The Dynamics and Determinants of Kuwait's Long-Run Economic Growth[*]

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Abstract

This paper develops a quarterly macro-econometric model for the Kuwaiti economy estimated over the period 1979Q2–2013Q1, allowing us to investigate the long-run role of oil income in the development of Kuwait as well as the direct effects of oil revenue, foreign output, and equity price shocks on real output. More specifically, we examine to what extent Kuwaiti real output in the long run is shaped by oil revenue through its impact on capital accumulation, and technological transfers through foreign output. Using the same modelling strategy we also explore the role of oil income in terms of long-run private and public sector output growth (separately). The estimates suggest that real domestic output in the long run is influenced by oil revenues and foreign output (a proxy for technological progress), and technological growth in Kuwait is on a par with the rest of the world. Furthermore, while we show that both oil revenues and foreign output drive growth in the public sector, it seems that technological progress is the main (and only) driver for private sector real growth. Finally, our results show that oil revenue and global equity market shocks have a large and significant long-run impact on Kuwait's real output and public sector GDP. In comparison, the effects of the foreign output shock is muted.

JEL Classifications: C32, C53, E17, F43, F47, Q32.
Keywords: Growth models, long-run relations, oil exporters, Kuwaiti economy, oil revenue and foreign output shocks.

1   Introduction

The ups and downs of Kuwait's economy since the 1970s are often viewed as driven by two main factors: domestic political shocks and the price of oil. While these two factors have been visibly important in shaping economic fluctuations and growth in Kuwait, their effects have been conditioned by and combined with influences from other domestic and global factors. In particular, GDP growth, inflation, interest rates, and equity prices in the rest of the world are likely to have direct or indirect impacts on Kuwait's economy, though little is known about the significance of such effects in Kuwait; or the other five relatively similar Gulf Cooperation Council (GCC) countries (Bahrain, Oman, Qatar, Saudi Arabia, or the UAE) in general. Assessing the role of various factors involved in the country's macroeconomic process is important for understanding the trends and fluctuations in the economy and for forecasting and policy analysis.

To this end we build and estimate a vector autoregressive model with weakly exogenous foreign variable (VARX*) for Kuwait, which we refer to as the K-VARX* model, based on quarterly data covering the period from 1979Q2 to 2013Q1. The model has both real and financial variables: real domestic output, inflation, real exchange rate, oil revenue, global equity prices, foreign real output, as well as foreign inflation and short-term interest rates. The model is developed to address some of the key economic policy issues relevant to Kuwait. For instance, like other Gulf Cooperation Council (GCC) countries, the public sector in Kuwait dominates the economy (accounting for approximately 70% of the total output) and diversification and increasing the role of the private sector has been one of the main policy objectives. Also, while government expenditure is the only policy tool available to the authorities to regulate economic activities within the economy, its effectiveness is not well established. Moreover, to our knowledge, this is the first attempt to model public and private sector outputs separately for oil-based (resource based) economies. Therefore, the main objective of developing the model is to examine the extent to which real GDP, as well as real public and private sector outputs in Kuwait in the long-run are shaped by oil revenues through its impact on capital accumulation and technological transfers through foreign output, and to examine the role of government expenditure in the economy.

As shown in Pesaran and Smith (2006), the VARX* model can be derived as the solution to a small open economy Dynamic Stochastic General Equilibrium (DSGE) model. Therefore, it is possible in principle to impose short- and long-run DSGE-type restrictions on the model, though we shall focus on the long-run relations and leave the short-run parameters unrestricted. We incorporate those key relations from economic theory that can be expected to have an important effect on the Kuwaiti economy. One of these long-run restrictions is the

augmented output equation, which postulates a relationship between domestic output, foreign GDP, and real oil income, see Esfahani et al. (2014). Another is the inflation differential equation, which establishes a long-run relation between domestic and foreign inflations.

We estimated the K-VARX* model subject to exact and over-identifying restrictions using quarterly data over the period 1979Q2 to 2031Q1. Having imposed the theory derived over-identifying restrictions, our results show that real domestic output in the long run is influenced by oil revenues and foreign output (a proxy for technological progress), and technological growth in Kuwait is on a par with the rest of the world. Moreover, while we show that both oil revenues and foreign output drive growth in the public sector, it seems that technological progress is the main (and only) driver for private sector real growth.

Finally, using generalized impulse response functions (GIRFs) we investigate the dynamic properties of the various K-VARX* models following shocks to the exogenous variables (oil revenues, foreign output, and global equity markets). We find that oil revenue and global equity market shocks have a large and significant long-run impact on Kuwait's real output and public sector GDP. In comparison, the effects of foreign output shock is muted. However, most interestingly, the responses of the private sector output to the shocks are not statistically significant, implying that Kuwait's private sector is insulated from the rest of the world and suggesting that there are some potential inefficiencies (perhaps in both the institutions and economic policies) when it comes to the private sector.

The rest of this paper is organized as follows. Section 2 provides a brief overview of the Kuwaiti Economy. Section 3 develops a long-run macroeconometric model for Kuwait while Section 4 estimates several different VARX* models for Kuwait imposing long-run restriction based on economic theory. In Section 5 we illustrate how shocks to oil revenue, foreign output, and global equity markets affect Kuwaiti real GDP, and, finally, we give some concluding remarks in Section 6.

2   Overview of the Kuwaiti Economy

The size and structure of the Kuwaiti economy differ from that of other countries of the world in many respects. On the one hand, in terms of size (i.e., area and population), it is one of the smaller countries of the world, but is rich in hydrocarbon resources (mainly oil), and it has one of the highest per capita incomes in the world.[1] To the world's modern socioeconomic

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[1] The total land area of Kuwait is approximately 17,818 square kilometres, and at the end of 2016 its total population was around 4.2 million, out of which the share of foreigners (or expatriates) was approximately 69%. As for its hydrocarbon resources, at the end of 2015, Kuwait's proven oil reserves were 101,500 million barrels, accounting for approximately 7% of total world reserves, which at the current production rate of 2.9 million barrels per day are expected to last around 100 years (OPEC Annual Statistical Bulletin 2016).

arena, Kuwait is a fairly recent arrival, and it owes its emanation to the discovery of oil in 1938 and its subsequent exportation, which started in 1946. In recent years, as a result of the oil-price driven process, the Kuwaiti economy has enjoyed an impressive economic development. Significant as they may be, the positive developments are not indicative of any sizeable productivity surge across different sectors of the economy and do not mask the structural problems that have been the key characteristics of the Kuwaiti economy for a long time. Indeed, Kuwait's economic performance is constrained by the existence and persistence of internal structural imbalances and exposure to global markets. The internal structural imbalances relate to the dominance of oil in terms of the shares in GDP, exports, and government revenues; dualistic labor market (nationals versus expatriates); a relatively large public sector; and a small non-oil production base. Burney et al. (2016) present a detailed discussion of the nature and degree of these structural imbalances.

Apart from the structural imbalances, Kuwait's economic performance has also been influenced by domestic and external shocks experienced over the years, and exposure to global markets (Figure 1). The main shocks that have affected the Kuwaiti economy since 1970 have been due to developments in the international oil markets (the oil shock of 1973/74, see Mohaddes (2013) for more details), the Iran-Iraq war (1980-1988), the domestic stock market crisis (Souk Al-Manakh, 1983), Iraqi invasion of Kuwait (August 1990), oil price crash (early 1990s), and global financial crisis (2007).[2] The most serious of these shocks was the Iraqi invasion in August 1990, which damaged the industrial and physical infrastructure, disrupted economic activities, and resulted in the depletion of foreign assets which were liquidated for the reconstruction of the economy.

Kuwait's exposure to global markets comes from oil production and the oil prices, being determined by the Organization of the Petroleum Exporting Countries (OPEC) and the international market, respectively. Most of the country's annual crude oil output and its products are exported, and the necessary capital and consumer items, including food, clothing, and durables are imported. In 2015, approximately 95% of the country's crude oil production was exported, either in crude or in refined form, and commodity trade (i.e., export and import of goods and services) accounted for around 75% of the country's GDP, which points to country's vulnerabilities to developments in the oil market. At the same time, barring two years following liberation (i.e., 1991 and 1992), during the last four decades (since 1975), the country has experienced a surplus in its current account balance. The surplus in the current account has led to a capital outflow, and consequently, a large proportion of the country's public and private capital is invested abroad.

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[2]See also Mohaddes and Pesaran (2016, 2017) for an analysis of the macroeconomic implications of the recent plunge in oil prices.

Figure 1: Kuwait's Real GDP and various External Shocks, in million Kuwaiti Dinar
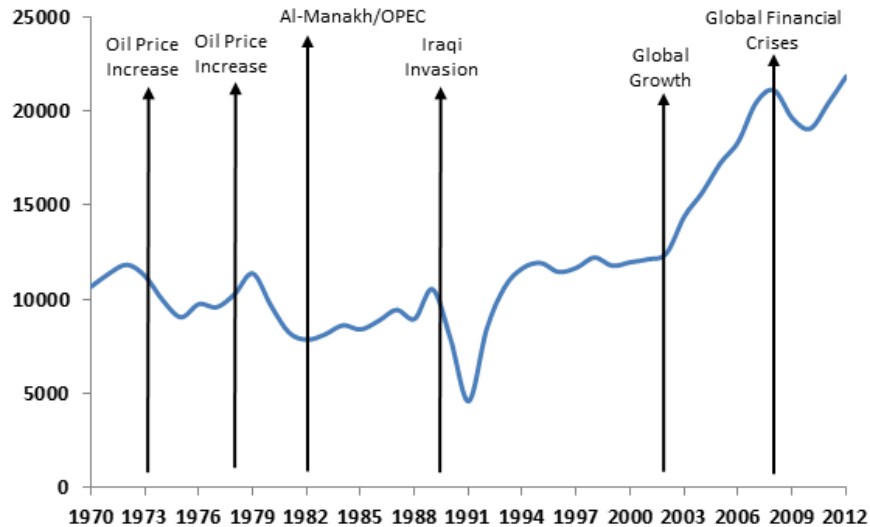
As a result of high oil prices, the government has experienced surplus in the annual budget for most of the years since 1970. Under the law, any surplus in the annual budget is transferred to the General Reserve Fund (GRF), which is used to finance the deficit in the annual budget. In addition, in consideration of the rights of future generations to the country's oil wealth, in 1976, Kuwait established a Future Generation Fund (FGF) through an Amiri decree. Under the law, each year, 10% of the State's revenues are transferred to the FGF, and no outlays or expenditures are spent from either the assets of the fund or the annual income from these assets. The FGF and GRF, which are part of Kuwait's assets, are managed by the Kuwait Investment Authority (KIA), and invested in domestic and foreign assets. According to the Sovereign Wealth Fund Institute's estimates, in June 2015, the holdings of KIA stood at US $548 billion and is the fifth largest sovereign wealth fund in the world after Norway's Government Pension Fund (US $882 billion, established in 1990); Abu Dhabi Investment Authority (US $773 billion, established in 1976); Saudi Arabia Monetary Authority (SAMA) Foreign Holdings (US $757 billion); and China Investment Corporation (US $653 billion, established in 2007). Kuwait Sovereign Wealth Fund was established in 1953 and is one of the oldest in the world. Over the years, Kuwait's annual income from assets held abroad has been increasing and in 2014 was approximately 4 billion Kuwaiti Dinar (KD). Given the size of its sovereign wealth and annual income from foreign assets, the country is vulnerable to developments in the international capital markets (Burney et al.

