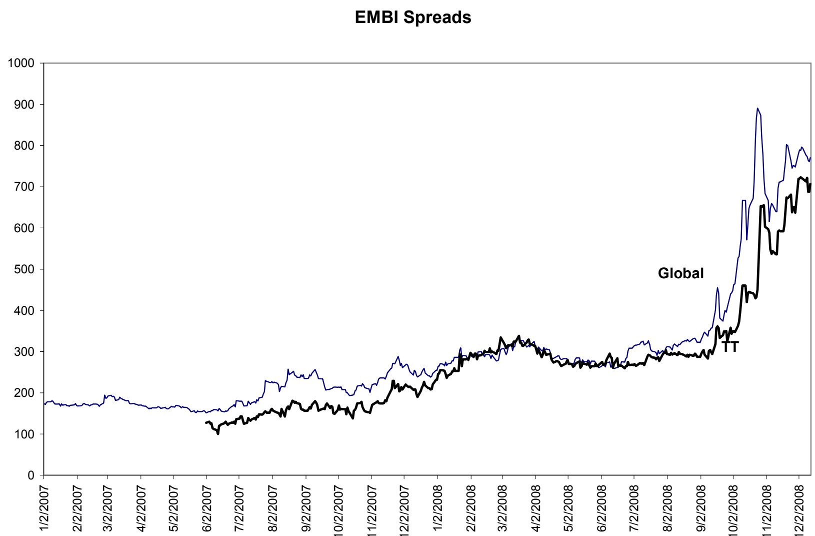


Figure 5. Trinidad and Tobago: Recent