(2016)).

3   The Kuwaiti VARX* (K-VARX*) Model

Esfahani et al. (2014) develop a long-run growth model for a major oil exporting economy and derive conditions under which oil revenues are likely to have a lasting impact. They do so by extending the stochastic growth model developed in Binder and Pesaran (1999) to allow for the possibility that a certain fraction of oil revenues is invested in the domestic economy. They show that the possibility of a long-run impact of oil income on per capita output depends on the relative growth of oil income (g^o) relative to the combined growth of labour (n) and technology (g). In the case where $g^o < g + n$, the importance of oil income in the economy will tend towards zero in the limit and the standard growth model will become applicable. This is as to be expected since with oil income rising but at a slower pace than the growth of real output, the share of oil income in aggregate output eventually tends towards zero. However, if $g^o \geq g + n$, oil income continues to exert an independent impact on the process of capital accumulation even in the long run.

In the case Kuwait in which g^o is clearly larger than $g + n$, under certain regularity conditions and assuming a Cobb-Douglas production function, $Y_t = (A_t L_t)^{1-\alpha} K_t^{\alpha}$, it is shown that (log) oil revenue enter the long-run output equation (through the capital accumulation equation) with a coefficient equal to the share of capital (α), or more specifically:

$$y_t - \psi_1 y_t^* = \psi_2 (e_t - p_t) + \psi_3 or_t + c_y + \gamma_y t + \xi_{y,t} \tag{1}$$

where y_t (y_t^*) is the log of real domestic (foreign) Gross Domestic Product, p_t is the log of the consumer price index (CPI_t), e_t is the log of the nominal exchange rate (the number of domestic currency per one US dollar), $or_t = \ln(P_t^o Q_t^o)$, where P_t^o is the nominal price of oil per barrel in US dollars, and Q_t^o is the domestic oil production in thousands of barrels per day, c_y is an unrestricted fixed constant, and $\xi_{y,t}$ is a mean zero stationary process, which represents the error correction term of the long-run output equation, and

$$\psi_1 = \theta(1 - \psi_2), \psi_2 = \psi_3 = \alpha, \text{ and } \gamma = (1 - \alpha)(n - \theta n^*), \tag{2}$$

where n and n^* are labour force growth rates of domestic and world economy, and θ measures the extent to which foreign technology is diffused and adapted successfully by the domestic economy in the long run. For a detailed derivation of the long-run output equation (1) we refer the reader to Section 2.1 of Esfahani et al. (2014), which illustrates the conditions under which income from a natural resource can have a lasting impact on growth and per

capita income and which explains why the restrictions in equation (2) must be satisfied in the long run.

Note that log of real foreign domestic output, y_t^*, is computed as trade weighted averages of log real output indices (y_{jt}) of Kuwait's trading partners. Specifically, $y_t^* = \sum_{j=1}^{N} w_j y_{jt}$, where w_j is the trade share of country j for Kuwait, computed as a three-year average to reduce the impact of individual yearly movements on the trade weights.[3] More specifically, the trade weights are computed as

$$w_j = \frac{T_{j,2006} + T_{j,2007} + T_{j,2008}}{T_{2006} + T_{2007} + T_{2008}},$$

where T_{jt} is the bilateral trade of Kuwait with country j during a given year t and is calculated as the average of exports and imports of Kuwait with j, and $T_i = \sum_{j=1}^{N} T_{jt}$ (the total trade of Kuwait) for $t = 2006, 2007, 2008$.

The above formulation also allows us to test other hypothesis of interest concerning θ and γ. The value of θ provides information on the long-run diffusion of technology to Kuwait. The diffusion of technology is at par with the rest of the world if $\theta = 1$, whilst a value of θ below unity suggests inefficiencies that prevents the adoption of best practice techniques, possibly due to rent-seeking activities. When $\theta = 1$ steady state per capita output growth in Kuwait can only exceed that of the rest of the world if oil income per capita is rising faster than the steady state per capita output in the rest of the world. The steady state output growth in Kuwait could be lower than the rest of the world per capita output growth if $\theta < 1$.

The long-run relation given by equation (1) can be written more compactly as deviations from equilibrium:

$$\xi_{y,t} = \boldsymbol{\beta}' \mathbf{z}_t - c_y - \gamma_y t \tag{3}$$

where $\mathbf{z}_t = (\mathbf{x}_t', \mathbf{x}_t^{*\prime})'$, with $\mathbf{x}_t = (y_t, e_t - p_t)'$, $\mathbf{x}_t^* = (y_t^*, or_t)'$, and $\boldsymbol{\beta}' = \begin{pmatrix} -1 & \psi_2 & \psi_1 & \psi_3 \end{pmatrix}$. The long-run theory for oil exporting countries, as derived in Esfahani et al. (2014), require two further restrictions on the output equation (1) for Kuwait, namely $\psi_2 = \psi_3 = \alpha$ and $\psi_1 = \theta(1 - \alpha)$, where we are interested in seeing whether in fact the coefficients of oil revenue, or_t, and the real exchange rate, $(e_t - p_t)$, are the same and equal to the share of capital in output (α) and whether technological progress in Kuwait is on par with that of the rest of the world, in other words whether $\theta = 1$, and as a result the coefficient of the foreign real output is equal to $(1 - \alpha)$.

The VECX*(s, s^*) model that embodies $\boldsymbol{\xi}_t$ is constructed from a suitably restricted ver-

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[3]A similar approach has also been followed in the global VAR (GVAR) literature. See, for example, Cashin et al. (2016, 2017) and Cashin et al. (2014).

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sion of the VAR in $\mathbf{z}_t$. In the present application $\mathbf{z}_t = (\mathbf{x}'_t, \mathbf{x}^{*\prime}_t)'$ is partitioned into the 2×1 vector of endogenous variables, $\mathbf{x}_t = (y_t, e_t - p_t)'$, and the 2×1 vector of the weakly exogenous variables, $\mathbf{x}^*_t = (y^*_t, or_t)'$. Also the hypothesis that all four variables are $I(1)$ cannot be rejected; see Table 9 in Section B.1 of the Appendix for the unit root properties of the core variables in our model. Moreover, it is easily established that the two exogenous variables are not cointegrated (see Table 10 in Section B.1 of the Appendix). Under these conditions, following Pesaran et al. (2000), the VAR in $\mathbf{z}_t$ can be decomposed into the conditional model for the endogenous variables:

$$\Delta\mathbf{x}_t = -\mathbf{\Pi}_x\mathbf{z}_{t-1} + \sum_{i=1}^{s-1} \mathbf{\Psi}_i\Delta\mathbf{x}_{t-i} + \mathbf{\Lambda}_0\Delta\mathbf{x}^*_t + \sum_{i=1}^{s^*-1} \mathbf{\Lambda}_i\Delta\mathbf{x}^*_{t-i} + \mathbf{a}_0 + \mathbf{a}_1 t + \boldsymbol{v}_t, \qquad (4)$$

and the marginal model for the exogenous variables:

$$\Delta\mathbf{x}^*_t = \sum_{i=1}^{s-1} \mathbf{\Gamma}^*_i\Delta\mathbf{z}_{t-i} + \mathbf{b}_0 + \mathbf{u}_{x^*t}, \qquad (5)$$

If the model includes an unrestricted linear trend, in general there will be quadratic trends in the level of the variables when the model contains unit roots. To avoid this, the trend coefficients are restricted such that $\mathbf{a}_1 = \mathbf{\Pi}_x\boldsymbol{\delta}$, where $\boldsymbol{\delta}$ is an 4×1 vector of free coefficients, see Pesaran et al. (2000) and Section 6.3 in Garratt et al. (2006). The nature of the restrictions on $\mathbf{a}_1$ depends on the rank of $\mathbf{\Pi}_x$. In the case where $\mathbf{\Pi}_x$ is full rank, $\mathbf{a}_1$ is unrestricted, whilst it is restricted to be equal to $\mathbf{0}$ when the rank of $\mathbf{\Pi}_x$ is zero. Under the restricted trend coefficients the conditional VECX*(s, s^*) model can be written as

$$\Delta\mathbf{x}_t = -\mathbf{\Pi}_x\left[\mathbf{z}_{t-1} - \boldsymbol{\delta}(t-1)\right] + \sum_{i=1}^{s-1} \mathbf{\Psi}_i\Delta\mathbf{x}_{t-i} + \mathbf{\Lambda}_0\Delta\mathbf{x}^*_t + \sum_{i=1}^{s^*-1} \mathbf{\Lambda}_i\Delta\mathbf{x}^*_{t-i} + \tilde{\mathbf{a}}_0 + \boldsymbol{v}_t, \quad (6)$$

where $\tilde{\mathbf{a}}_0 = \mathbf{a}_0 + \mathbf{\Pi}_x\boldsymbol{\delta}.$ We refer to this specification as the vector error-correcting model with weakly exogenous $I(1)$ variables, or VECX*(s, s^*) for short. Note that $\tilde{\mathbf{a}}_0$ remains unrestricted since $\mathbf{a}_0$ is not restricted. While for consistent and efficient estimation (and inference) we only require the conditional model as specified in (4), for impulse response analysis and forecasting we need the full system vector error correction model which also includes the marginal model; as such we need to specify the process driving the weakly exogenous variables, $\Delta\mathbf{x}^*_t$.

The long-run theory imposes a number of restrictions on $\mathbf{\Pi}_x$ and $\boldsymbol{\delta}$. First, for the conditional model to embody the equilibrium error defined by, (3), we must have $\mathbf{\Pi}_x = \boldsymbol{\alpha}_x\boldsymbol{\beta}'$, which in turn implies that $rank(\mathbf{\Pi}_x) = 1$. Furthermore, the restrictions on the trend coeffi-

cients are given by

$$\mathbf{\Pi}_x \boldsymbol{\delta} = \boldsymbol{\alpha_x} \boldsymbol{\beta}' \boldsymbol{\delta} = \boldsymbol{\gamma}.$$

Since under cointegration $\boldsymbol{\alpha}_x \neq \mathbf{0}$, it then follows that a trend will be absent from the long-run relations if one of the two elements of $\boldsymbol{\beta}'\boldsymbol{\delta}$ is equal to zero. These restrictions are known as co-trending restrictions, meaning that the linear trends in the various variables of the long-run relations gets cancelled out. This hypothesis is important in the analysis of output convergence between the domestic and the foreign variables, since without such a co-trending restriction the two output series will diverge even if they are shown to be cointegrated.

4   Long-Run Estimates and Tests

In this section we investigate the long-run role of oil income in the development of Kuwait by estimating various versions of the K-VARX*; including models with private and public sector GDPs (separately), as well as a small (what we call Model A) as well as an extended version (what we call Model B) of the original model.