Data on Spreads and Exchange Rate



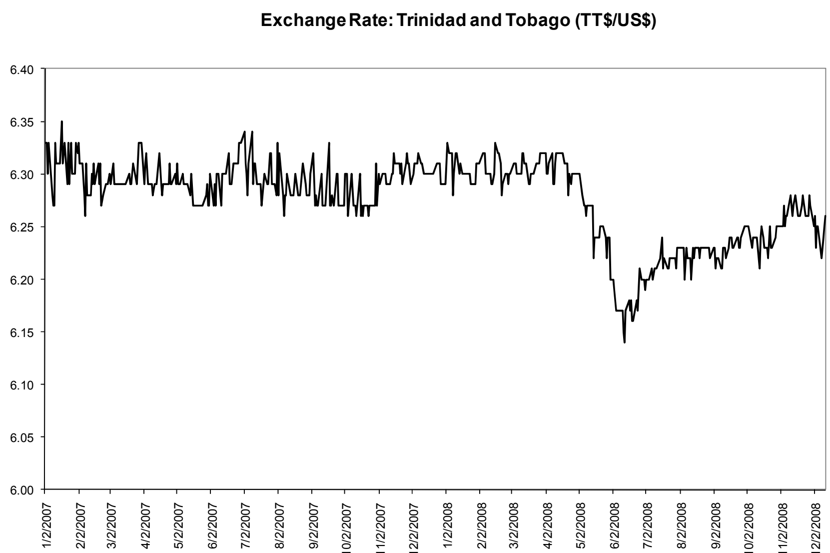
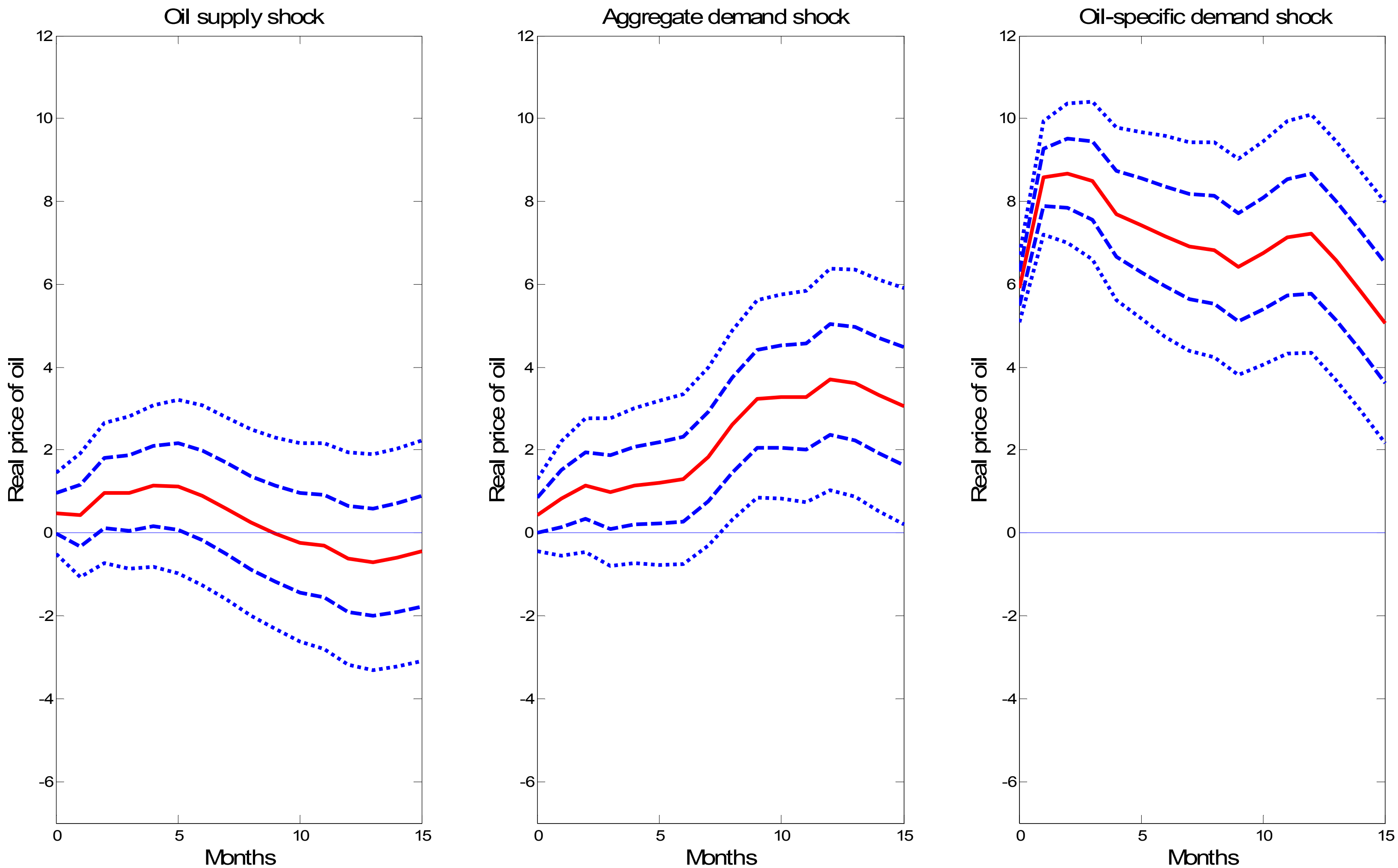
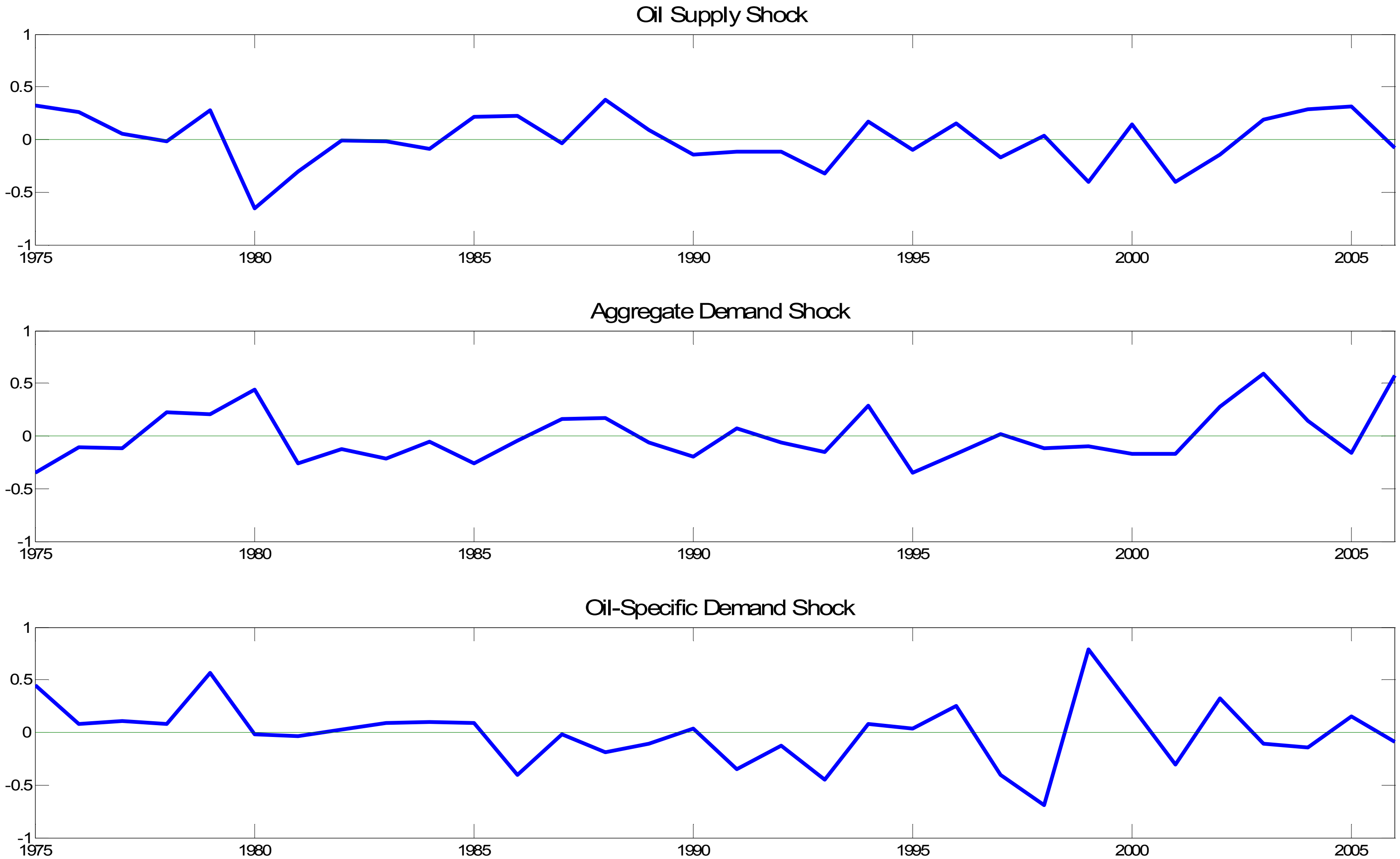