4.1   Model A: Small Version of the K-VARX* Model

We set the VARX* order to (2,1), as selected by the Akaike Information Criterion, and proceed to determine the number of cointegrating relations given by $r = rank(\mathbf{\Pi}_x)$, where $\mathbf{\Pi}_x$ is defined by equation (6). Table 1 reports the cointegration tests results with the null hypothesis of no cointegration ($r = 0$), one cointegrating relation ($r = 1$), and so on. These tests are carried out using Johansen's maximum eigenvalue and trace statistics as developed in Pesaran et al. (2000) for models with weakly exogenous regressors. The maximal eigenvalue statistic and the trace statistic indicates the presence of one cointegrating relation at the 5 percent level, which is the same as that suggested by economic theory, thus we set $r = 1$.

Given that $r = 1$, and to exactly identify the long-run relations, we need to impose 1 restriction on the cointegration relation. To this end, we let the long-run relation be the output gap, given by equation (1) and normalized on y_t. that is: $\boldsymbol{\beta}_{EX}^{\mathrm{Model\ A}'} = \begin{pmatrix} -1 & \beta_2 & \beta_3 & \beta_4 \end{pmatrix}$, where the rows of $\boldsymbol{\beta}_{EX}^{\mathrm{Model\ A}'}$ correspond to $\mathbf{z}_t = (\mathbf{x}_t', \mathbf{x}_t^{*\prime})' = (y_t, e_t - p_t, y_t^*, or_t)'$. Using this exactly identified specification, we test the co-trending restriction $\gamma_y = 0$. The log-likelihood ratio (LR) statistic for testing the co-trending restriction is asymptotically distributed as a chi-squared variate with one degrees of freedom and takes the value 2.88. Therefore, based on the asymptotic distribution, the co-trending restrictions are rejected at the 10 percent but not the 5 percent level. However, given that the LR tests could over-reject in small

Table 1: Cointegration Rank Test Statistics for the VARX*(2,1) Model

H_0	H_1	Test Statistic	95% Critical Values	90% Critical Values
(a) Maximal eigenvalue statistic				
$r = 0$	$r = 1$	57.22	26.95	24.27
$r \leq 1$	$r = 2$	15.60	18.60	16.20
(b) Trace statistic				
$r = 0$	$r = 1$	72.82	37.54	34.61
$r \leq 1$	$r = 2$	15.60	18.60	16.20

Notes: The underlying VARX* model is of order (2,1) and contains unrestricted intercept and restricted trend coefficients. The endogenous variables are y_t and $e_t - p_t$, whereas y_t^* and or_t are treated as weakly exogenous, non-cointegrated $I(1)$ variables. The test statistics refer to Johansen's log-likelihood-based maximum eigenvalue and trace statistics and are computed using 134 observations from 1979Q4 to 2013Q1.

samples such as ours (see, for example, Gredenhoff and Jacobson (2001) as well as Gonzalo (1994), Haug (1996) and Abadir et al. (1999)), we compute bootstrapped critical values based on 1,000 replications of the LR statistic. The bootstrapped critical values for testing the co-trending restriction is 3.42 and 4.57 at the 10 and 5 percent levels respectively, as compared to the LR statistic of 2.88. Therefore, based on the bootstrapped critical values, the co-trending restrictions cannot be rejected even at the 10 percent level.

To investigate the theory restrictions on the output equation, we impose the co-trending restriction and set $\beta_2 = \beta_4 = \alpha$. That is, we impose the coefficients of oil revenue and the real exchange rate to be the same, but allow for the coefficient of foreign output, β_3, to be freely estimated. Imposing these additional restrictions on the first cointegrating relation yields:

$$\hat{\psi}_1 = \underset{(0.040)}{0.721}, \ \hat{\psi}_2 = \hat{\psi}_3 = \hat{\alpha} = \underset{(0.020)}{0.234},$$

where the figures in brackets are asymptotic standard errors. The implicit estimate of θ, computed as $\widehat{\theta} = \widehat{\psi}_1/(1 - \hat{\psi}_2) = 0.94$, is very close to unity, thus implying that the technological growth in Kuwait is on par with that of the rest of the world. In fact imposing $\theta = 1$, the estimated share of capital in output hardly changes: $\hat{\alpha} = 0.235$ and the LR statistic for testing the three over-identifying restrictions is 4.86 which is to be compared to the bootstrapped critical values of 7.49 at the 10 percent level, thus, these restrictions cannot be rejected even at the 10 percent significance level, and once the effects of oil revenue and the real exchange rate are taken into account, the estimates support output growth convergence between Kuwait and the rest of the world.

Note that the long-run positive growth effect of oil income documented above provides evidence against the traditional resource curse hypothesis, which argues that it is the level of resource abundance that affects economic growth negatively, and is in line with results

obtained recently in the literature; see, for instance, Alexeev and Conrad (2009), Cavalcanti et al. (2011b), El-Anshasy et al. (2015), and Esfahani et al. (2013). But we should also note that the positive influence of oil income has often in major oil/commodity exporting countries been counteracted by the adverse effects of excessive volatility of oil revenues and government's inappropriate responses to it. See, for instance, Cavalcanti et al. (2015), Leong and Mohaddes (2011), Mohaddes and Pesaran (2014), and Mohaddes and Raissi (2015, 2017).

4.2   Model B: Extended Version of the K-VARX* Model

A number of other long-run relations are also considered in the literature, namely the money demand function, the uncovered interest parity condition and the Fisher equation; see Garratt et al. (2006) for further details. However, considering that Kuwait has maintained a peg to a basket that closely follows the US dollar since 1980 as well as an open capital account, the domestic interest rate and the real money balance, as instruments for monetary policy, are exogenously determined and therefore we do not consider those long-run relationships here.[4]   On the other hand, given that Kuwait has maintained a peg for most of the past three decades, in addition to the output equation (1), we would also like to consider the relationship between domestic ($\pi_t = p_t - p_{t-1}$) and foreign ($\pi_t^* = p_t^* - p_{t-1}^*$) inflation rates:

$$\pi_t - \phi_1 \pi_t^* = c_\pi + \gamma_\pi t + \xi_{\pi,t}, \tag{7}$$

where c_π is a fixed constant and $\xi_{\pi,t}$ is the stationary error correcting term for the relationship between domestic and foreign inflation. This is in fact one of the long-run relationships in a canonical New Keynesian Model; see Pesaran and Smith (2006) for more details. In addition, equation (7) can also be derived from the Purchasing Power Parity (PPP) equation. To see this, note that if PPP holds we have:

$$p_t - p_t^* - e_t = c_p + \gamma_p t + \xi_{p,t}, \tag{8}$$

where c_p is a fixed constant and $\xi_{p,t}$ is the stationary error correcting term for the PPP relationship, but given a fixed exchange rate regime (which Kuwait has maintained for several decades), taking the difference of equation (8) yields (7).

To accommodate an investigation of the PPP relationship, we extend the small version of the K-VARX* model (which only has four macro variables) by including domestic (π_t) and foreign inflation (π_t^*). As we are also interested in the potential role of global financial markets, we also include a measure of global equity (eq_t) and short-term interest rates (r_t^{S*})

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[4]See Mohaddes and Williams (2013) for more details.

in this extended version of the K-VARX* model.

Before estimating the two long-run relations given by (1) and (7) we note that they can be written compactly as deviations from equilibrium:

$$\boldsymbol{\xi}_t = \boldsymbol{\beta}' \mathbf{z}_t - \mathbf{c} - \boldsymbol{\gamma} t \tag{9}$$

where

$$\begin{aligned}
\mathbf{z}_t &= (\mathbf{x}_t', \mathbf{x}_t^{*\prime})' = \left(y_t,\ \pi_t,\ e_t - p_t,\ y_t^*,\ \pi_t^*,\ r_t^{S*},\ eq_t,\ or_t \right)', \\
\mathbf{c} &= (c_y,\ c_\pi)',\ \boldsymbol{\gamma} = (\gamma_y,\ \gamma_\pi)',\ \boldsymbol{\xi}_t = \left(\xi_{yt},\ \xi_{\pi,t} \right)'
\end{aligned}$$

and

$$\boldsymbol{\beta}' = \begin{pmatrix} -1 & 0 & \psi_2 & \psi_1 & 0 & 0 & 0 & \psi_3 \\ 0 & -1 & 0 & 0 & \phi_1 & 0 & 0 & 0 \end{pmatrix} \tag{10}$$

As explained above, the long-run theory for oil exporting countries, as derived in Esfahani et al. (2014), require two further restrictions on the output equation (1) for Kuwait, namely $\psi_2 = \psi_3 = \alpha$ and $\psi_1 = \theta (1 - \alpha)$.

Having chosen the order of the VARX* to be (2,1) based on the Akaike Information Criterion, we proceed to determine the number of cointegrating relations given by $r = rank(\boldsymbol{\Pi}_x)$. Table 2 reports the cointegration tests results where the maximal eigenvalue statistic and the trace statistic indicates the presence of two cointegrating relations at the 5 percent level, which is the same as that suggested by economic theory, thus we set $r = 2$.

Table 2: Cointegration Rank Test Statistics for the VARX*(2,1) Model

H_0	H_1	Test Statistic	95% Critical Values	90% Critical Values
(a) Maximal eigenvalue statistic				
$r = 0$	$r = 1$	94.34	44.26	40.99
$r \leq 1$	$r = 2$	61.62	36.55	33.04
$r \leq 2$	$r = 3$	19.93	27.28	25.05
(b) Trace statistic				
$r = 0$	$r = 1$	175.89	84.43	81.12
$r \leq 1$	$r = 2$	81.55	53.49	49.78
$r \leq 2$	$r = 3$	19.93	27.28	25.05

Notes: The underlying VARX* model is of order (2,1) and contains unrestricted intercept and restricted trend coefficients. The endogenous variables are y_t, π_t, and $e_t - p_t$, whereas y_t^*, π_t^*, r_t^{S*}, eq_t, and or_t are treated as weakly exogenous, non-cointegrated $I(1)$ variables. The test statistics refer to Johansen's log-likelihood-based maximum eigenvalue and trace statistics and are computed using 134 observations from 1979Q4 to 2013Q1.

Given that $r = 2$, and to exactly identify the long-run relations, we need to impose 2

restrictions on each of the 2 cointegration relations. To this end, we let the first long-run relation be the output gap, given by equation (1) and normalized on y_t; and the second relation be the one between domestic and foreign inflations, defined by equation (7) and normalized on π_t. That is:

$$\boldsymbol{\beta}_{EX}^{\text{Model B}'} = \begin{pmatrix} -1 & 0 & \beta_{13} & \beta_{14} & \beta_{15} & \beta_{16} & \beta_{17} & \beta_{18} \\ \beta_{21} & -1 & \beta_{23} & \beta_{24} & \beta_{25} & \beta_{26} & \beta_{27} & 0 \end{pmatrix}, \tag{11}$$

where the rows of $\boldsymbol{\beta}_{EX}^{\text{Model B}'}$ correspond to $\mathbf{z}_t = (\mathbf{x}_t', \mathbf{x}_t^{*\prime})' = \left(y_t, \pi_t, e_t - p_t, y_t^*, \pi_t^*, r_t^{S*}, eq_t, or_t\right)'$. Using this exactly identified specification, we test the co-trending restriction $\gamma_y = 0$ and find that this cannot be rejected at the 10 percent level – the bootstrapped critical values for testing the co-trending restriction is 3.65 at the 10 level as compared to the LR statistic of 0.02.