Figure 6: Responses to One-Standard Deviation Structural Shocks
(with one and two standard deviation error bands)



Notes: From Kilian et al. (2009), estimates based on model (3) described in the text. The confidence intervals were constructed using a recursive-design wild bootstrap.

Figure 7: Annual Averages of the Shocks that Determine the Real Price of Oil: 1975-2006

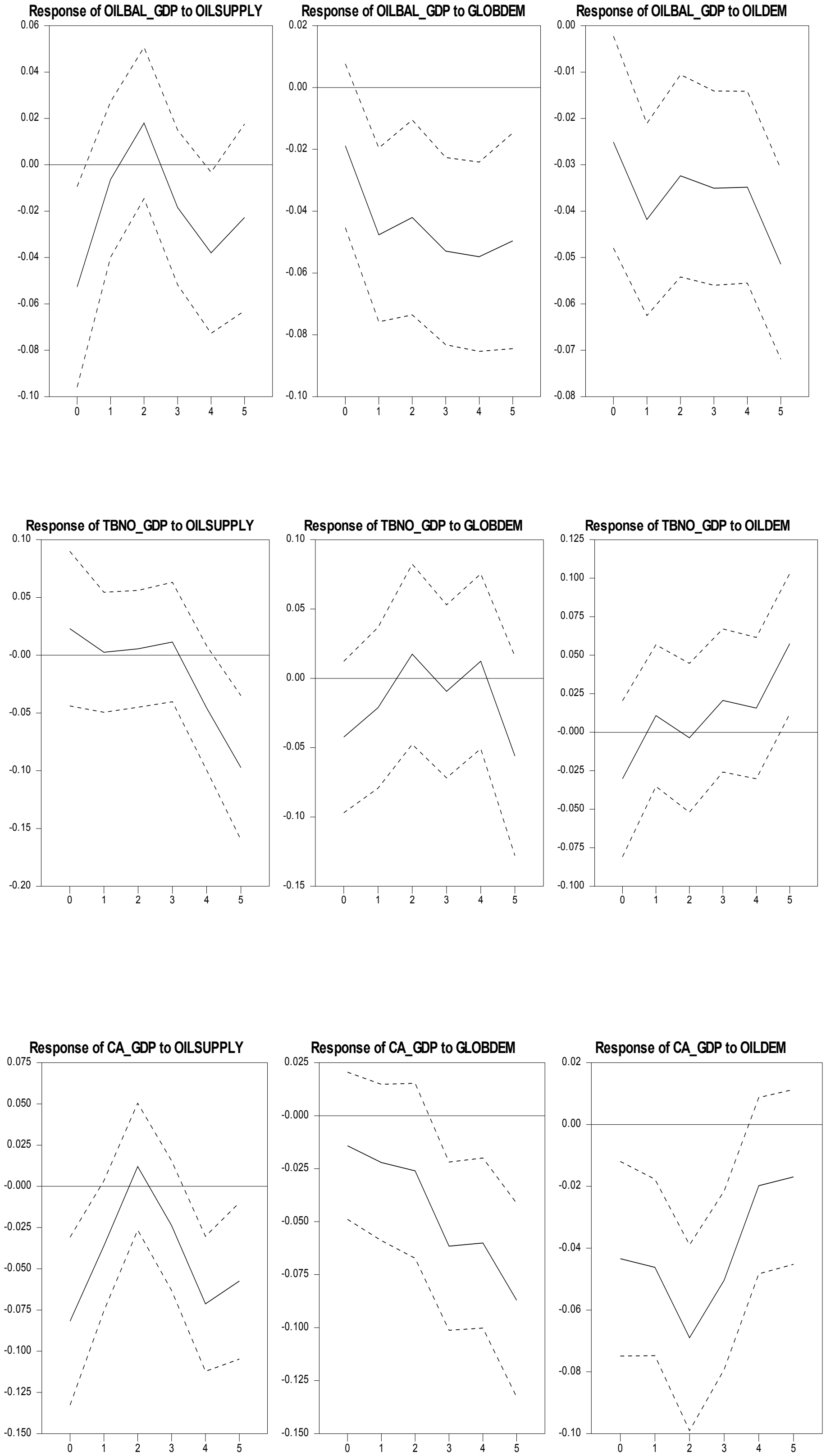


Notes: From Kilian et al. (2009), annual averages of the structural shocks underlying the responses in Figure 6.

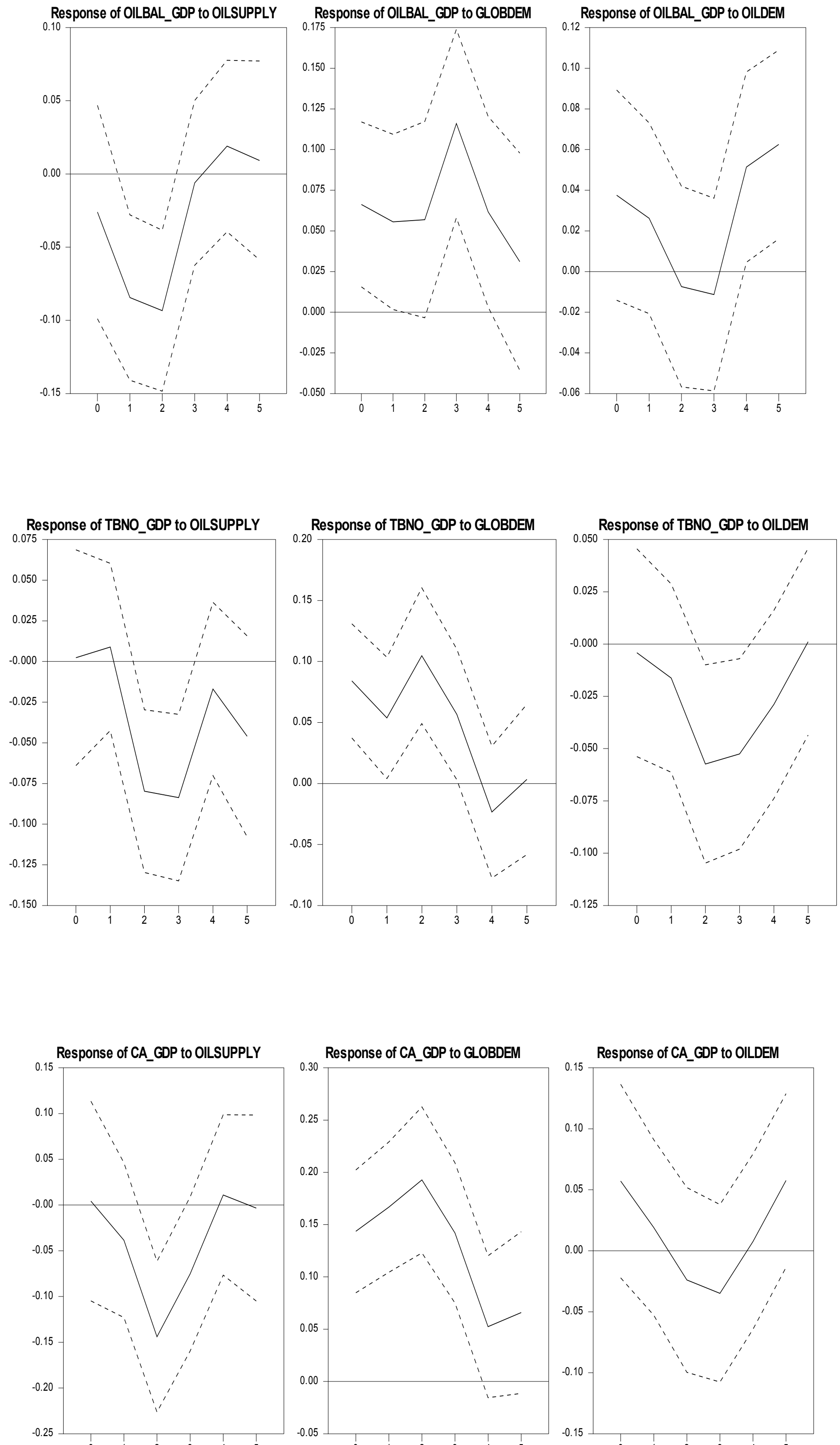
Figure 8. Responses of External Balances to Oil Shocks

The figures show estimated responses of external balances to three types of oil shocks: oil supply, global demand, and oil demand. Panels (a) and (b) show the responses of non-oil merchandise trade balance (TBNO), oil trade balance (OILBAL), and current account (CA), all scaled by nominal GDP, to these shocks. Panels (c) and (d) show the responses of capital gains on gross foreign assets and liabilities (CAPGAIN), current account (CA), and the change in the net foreign asset position (DNFA). All measures of external balances are scaled by nominal GDP. Each shock is defined so that it implies an increase in the real price of oil.