To investigate the theory restrictions on the output equation, we impose the co-trending restriction and maintain the exactly identified specification on the second long-run relation, while setting

$$\beta_{15} = 0, \ \beta_{16} = 0, \ \beta_{17} = 0, \ \text{and} \ \beta_{13} = \beta_{18} = \alpha.$$

That is, we impose the coefficients of oil revenue and the real exchange rate to be the same, but allow for the coefficient of foreign output, β_{14}, to be freely estimated. Imposing these additional restrictions on the first cointegrating relation yields:

$$\hat{\psi}_1 = \underset{(0.041)}{0.730}, \ \hat{\psi}_2 = \hat{\psi}_3 = \hat{\alpha} = \underset{(0.020)}{0.238},$$

where the figures in brackets are asymptotic standard errors. The LR statistic for testing the additional restrictions is 7.86 which is to be compared to the bootstrapped critical values of 12.22 at the 10 percent level, therefore not being rejected.

Turning to the second long-run equation, the theoretical restrictions in terms of the elements of $\boldsymbol{\beta}$ in equation (11) require six further restrictions, namely:

$$\beta_{21} = 0, \ \beta_{23} = 0, \ \beta_{24} = 0, \ \beta_{26} = 0, \ \beta_{27} = 0, \ \text{and} \ \phi_1 = 1.$$

Imposing these additional restrictions on $\boldsymbol{\beta}$ yields:

$$\hat{\psi}_1 = \underset{(0.041)}{0.730}, \ \text{and} \ \hat{\alpha} = \underset{(0.0202)}{0.237}$$

The implicit estimate of θ given by $0.730/(1 - 0.237) = 0.96$ is very close to unity, thus implying that the technological growth in Kuwait is on par with that of the rest of the

world. We are therefore justified in imposing $\theta = 1$ and by doing so obtain a share of capital in output of $\hat{\alpha} = 0.237$, which is very similar to the case in Model A and lies in the range as estimated for a panel of 29 countries in Pedroni (2007) and for a panel of 53 oil exporting and importing countries with very different historical and institutional backgrounds in Cavalcanti et al. (2011a).

The LR statistic for testing the 12 over-identifying restrictions on the long-run relations is 29.12 as compared to the bootstrapped critical values of 26.39 and 31.73 at the 5 and 1 percent significance levels, respectively. Thus, these restrictions cannot be rejected at the conventional levels of significance.

4.3 Inclusion of Other Variables

As noted earlier it is relatively straightforward to augment the VECX* model with other aggregate variables such as log real consumption (c_t), log real investment (i_t), and log real government expenditure (g_t). But given the long-run focus of our analysis, the inclusion of these variables are unlikely to alter the long-run relationship that we have estimated between real output and oil income if c_t, g_t, and i_t are cointegrated with y_t and or_t. This is because any linear combination of cointegrating relations will also be cointegrated.

In fact the long-run estimates above have shown that real output in the long run is shaped by oil revenue through their impact on capital accumulation, and technological transfers through foreign output. That is changes in oil revenue (or_t) affect real output in Kuwait through changes in investment (i_t). Estimating a cointegrating VAR(2) model for investment (based on gross fixed capital formation) and oil revenues, the cointegration rank test statistics in Table 3 suggest that there is cointegration relation between the two variables. Furthermore, we cannot reject the co-trending restriction or the hypothesis that the long-run elasticity of investment to real oil income is unity, and as a result: $i_t = or_t + \xi_{i,t}$, where $\xi_{i,t} \sim I(0)$. Therefore, oil revenues is an excellent proxy for investment in the Kuwaiti economy. We also conducted the same analysis, replacing total investment, i_t, with public and private investment separately, and found similar results. These results are not reported in the paper, but are available from the authors on request.

4.3.1 The Role of Government Expenditure

Since it is generally believed that changes in Kuwaiti oil income affect real output primarily through changes in government expenditure, we next focus on the role of government expenditure in the interrelation of oil income, oil prices and real government expenditure. Figure 2 shows the evolution of log real government expenditure and oil prices as well as oil revenue

Table 3: Cointegration rank test statistics for the VAR(2) model with Investment and Oil Revenue

H_0	H_1	Test statistic	95% Critical Values	90% Critical Values
(a) Maximal eigenvalue statistic				
$r = 0$	$r = 1$	27.38	19.22	17.18
$r \leq 1$	$r = 2$	4.00	12.39	10.55
(b) Trace statistic				
$r = 0$	$r = 1$	31.38	25.77	23.08
$r \leq 1$	$r = 2$	4.00	12.39	10.55

Notes: The test statistics refer to Johansen's log-likelihood-based maximum eigenvalue and trace statistics and are computed using 133 observations from 1980Q1 to 2013Q1.

over the period 1979Q2-2013Q1. As expected it is clear that government expenditure and the two oil series move quite closely, although oil revenue tends to be much more volatile than government expenditure.

Figure 2: Real Government Expenditure (g), the Price of Oil (poil) and Oil Revenue (or), in log level

(a) Government Expenditure and Price of Oil **(b) Government Expenditure and Oil Revenue**
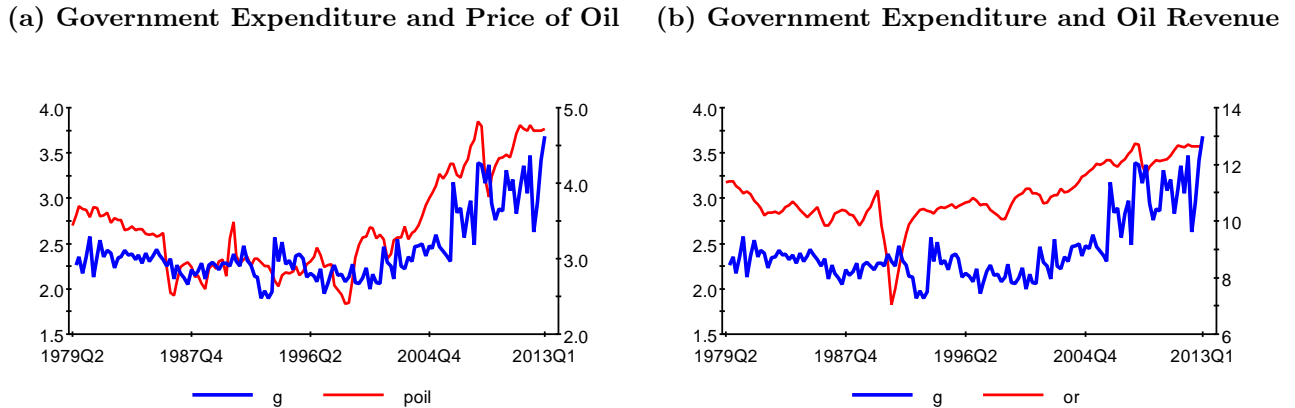
Note: The second variable should be read using the right-hand scale.

To check their cointegrating properties we estimated an exactly identified cointegrating VAR(2) in g_t and or_t with an unrestricted intercept and a restricted trend. The cointegration rank test statistics for this model is given in Table 4. The test results strongly support the existence of cointegration between g_t and or_t, and the co-trending restriction (that real government expenditure and oil revenue have the same deterministic trend components) cannot be rejected. The cointegrating relationship between government expenditure and oil

revenue is given by

$$g_t = \underset{(0.0406)}{0.371} \, or_t + \xi_{g,t}, \text{ where } \xi_{g,t} \sim I(0). \tag{12}$$

The long-run impact of oil revenue on government expenditure is not significantly different from unity, and one can easily impose an over-identifying cointegrating relation between real government expenditure and oil revenue, i.e.: $g_t = or_t + \xi_{g,t}$. Therefore, oil revenue represent an excellent proxy for government expenditure in the Kuwaiti economy, providing further justification for our modelling strategy of using oil revenue as one of the main long-run drivers of real output. The above results also show that from a long-run perspective only one of the two variables (government expenditure or oil revenue) need to be included in the cointegrating model. Our decision of including oil revenue rather than government expenditure is justified on the ground that or_t is likely to be exogenous to the Kuwaiti economy whilst the same cannot be said of g_t.

Table 4: Cointegration rank test statistics for the VAR(2) model with Government Expenditure and Oil Revenue

H_0	H_1	Test statistic	95% Critical Values	90% Critical Values
(a) Maximal eigenvalue statistic				
$r = 0$	$r = 1$	23.46	19.22	17.18
$r \leq 1$	$r = 2$	7.23	12.39	10.55
(b) Trace statistic				
$r = 0$	$r = 1$	30.70	25.77	17.18
$r \leq 1$	$r = 2$	7.23	12.39	10.55

Notes: The test statistics refer to Johansen's log-likelihood-based maximum eigenvalue and trace statistics and are computed using 133 observations from 1980Q1 to 2013Q1.

4.3.2 The Role of Oil Income in terms of Private and Public GDP Long-Run Growth

We use the same specification as in Model B, but instead of real GDP, we investigate the long-run output gap equation using public sector (pub_t^y) and private sector ($priv_t^y$) outputs, separately. Figure 3a shows the relationship between total and public sector GDP, from which it is quite clear that the relationship between the two variables are very close, which is not surprising given that the public sector has remained roughly 70% of total GDP over the last three decades.

Table 5 reports the cointegration tests results for the model with public GDP, where

$$\mathbf{z}_t^{pub} = (\mathbf{x}_t', \mathbf{x}_t^{*\prime})' = \left(pub_t^y, \, \pi_t, \, e_t - p_t, \, y_t^*, \, \pi_t^*, \, r_t^{S*}, \, eq_t, \, or_t \right)',$$

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Figure 3: Public Sector (pub), Private Sector (priv), and real GDP (y), in log level

(a) Public Sector GDP and Real GDP	(b) Private Sector GDP and Real GDP
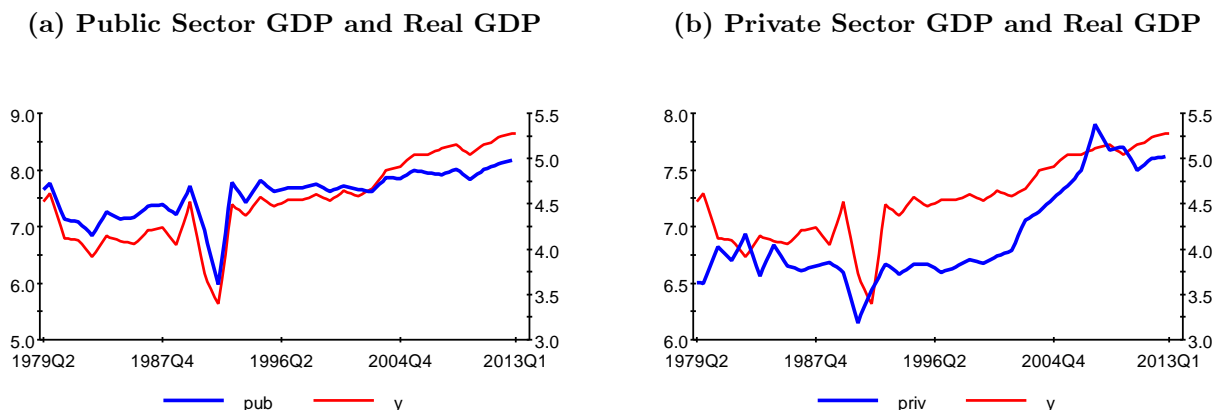
Note: The second variable should be read using the right-hand scale.