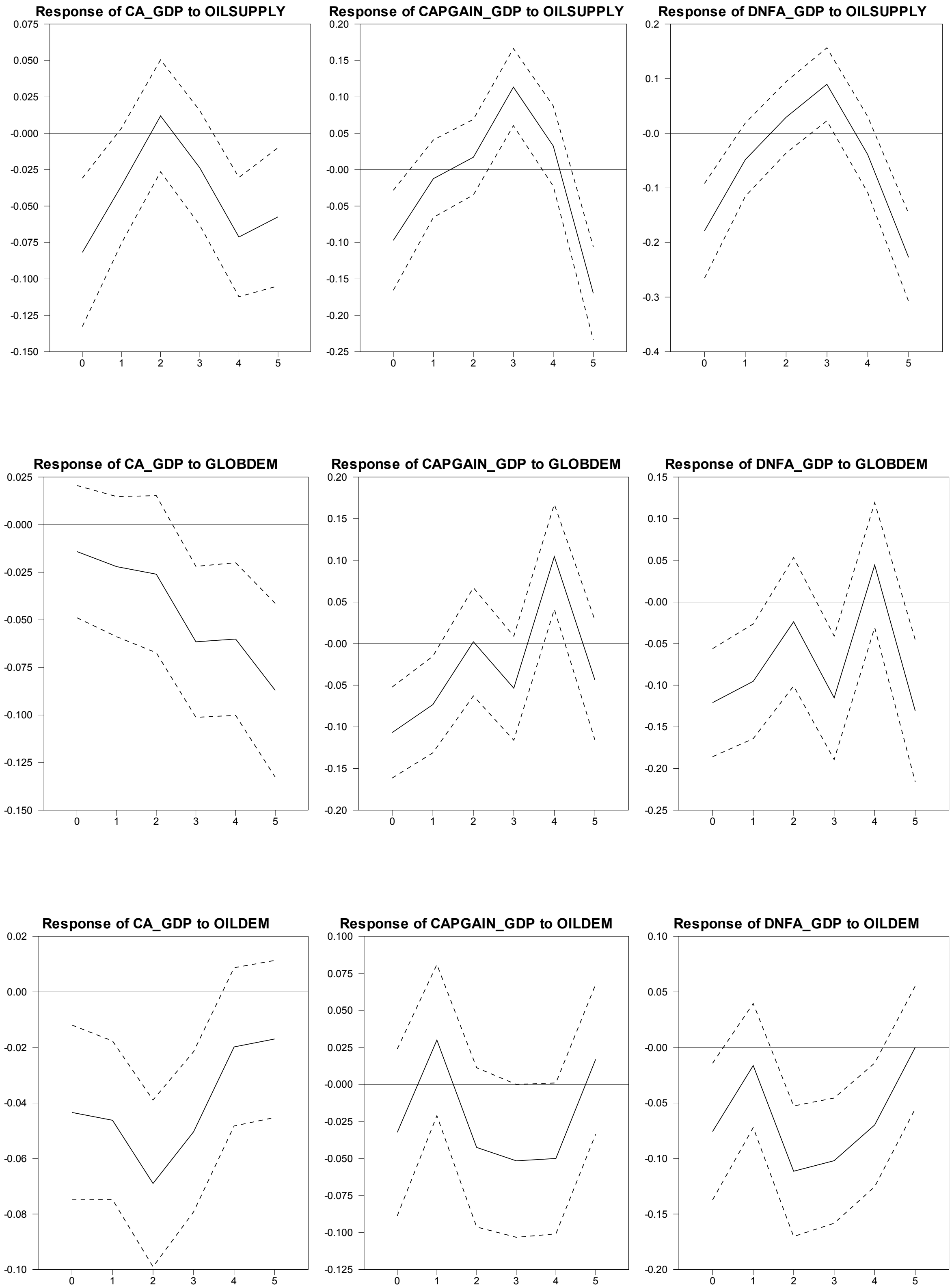
(a) Jamaica: OILBAL, TBNO, and CA



(b) Trinidad and Tobago: OILBAL, TBNO, and CA



(c) Jamaica: CA, CAPGAIN, and DNFA



(d) Trinidad and Tobago: CA, CAPGAIN, and DNFA

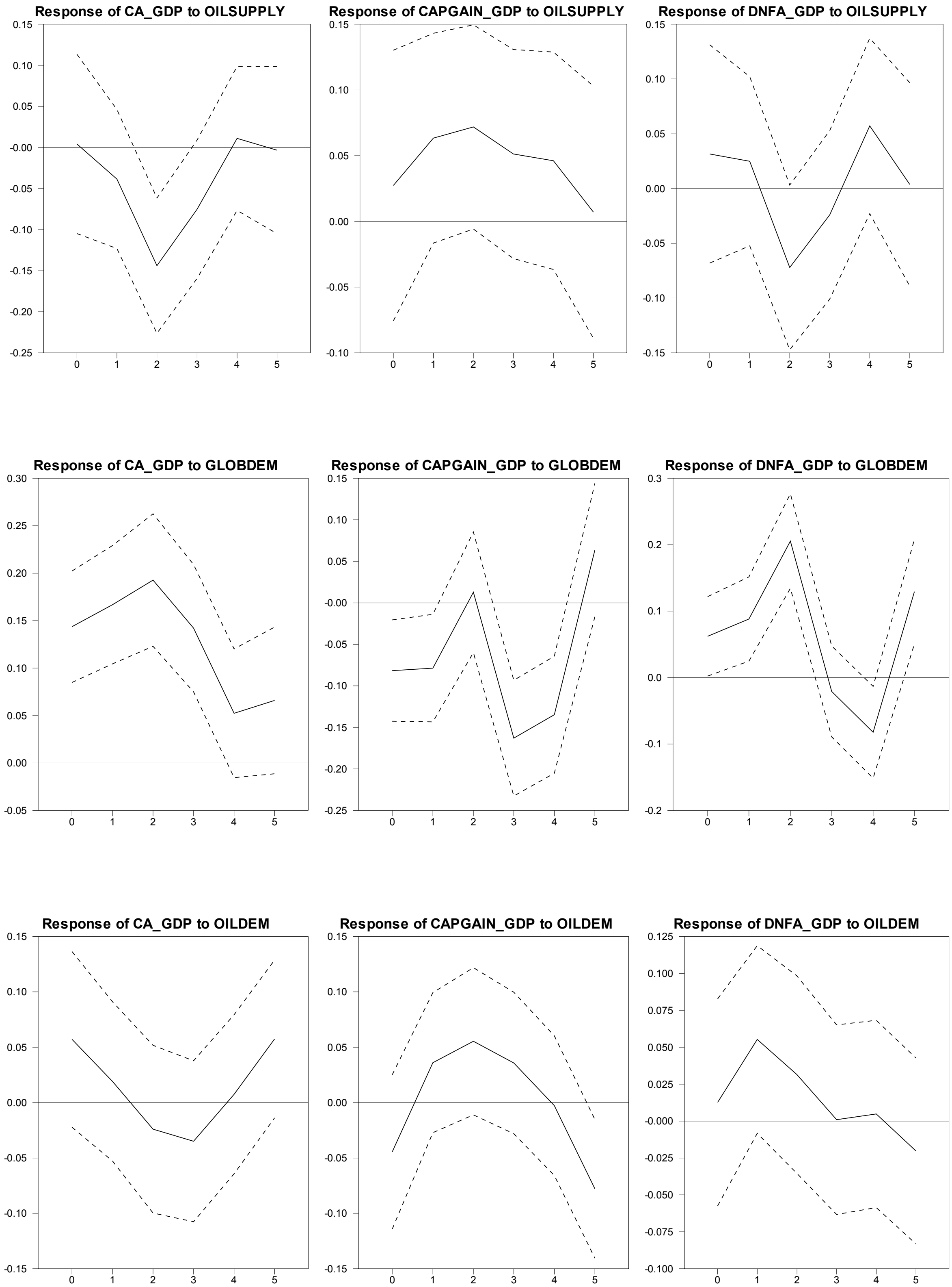
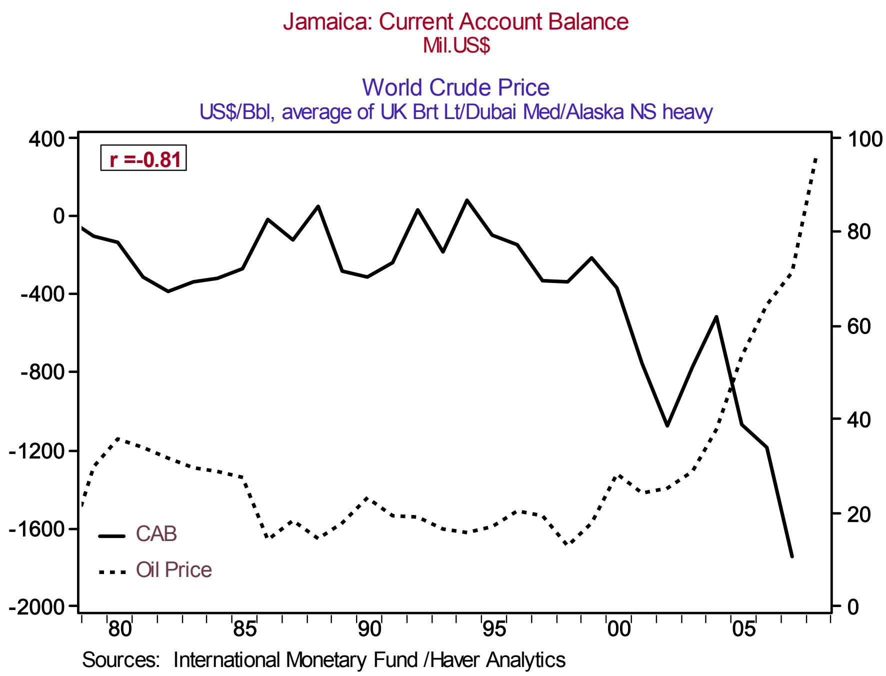