Table 5: Cointegration Rank Test Statistics for the VARX*(2,1) Model with Public GDP

H_0	H_1	Test Statistic	95% Critical Values	90% Critical Values
(a) Maximal eigenvalue statistic				
$r = 0$	$r = 1$	97.87	44.02	41.16
$r \leq 1$	$r = 2$	59.90	36.33	33.23
$r \leq 2$	$r = 3$	17.43	27.82	24.87
(b) Trace statistic				
$r = 0$	$r = 1$	175.20	84.41	79.71
$r \leq 1$	$r = 2$	77.34	54.35	50.04
$r \leq 2$	$r = 3$	17.43	27.82	24.87

Notes: The underlying VARX* model is of order (2,1) and contains unrestricted intercept and restricted trend coefficients. The endogenous variables are pub_t^y, π_t, and $e_t - p_t$, whereas y_t^*, π_t^*, r_t^{S*}, eq_t, and or_t are treated as weakly exogenous, non-cointegrated $I(1)$ variables. The test statistics refer to Johansen's log-likelihood-based maximum eigenvalue and trace statistics and are computed using 134 observations from 1979Q4 to 2013Q1.

from which see that the maximal eigenvalue statistic and the trace statistic indicates the presence of two cointegrating relations at the 5 percent level, which is the same as that suggested by Model B above and economic theory, thus we set $r = 2$. Imposing the same restrictions as before on the two cointegrating vectors, that is:

$$\boldsymbol{\beta}' = \begin{pmatrix} -1 & 0 & \psi_2 & \psi_1 & 0 & 0 & 0 & \psi_3 \\ 0 & -1 & 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix} \tag{13}$$

we obtain an estimate of

$$\hat{\psi}_1 = \underset{(0.070)}{0.651}, \; \hat{\psi}_2 = \hat{\psi}_3 = \hat{\alpha} = \underset{(0.035)}{0.178},$$

where the figures in brackets are asymptotic standard errors. The LR statistic for testing the eleven over-identifying restrictions is 28.05 which is to be compared to the bootstrapped critical values of 25.18 and 30.39 at the 5 and 1 percent levels respectively, thus, these restrictions cannot be rejected at the 1 percent significance level, and once the effects of oil revenue and the real exchange rate are taken into account, the estimates provides evidence for both oil income and foreign output (as a proxy for technological progress) in driving growth in the public sector. The implicit estimate of θ, computed as $\hat{\theta} = \hat{\psi}_1/(1 - \hat{\psi}_2) = 0.79$, is clearly not close to unity (and might be suggestive of economic inefficiencies), and we therefore do not impose $\theta = 1$.

We next turn to the model with $priv_t^y$. Figure 3b shows the relationship between private sector GDP and total economic activity in Kuwait, from which see that there are important short-run deviations between the two, especially in the post Great Recession period. Estimating a VARX*(2,1) model the cointegration rank test statistics in Table 6 suggest that there is one cointegration relation between the variables in

$$\mathbf{z}_t^{priv} = (\mathbf{x}_t', \mathbf{x}_t^{*\prime})' = \left(priv_t^y, \; \pi_t, \; e_t - p_t, \; y_t^*, \; \pi_t^*, \; r_t^{S*}, \; eq_t, \; or_t \right)'.$$

Setting $r = 1$, we investigate the long-run output gap equation but find that we cannot reject that $\hat{\psi}_2 = \hat{\psi}_3 = 0$, in other words oil income does not seem to be a driver of long-run growth for the private sector in Kuwait. On the other hand technological progress seems to be the main driver with $\hat{\psi}_1 = 1.008$, which clearly implies that $\theta = 1$ cannot be rejected. We also find that we cannot restrict the coefficient of inflation to be zero (and therefore $\beta_{12} \neq 0$), thereby suggesting that there are some potential inefficiencies (perhaps in both the institutions and economic policies) when it comes to the private sector. Clearly, further research is required to understand drivers of growth in the private sector and the nature of these inefficiencies, for this more detailed disaggregated analysis is required, which is beyond

the scope of the current model.

Table 6: Cointegration Rank Test Statistics for the VARX*(2,1) Model with Private GDP

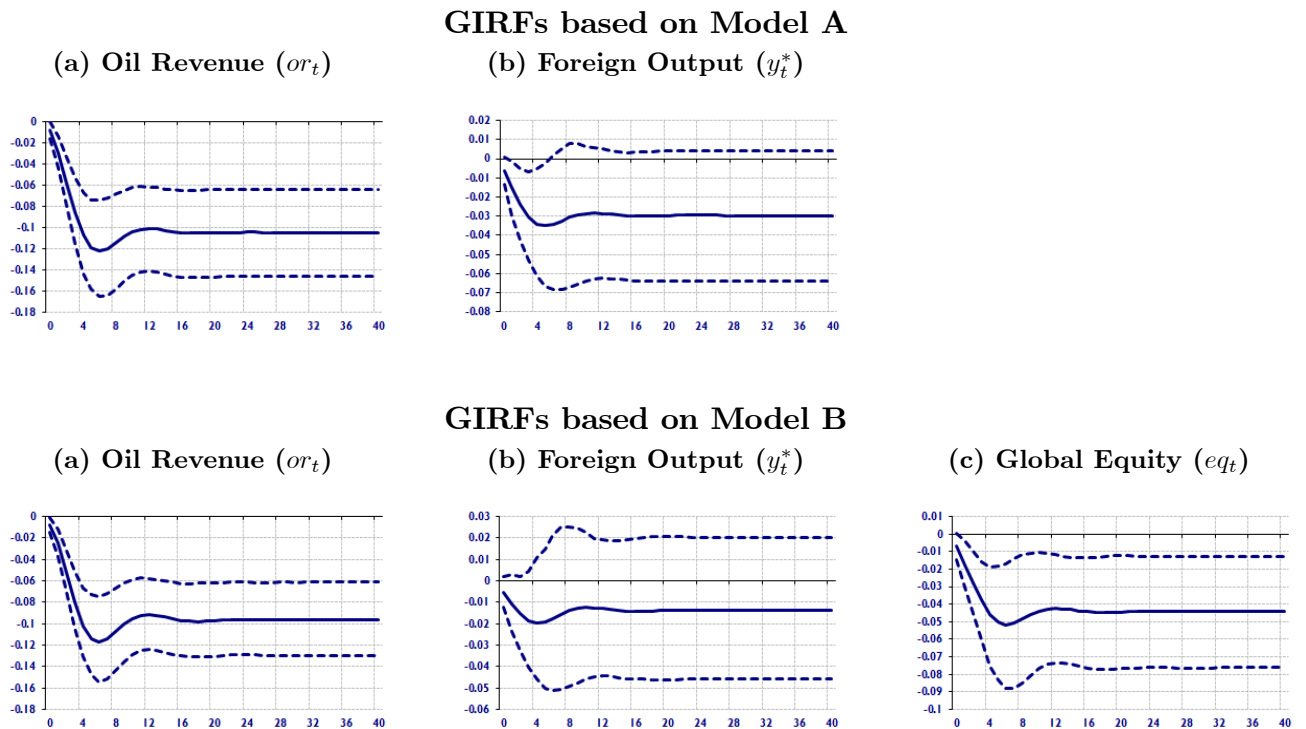| H_0	H_1	Test Statistic	95% Critical Values	90% Critical Values
(a) Maximal eigenvalue statistic				
$r = 0$	$r = 1$	92.18	44.02	41.16
$r \leq 1$	$r = 2$	23.89	36.33	33.23
$r \leq 2$	$r = 3$	11.28	27.82	24.87
(b) Trace statistic				
$r = 0$	$r = 1$	127.35	84.41	79.71
$r \leq 1$	$r = 2$	35.17	54.35	50.04
$r \leq 2$	$r = 3$	11.28	27.82	24.87

Notes: The underlying VARX* model is of order (2,1) and contains unrestricted intercept and restricted trend coefficients. The endogenous variables are $priv_t^y$, π_t, and $e_t - p_t$, whereas y_t^*, π_t^*, r_t^{S*}, eq_t, and or_t are treated as weakly exogenous, non-cointegrated $I(1)$ variables. The test statistics refer to Johansen's log-likelihood-based maximum eigenvalue and trace statistics and are computed using 134 observations from 1979Q4 to 2013Q1.

5 Responses of Kuwaiti Output to External Shocks

We use the estimated VECX* models A and B to examine the dynamic (short-run) responses of the Kuwaiti economy to various types of shocks. We are primarily interested in the effects of an oil revenue shock, and so make use of the Generalized Impulse Response Functions (GIRFs), developed in Koop et al. (1996) and Pesaran and Shin (1998). Note that the GIRFs are invariant to the ordering of the variables in the VARX* model, while the orthogonalized impulse responses popularized in macroeconomics by Sims (1980) are not.

We compute the GIRFs for negative shocks to the two exogenous variables in Model A: y_t^* and or_t and do the same exercise for Model B where we also look at a negative shocks to global equity markets (eq_t). Although GIRFs can also be computed for the endogenous variables, their interpretation are less straightforward and so these are not discussed here. Figure 4 shows the GIRFs of a unit shock, equal to one standard error, to oil revenue in panel (a) and to foreign output in panel (b) for Models A and B separately. As can be seen, the steady state value of the effect of the oil revenue shock (being 41.5%) is around 10.5%. Note that the large standard deviation reflects the high historical volatility of oil revenue in Kuwait (relative to all major oil exporters), due to the Iraqi invasion of Kuwait in 1990 and its aftermath. Quantitatively, the oil revenue shock decreases domestic output by a similar magnitude across the two models. In comparison to the effects of shocks to or_t, the effects of foreign output shocks are muted as they are only significant in the first few quarters following

Figure 4: Generalized Impulse Responses of Domestic Output (y_t)

GIRFs based on Model A

(a) Oil Revenue (or_t)　　　　　**(b) Foreign Output (y_t^*)**

GIRFs based on Model B

(a) Oil Revenue (or_t)　　**(b) Foreign Output (y_t^*)**　　**(c) Global Equity (eq_t)**

Notes: The figures in (a) are median generalized impulse responses to a one standard deviation fall in oil revenue, together with 95 percent bootstrapped confidence bounds, while in (b) are median generalized impulse responses to a one standard deviation fall in foreign output, and (c) are median generalized impulse responses to a one standard deviation fall in global equity markets. The impact is in percentage points and the horizon is quarterly.

the shock, however, the effects of a global equity shock is highly significant and relatively large. This, therefore, illustrates the importance of including foreign variables in any macro model for Kuwait.