Figure 9. Jamaica: Current Account, Oil Prices, and the U.S. Dollar



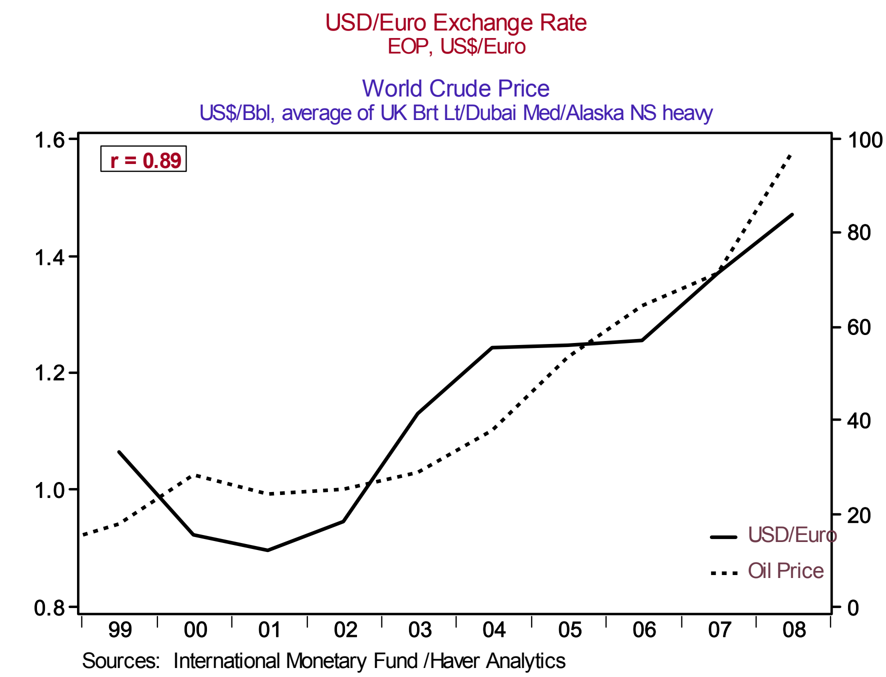


Figure 10. Trinidad and Tobago: Current Account, Oil Prices, and the U.S. Dollar