Figure 5: Generalized Impulse Responses of Domestic Public and Private Sector GDPs
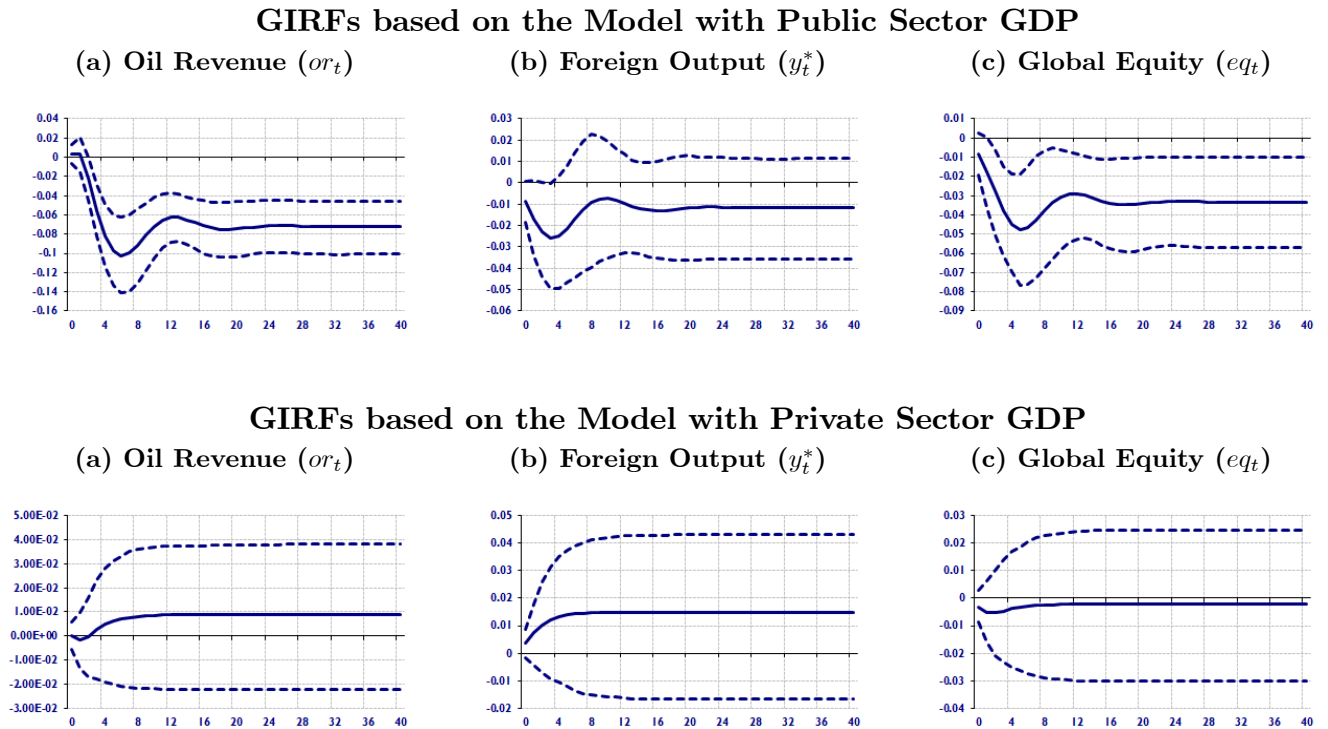
GIRFs based on the Model with Public Sector GDP
(a) Oil Revenue (or_t) (b) Foreign Output (y_t^*) (c) Global Equity (eq_t)

GIRFs based on the Model with Private Sector GDP
(a) Oil Revenue (or_t) (b) Foreign Output (y_t^*) (c) Global Equity (eq_t)

Notes: The figures in (a) are median generalized impulse responses to a one standard deviation fall in oil revenue, together with 95 percent bootstrapped confidence bounds, while in (b) are median generalized impulse responses to a one standard deviation fall in foreign output, and (c) are median generalized impulse responses to a one standard deviation fall in global equity markets. The impact is in percentage points and the horizon is quarterly.

We conduct a similar exercise as above using the VARX* models with public and private sector GDPs developed in Section 4.3.2. The GIRFs of shocks to oil revenue (or_t), foreign output (y_t^*), and global equity (eq_t) for the model with real public sector GDP are shown in the top panel of Figure 5, from which we can see that the responses are not that different from the model with total GDP; compare the GIRFs in panels (a) to (c) with those in the bottom panel of Figure 4. This is perhaps not surprising given the close relationship between total economic activity and the public sector GDP as illustrated in Figure 3a, and given that the public-sector-to-total GDP ratio has been roughly 0.70 over the last few decades.

We then shock the same three exogenous variables but using the VARX* model with private sector GDP, and notice that none of the output responses are statistically significant. This either means that the Kuwaiti private sector is totally insulated from the rest of the world, or, as our long-run estimates suggested, that there could be both institutional and economic policy inefficiencies when it comes to the private sector in Kuwait. Future research and more disaggregated analysis is required in order to understand the dynamics of the private sector in Kuwait.

6   Concluding Remarks

Based on quarterly data covering the period from 1979Q2 to 2013Q1, this paper developed a model for the Kuwaiti economy, where the long-run implications of oil revenues were tested. The results support the long-run growth theory for major oil exporters as developed by Esfahani et al. (2014), with the existence of long-run relations between real output, foreign output and real oil income. Moreover, we show that technological growth in Kuwait is on a par with that of the rest of the world.

The size of the public sector in Kuwait is large; accounting for approximately 71% of the country's total output between 2000 and 2013, being concentrated in the oil industry with oil production and refining contributing around 77% to public sector output. One of the main policy objectives of the authorities has been to diversify the economy by promoting the private sector in terms of its relatively size, which is concentrated in three activities; wholesale and retail trade, transport and communication, and finance and insurance. In this context, we also investigated the determinants of long-run public and private sector output growth. The results showed that both oil revenues and foreign output (a proxy for technological progress) drive growth in the public sector, but there exists some economic inefficiency as technological progress was not found to be on a par with that of the rest of the world. In the case of the private sector, technological progress was found to be main (and only) driver of private sector output growth, suggesting that government's policies have not contributed to the growth of the private sector, which could be attributed to the nature of investments realized in the public and the private sectors. In this regard, it should be mentioned that between 2000 and 2013, on average, public investment accounted for approximately 60% of the total annual investment in Kuwait.[5]   While public investment is concentrated in three activities, oil industry (36%), public administration (34%) and electricity and water (26%), private investment is concentrated in finance and insurance (40%), transport and

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[5]Shares are calculated using gross fixed capital formation data using various issues of National Accounts Statistics published by Kuwait's Central Statistical Bureau between 2000 and 2013.

communication (29%) and construction (12%).

We also examined the role of government expenditure and investment in determining real output in Kuwait. This was done through testing cointegrating properties of government expenditure and oil revenues, and investment and oil revenues by estimating VAR(2) models. The results showed that the long-run impacts of oil revenues on government expenditure and investment were not significantly different from unity, implying that oil revenues represent an excellent proxy for both government expenditure and investment, and thereby justifying the use of oil revenues in the VARX* models as one of the main long-run drivers of real output, especially because it is exogenous to the Kuwaiti economy.

Finally, using generalized impulse response functions (GIRFs) we investigate the dynamic properties of the various K-VARX* models following shocks to the exogenous variables (oil revenues, foreign output, and global equity markets). We find that oil revenue and global equity market shocks have a large and significant long-run impact on Kuwait's real output and public sector GDP. In comparison, the effects of foreign output shock is muted. However, most interestingly, the responses of the private sector output to the shocks are not statistically significant, implying that Kuwait's private sector is insulated from the rest of the world and suggesting that there are some potential inefficiencies (perhaps in both the institutions and economic policies) when it comes to the private sector. Clearly, further research, and in particular more detailed disaggregated analysis, is required to understand drivers of growth in the private sector and the nature of these inefficiencies, which is beyond the scope of the current model.

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A   Data appendix

A.1   Data sources

The main data source used to estimate the Kuwaiti VARX* is Smith and Galesi (2014), which provides quarterly observations for the majority of the variables covering the period 1979Q2-2013Q1. We augment this database with quarterly observations for all six GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the UAE), Iran, and for oil production. For the GCC countries we use the International Monetary Fund (IMF) *International Financial Statistics* (IFS), series: BVPZF and B..ZF, and *World Economic Outlook* (WEO) databases to compile the real GDP data. We obtain seasonally adjusted quarterly observations on the consumer price index (CPI) for the six countries from IMF's INS database. For the exchange rate we use the IFS AE.ZF series, while the main source of data for short term interest rates are either IFS deposit rate (60L..ZF series), the three-month interbank deposit rate, or the money market rate (60B..ZF series).

Data on consumer price index, GDP, and the exchange rate for Iran for the period 1979Q1-2006Q4 are from Esfahani et al. (2014). These series are updated using the Central Bank of Iran's (CBI) online database as well as several volumes of the CBI's *Economic Report and Balance Sheets* and *Monthly CPI Workbook*. The Iranian GDP data were updated using the International Monetary Fund's (IMF) *International Financial Statistics* and *World Economic Outlook* databases, while the exchange rate data are from the IMF *International Financial Statistics* (for the official exchange rate) and IMF *INS* database (for the "free market" rate).[6]

The main source for the country-specific GDP weights is the World Development Indicator database of the World Bank. Finally, we obtain quarterly oil production series (in thousand barrels per day) from the U.S. Energy Information Administration *International Energy Statistics*.[7]

A.2   Construction of the variables

Log real GDP, y_{it}, the rate of inflation, π_{it}, short-term interest rate, r_{it}^S, the log deflated exchange rate, ep_{it}, and log real equity prices, eq_{it}, are the five variables included in our

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[6]Data on the "free market" rate are only available from the IMF between 1979Q1 to 2011Q3. We therefore make use of data from online traders, such as Eranico: www.eranico.com, to complete the series until 2013Q1.

[7]These data are only available from 1994Q1, so quarterly series from 1979Q2 to 1993Q4 were linearly interpolated (backward) using annual series. For a description of the interpolation procedure see Section 1.1 of Supplement A of Dees et al. (2007).

model. These variables are constructed as

$$y_{it} = \ln(GDP_{it}), \; \pi_{it} = p_{it} - p_{it-1}, \; p_{it} = \ln(CPI_{it}), \; ep_{it} = \ln\left(E_{it}/CPI_{it}\right),$$

$$r_{it}^{S} = 0.25\ln(1 + R_{it}^{S}/100), \; eq_{it} = \ln\left(EQ_{it}/CPI_{it}\right), \tag{14}$$

where GDP_{it} is the real Gross Domestic Product at time t for country i, CPI_{it} is the consumer price index, E_{it} is the nominal exchange rate in terms of US dollar, EQ_{it} is the nominal Equity Price Index, and R_{it}^{S} is the short-term interest rate. In addition to the above variables we also include the log of oil prices, p_t^o, and the log of oil production, q_{it}^o in our dataset.

Table 7: PPP-GDP Weights and Global Equity Weights (in percent), averages over 2007–2009

Country	PPP GDP Weights (w_i)	Global Equity Weights (w_i^{eq})	Country	PPP GDP Weights (w_i)	Global Equity Weights (w_i^{eq})
Argentina	0.98	1.03	Malaysia	0.66	0.69
Australia	1.41	1.48	Mexico	2.72	–
Brazil	3.41	–	Norway	0.48	0.50
Canada	2.22	2.33	New Zealand	0.22	0.23
China	14.34	–	Peru	0.42	–
Chile	0.42	0.44	Philippines	0.55	0.58
Euro Area	17.68	18.56	South Africa	0.87	0.91
GCC5	1.81	–	Singapore	0.43	0.46
India	6.09	6.39	Sweden	0.62	0.65
Indonesia	1.58	–	Switzerland	0.60	0.62
Iran	1.42	–	Thailand	0.94	0.98
Japan	7.39	7.76	Turkey	1.78	–
Korea	2.26	2.37	UK	3.83	4.02
Kuwait	0.23	–	USA	24.68	50.00

Notes: The euro area block includes 8 of the 11 countries that initially joined the euro on January 1, 1999: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, and Spain. Source: World Bank *World Development Indicators*, 2007-2009.

The world equity prices, eq_t, are computed as a weighted average of country-specific equity indices (when available), namely

$$eq_t = \sum_{i=1}^{N} w_i^{eq} eq_{it}, \; \text{with} \; \sum_{i=1}^{N} w_i^{eq} = 1, \tag{15}$$

where $w_i^{eq} \geq 0$ measures the importance of each country's equity market in the global economy. The weight w_i^{eq} is set to zero in the case of countries without substantial equity

markets. For countries with important equity markets one possibility would be to use PPP-GDP weights. But using such weights would understate the importance of the U.S. in the world equity markets which is much more substantial than the 25% PPP-GDP weight of the United States in the world economy (see Table 7). Therefore, to reflect the relative importance of U.S. financial markets we set $w_{US}^{eq} = 0.50$ and allocate the remaining 50% of the weights to the remaining countries using PPP-GDP weights. The resultant weights, w_i^{eq}, are summarized in Table 7.

A.3 Trade weights

The trade weights, w_{ij}, used to calculate the three foreign variables $\left(y_{it}^*, \ \pi_{it}^*, \ r_{it}^{*S}\right)$, are based on data from the International Monetary Fund's *Direction of Trade Statistics* database, and are given in the 28×28 matrix provided in Table 8.

The country-specific foreign variables are constructed as cross-sectional averages of the domestic variables using data on bilateral trade as the weights, w_{ij}

$$\mathbf{x}_{it}^* = \sum_{j=1}^{N} w_{ij} \mathbf{x}_{jt}, \tag{16}$$

where $j = 1, 2, ...N$, $w_{ii} = 0$, and $\sum_{j=1}^{N} w_{ij} = 1$. For empirical application, the trade weights are computed as three-year averages

$$w_{ij} = \frac{T_{ij,2006} + T_{ij,2007} + T_{ij,2008}}{T_{i,2006} + T_{i,2007} + T_{i,2008}}, \tag{17}$$

where T_{ijt} is the bilateral trade of country i with country j during a given year t and is calculated as the average of exports and imports of country i with j, and $T_{it} = \sum_{j=1}^{N} T_{ijt}$ (the total trade of country i) for $t = 2006, 2007$, and 2008, in the case of all countries.

Table 8: Trade Weights, averages over 2006–2008

	ARGENTINA	AUSTRALIA	BRAZIL	CANADA	CHINA	CHILE	EURO	GCC5	INDIA	INDONESIA	IRAN	JAPAN	KOREA	KUWAIT	MALAYSIA	MEXICO	NORWAY	NEW ZEALAND	PERU	PHILIPPINES	SOUTH AFRICA	SINGAPORE	SWEDEN	SWITZERLAND	THAILAND	TURKEY	UK	USA
ARGENTINA	0.00	0.00	0.11	0.00	0.01	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AUSTRALIA	0.00	0.00	0.01	0.00	0.03	0.01	0.01	0.01	0.03	0.04	0.00	0.04	0.03	0.01	0.03	0.00	0.00	0.24	0.00	0.01	0.02	0.03	0.01	0.01	0.04	0.01	0.01	0.01
BRAZIL	0.31	0.01	0.00	0.01	0.02	0.09	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.07	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02
CANADA	0.01	0.01	0.02	0.00	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.02	0.01	0.00	0.01	0.03	0.03	0.02	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.22
CHINA	0.12	0.17	0.11	0.06	0.00	0.15	0.12	0.10	0.11	0.11	0.15	0.21	0.24	0.06	0.12	0.06	0.03	0.11	0.14	0.11	0.10	0.13	0.04	0.03	0.12	0.08	0.06	0.15
CHILE	0.06	0.00	0.03	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
EURO	0.17	0.12	0.24	0.06	0.17	0.20	0.00	0.15	0.17	0.09	0.24	0.11	0.10	0.13	0.10	0.08	0.46	0.12	0.16	0.12	0.30	0.10	0.54	0.68	0.09	0.48	0.53	0.15
GCC5	0.01	0.03	0.03	0.01	0.04	0.00	0.04	0.00	0.18	0.04	0.12	0.11	0.11	0.05	0.03	0.00	0.00	0.04	0.00	0.06	0.06	0.06	0.01	0.02	0.09	0.06	0.02	0.03
INDIA	0.02	0.03	0.02	0.00	0.03	0.02	0.02	0.10	0.00	0.04	0.10	0.01	0.02	0.11	0.03	0.00	0.00	0.01	0.01	0.01	0.03	0.04	0.01	0.01	0.02	0.01	0.02	0.02
INDONESIA	0.01	0.03	0.01	0.00	0.02	0.00	0.01	0.01	0.02	0.00	0.00	0.03	0.03	0.02	0.04	0.00	0.00	0.03	0.00	0.02	0.01	0.05	0.00	0.00	0.04	0.01	0.00	0.01
IRAN	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.02	0.04	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.05	0.00	0.00
JAPAN	0.02	0.16	0.04	0.03	0.16	0.09	0.05	0.19	0.03	0.18	0.12	0.00	0.14	0.18	0.13	0.04	0.02	0.10	0.06	0.17	0.10	0.08	0.02	0.03	0.19	0.02	0.03	0.08
KOREA	0.01	0.06	0.03	0.01	0.11	0.05	0.03	0.10	0.03	0.07	0.08	0.07	0.00	0.15	0.05	0.03	0.01	0.04	0.03	0.06	0.02	0.05	0.01	0.01	0.04	0.02	0.01	0.03
KUWAIT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
MALAYSIA	0.01	0.03	0.01	0.00	0.03	0.00	0.01	0.01	0.03	0.06	0.01	0.03	0.02	0.01	0.00	0.01	0.00	0.03	0.00	0.05	0.01	0.16	0.00	0.00	0.07	0.01	0.01	0.02
MEXICO	0.03	0.01	0.03	0.03	0.01	0.04	0.02	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
NORWAY	0.00	0.00	0.01	0.01	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.04	0.00
NEW ZEALAND	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERU	0.01	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PHILIPPINES	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.01	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.01
SOUTH AFRICA	0.01	0.01	0.01	0.00	0.01	0.00	0.02	0.01	0.02	0.00	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.01
SINGAPORE	0.00	0.05	0.01	0.00	0.03	0.00	0.01	0.04	0.05	0.14	0.02	0.03	0.03	0.08	0.15	0.00	0.01	0.04	0.00	0.10	0.01	0.00	0.00	0.01	0.06	0.00	0.01	0.02
SWEDEN	0.00	0.01	0.01	0.00	0.01	0.01	0.06	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.01
SWITZERLAND	0.01	0.01	0.01	0.00	0.01	0.00	0.08	0.01	0.03	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.06	0.00	0.02	0.01	0.01	0.00	0.01	0.04	0.02	0.01
THAILAND	0.01	0.04	0.01	0.00	0.02	0.01	0.01	0.04	0.01	0.04	0.00	0.04	0.01	0.01	0.06	0.00	0.00	0.02	0.01	0.04	0.02	0.05	0.00	0.01	0.00	0.01	0.01	0.01
TURKEY	0.01	0.00	0.00	0.00	0.01	0.01	0.04	0.02	0.01	0.01	0.07	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.02	0.00
UK	0.01	0.05	0.02	0.03	0.03	0.01	0.19	0.03	0.04	0.01	0.02	0.02	0.02	0.04	0.02	0.01	0.23	0.04	0.01	0.01	0.07	0.03	0.09	0.05	0.02	0.07	0.00	0.04
USA	0.12	0.11	0.20	0.71	0.20	0.18	0.17	0.12	0.12	0.10	0.00	0.19	0.13	0.11	0.16	0.69	0.06	0.12	0.24	0.19	0.11	0.13	0.07	0.09	0.12	0.08	0.13	0.00

Notes: Trade weights are computed as shares of exports and imports, displayed in columns by country (such that a column, but not a row, sum to 1). Source: International Monetary Fund *Direction of Trade Statistics*, 2006-2008.

B Additional estimates and tests

The estimation of the K-VARX* model is conducted under the assumption that the foreign variables are weakly exogenous. We will test and provide evidence for this assumptions in Section B.2. We will also demonstrate the robustness of the long-run estimates and the generalized impulse responses to a one standard deviation fall in (a) oil revenue, (b) foreign output, and (c) global equity markets in Section B.3. But first we discuss the unit root properties of the core variables in our model as well as provide evidence that the weakly exogenous variables are not cointegrated.

B.1 Unit root tests

For interpretation of the long-run relations and also to ensure that we do not work with a mixture of $I(1)$ and $I(2)$ variables we need to consider the unit root properties of the core variables in our model: $\left(y_t,\ \pi_t,\ ep_t,\ y_t^*,\ \pi_t^*,\ r_t^{S*},\ eq_t,\ or_t\right)$. Table 9 reports the standard Augmented Dickey-Fuller (ADF) test. But as the power of unit root tests are often low we also report the generalized least squares version of the Dickey-Fuller test (ADF-GLS) proposed by Elliott et al. (1996), and the weighted symmetric ADF test (ADF-WS) of Park and Fuller (1995), as they both have been shown to have better power properties than the ADF test.

Table 9: Unit root test statistics (based on AIC order selection)

(a) Unit root test statistics for the levels

	y_t	p_t	ep_t	y_t^*	p_t^*	r_t^{S*}	or_t	eq_t	CV	CV T
ADF	-3.09	-2.48	-2.01	-1.49	-0.85	-2.63	-2.69	-2.07	-2.89	-3.45
ADF-GLS	-1.23	-1.88	-2.03	-1.52	-0.68	-2.26	-1.31	-2.07	-2.14	-3.03
ADF-WS	-1.76	-2.20	-2.26	-1.58	-0.10	-2.68	-1.58	-2.27	-2.55	-3.24

(b) Unit root test statistics for the first differences

	Δy_t	Δp_t	Δep_t	Δy_t^*	Δp_t^*	Δr_t^{S*}	Δor_t	Δeq_t	CV	CV T
ADF	-4.67	-8.88	-8.64	-6.59	-3.31	-6.28	-8.05	-8.52	-2.89	-3.45
ADF-GLS	-3.85	-8.43	-7.08	-5.60	-0.40	-3.54	-8.07	-8.52	-2.14	-3.03
ADF-WS	-4.74	-9.14	-8.82	-7.21	-0.72	-5.99	-8.26	-8.76	-2.55	-3.24

(c) Unit root test statistics for the second differences

	$\Delta^2 y_t$	$\Delta^2 p_t$	$\Delta^2 ep_t$	$\Delta^2 y_t^*$	$\Delta^2 p_t^*$	$\Delta^2 r_t^{S*}$	$\Delta^2 or_t$	$\Delta^2 eq_t$	CV	CV T
ADF	-10.31	-10.01	-9.37	-10.35	-8.22	-8.27	-8.32	-8.79	-2.89	-3.45
ADF-GLS	-10.31	-5.39	-4.61	-2.25	-5.37	-5.89	-8.15	-4.02	-2.14	-3.03
ADF-WS	-10.48	-10.29	-9.65	-10.92	-8.47	-8.36	-8.58	-9.04	-2.55	-3.24

Notes: ADF denotes the Augmented Dickey-Fuller Test, ADF-GLS the generalized least squares version of the ADF test, and ADF-WS the weighted least squares ADF test. The sample period runs from 1979Q2 to 2013Q1. CV T gives the 95% simulated critical values for the test with intercept and trend, while CV is the 95% simulated critical values for the test including an intercept only.

As the core variables are trended, we include a linear trend and an intercept in the ADF regressions for all the variables, however, when testing for the presence of unit roots in the first and second differences of the core variables only an intercept is included in the ADF regressions. As can be seen from Table 9, the available evidence supports our treatment of the core variables as being $I(1)$ as the unit root hypothesis is clearly rejected when applied to the first differences of these variables, but not when the tests are applied to the (log) levels.

Next we investigate whether the weakly exogenous variables in the K-VARX* model are cointegrated. Table 10 reports the cointegration tests results with the null hypothesis of no cointegration ($r = 0$), one cointegrating relation ($r = 1$), and so on. These tests are carried out using Johansen's maximum eigenvalue and trace statistics. As can be seen both the maximal eigenvalue statistic and the trace statistic indicate that the exogenous variables are not cointegrated.

Table 10: Cointegration Rank Test Statistics for the Weakly Exogenous Variables

H_0	H_1	Test Statistic	95% Critical Values	90% Critical Values
(a) Maximal eigenvalue statistic				
$r = 0$	$r = 1$	12.00	14.88	12.98
$r \leq 1$	$r = 2$	3.31	8.07	6.50
(b) Trace statistic				
$r = 0$	$r = 1$	15.31	17.86	15.75
$r \leq 1$	$r = 2$	3.31	8.07	6.50

Notes: The test statistics refer to Johansen's log-likelihood-based maximum eigenvalue and trace statistics and are computed using 132 observations from 1980Q2 to 2013Q1.

B.2 Testing the weak exogeneity assumption

Weak exogeneity of the foreign variables, $\mathbf{x}_t^* = (y_t^*, \ or_t)'$ in the case of Model A and $\mathbf{x}_t^* = \left(y_t^*, \ \pi_t^*, \ r_t^{*S}, \ or_t, \ eq_t\right)'$ in the case of Model B, with respect to the long-run parameters of the conditional model is vital in the construction and the implementation of the VARX* model. We formally test this assumption following the procedure in Johansen (1992) and Harbo et al. (1998). Thus, we first estimate the K-VARX* model under the assumption that the foreign variables are weakly exogenous and then run the following regression for each lth element of $\mathbf{x}_t^*$

$$\Delta x_{t,l}^* = \mu_l + \sum_{j=1}^{r} \gamma_{j,l} \widehat{ECM}_{j,t-1} + \sum_{n=1}^{p^*} \varphi_{k,l}' \Delta \mathbf{x}_{t-k} + \sum_{m=1}^{q^*} \vartheta_{m,l} \Delta \mathbf{x}_{t-m}^* + \varepsilon_{t,l}, \qquad (18)$$

where $\widehat{ECM}_{j,t-1}$, $j = 1, 2, ..., r$, are the estimated error correction terms corresponding to the r cointegrating relations found, and p^* and q^* are the orders of the lag changes for the domestic and foreign variables. Under the null hypothesis that the variables are weakly exogenous, the error correction term must not be significant; therefore, the formal test for weak exogeneity is an F-test of the joint hypothesis that $\gamma_{j,l} = 0$ for each $j = 1, 2, ..., r$ in equation (18).

Table 11: F-Statistics for Testing the Weak Exogeneity of the Foreign Variables

	Critical Value	y^*	π^*	r^{S*}	eq_t	or_t
Model A	3.92	0.11	-	-	-	0.01
Model B	3.07	0.02	1.90	1.49	0.90	0.85

Notes: * denotes statistical significance at the 5% level.

The test results together with the 95% critical values are reported in Table 11, from which we see that the weak exogeneity assumption cannot be rejected in the case for all the variables regardless of model specification (A or B). Therefore, the available evidence in Table 11 supports our treatment of the foreign variables in the K-VARX* model as weakly exogenous.

B.3   Robustness to choice of the VARX* lag order

To illustrate the robustness of our results to the choice of the VARX* lag order, in addition to the optimal lag order selected by the Akaike Information Criterion $(2, 1)$ and used throughout the paper, we estimate four new models and report the long-run estimates and the Generalized Impulse Responses (GIRFs) of domestic output (y_t) to a one standard deviation fall in (a) oil revenue, (b) foreign output, and (c) global equity markets based on VARX* lag orders $(1, 1)$ and $(2, 2)$.

Imposing the same long-run restrictions as in Section 4, the estimated share of capital in output hardly changes across various model specifications, models A and B, and across the various lag orders, $(1, 1)$ and $(2, 2)$, with $\hat{\alpha}$ being between 0.271 and 0.285, see Table 12. This clearly illustrates the robustness of our results in terms of the long-run estimates. It should also be noted that these estimated shares of capital in output are generally in line with the estimates obtained in the literature; see, for instance, Pedroni (2007) and Cavalcanti et al. (2011a).

Moreover, we plot the median generalized impulse responses to a one standard deviation fall in (a) oil revenue, (b) foreign output, and (c) global equity markets, together with 95

Table 12: Share of Capital in Output based on various lag orders

Model Specification	VARX* order	Share of capital in output	
		$\hat{\alpha}$	S.E.
Model A	$(1,1)$	0.278	(0.0256)
Model A	$(2,2)$	0.272	(0.0196)
Model B	$(1,1)$	0.285	(0.0253)
Model B	$(2,2)$	0.271	(0.0197)

Notes: For the various model specifications see Section 4.

percent bootstrapped confidence bounds in Figure 6. As can be seen, overall, the median responses, the shapes and the significance of the GIRFs across various model specifications, models A and B, and across the various lag orders, $(1,1)$ and $(2,2)$, are very much in line with those reported in the paper, see Figure 4. Thereby, illustrating the robustness of our results to the choice of lag order.

Figure 6: Generalized Impulse Responses of Domestic Output (y_t)

GIRFs based on Model A and VARX*$(1,1)$

(a) Oil Revenue (or_t)
(b) Foreign Output (y_t^*)
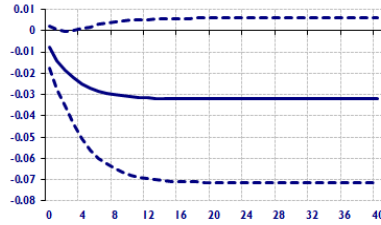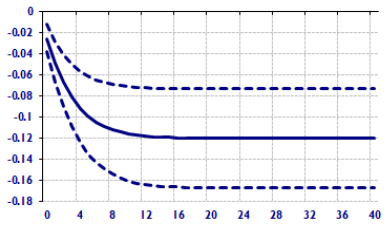
GIRFs based on Model A and VARX*$(2,2)$

(a) Oil Revenue (or_t)
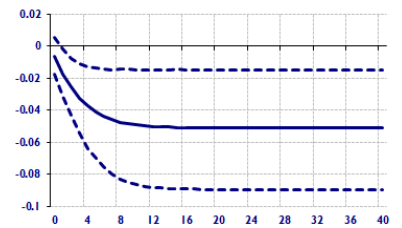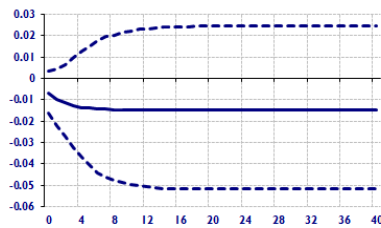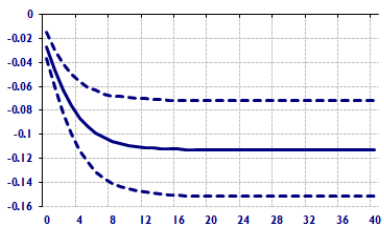**(b) Foreign Output (y_t^*)**
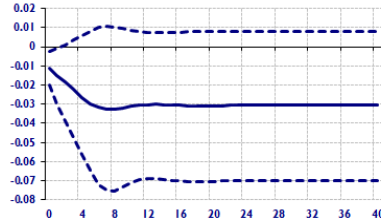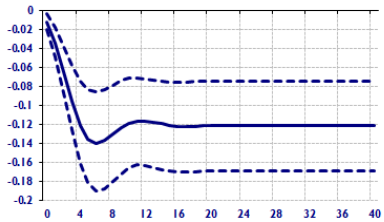
GIRFs based on Model B and VARX*$(1,1)$

(a) Oil Revenue (or_t)
(b) Foreign Output (y_t^*)
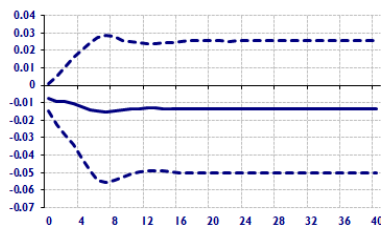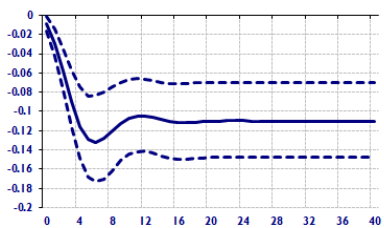**(c) Global Equity (eq_t)**

GIRFs based on Model B and VARX*$(2,2)$

(a) Oil Revenue (or_t)
(b) Foreign Output (y_t^*)
(c) Global Equity (eq_t)

Notes: The figures in (a) are median generalized impulse responses to a one standard deviation fall in oil revenue, together with 95 percent bootstrapped confidence bounds, while in (b) are median generalized impulse responses to a one standard deviation fall in foreign output, and (c) are median generalized impulse responses to a one standard deviation fall in global equity markets. The impact is in percentage points and the horizon is quarterly.

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