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Understanding the Inflationary Process in the GCC Region: The Case of Saudi Arabia and Kuwait

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Understanding the Inflationary Process in the GCC Region: The Case of Saudi Arabia and Kuwait

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Abstract

This paper investigates the factors that affect inflation in the GCC region by examining the inflationary processes in Saudi Arabia and Kuwait. The paper utilizes a model that accounts for foreign factors affecting inflation, such as trading partners' inflation and exchange rate pass-through effect, as well as domestic influences. The analysis concludes that, in the long run, higher inflation in trading partners' countries is the main driving force for inflation in the two countries, with significant but lower contributions from the exchange rate pass-through effect and oil prices. Demand and money supply shocks affect inflation in the short run.

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Keywords: Inflation, trading partners' inflation, pass-through effect, demand shocks, excess money supply, error correction model (ECM).

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I. Introduction

After achieving an impressive success in maintaining price stability over the last two decades, inflationary pressures have emerged since 2003 in all GCC countries with the recent oil boom putting tackling inflation on top of the agenda for policy makers in the region. Some have blamed these pressures mainly on the peg to the weakening U.S. dollar, others on global shocks related to high food prices, local supply shortages related to rent, and demand shocks induced by large fiscal spending and an expansionary monetary stance imported from the U.S. through the dollar peg. Accordingly, the remedies proposed include revaluation or adopting more flexible exchange rate regime to gain monetary policy independence, higher subsidies, addressing supply bottlenecks, and containing government expenditures.

Although all these factors might have played a role in the recent inflationary pressures, the design of an appropriate policy response, especially the choice of exchange or monetary regimes, will likely be guided by the forces driving inflation in the long run[2]. Understanding these driving forces is not only key to adopt appropriate policies to maintain price stability, but it is also essential to assess the potential cost and benefits of the planned monetary union among GCC countries, with more homogenous inflationary processes implying lower cost. This paper seeks to contribute to the understanding of what are the factors that affect inflation in the GCC region by examining the inflationary processes in Saudi Arabia and Kuwait. Given the similarity of the economic structure of the GCC countries, it seems plausible to assume that the inflationary processes in Saudi Arabia and Kuwait could help gain a better understanding of the forces driving inflation in the other GCC countries.

The analysis concludes that, in the long run, inflation in trading partners is the main factor affecting inflation in Saudi Arabia and Kuwait, with significant but lower contribution from exchange rate pass-through. Positive demand shocks and excess money supply exert upward pressures on inflation in the short run, but tend to dissipate quickly as real exchange rate and the money market reach a new equilibrium.

The rest of the paper is organized as follows: section II provides a brief review of the literature; section III describes the economic model and methodology. The empirical analysis and results are discussed in section IV followed by conclusions.

II. Brief Review of the Literature

There is a huge body of literature on inflation and its determinants in both developed and developing countries. The literature considers inflation the outcome of four main factors: supply side factors that come from cost push or mark up relationships; foreign factors;

[2] This does not mean that the driving forces for inflation in the short term do not influence the regime choice. However, given their short term nature, policy makers would probably assign lower weight to them in deciding on the exchange rate and monetary regimes.

monetary factors; and demand factors. In addition, the literature considers inflation expectations as another source of inflation. For example, De Brouwer and Ericsson (1998) used the mark-up model to empirically model the inflation process in Australia. Juselius (1992) investigates the long run foreign transmission effects for Danish and German prices, exchange rates and interest rates, finding strong evidence of the dependence of Danish prices on West German price levels. Lim and Papi (1997) find strong evidence for a key role for money and the exchange rates in explaining the inflation process in Turkey during 1970–95, and Leo (2007) finds a strong relation between money and inflation in Iran. Empirical analysis has often identified country-specific factors that affect inflation, for example Sekine (2001; Japan), Khan and Schimmelpfennig (2006; Pakistan), and Diouf (2007; Mali).

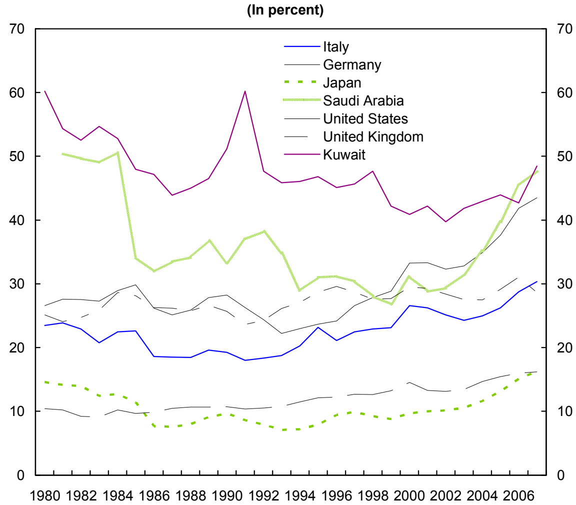
Few studies have analyzed the inflation process in the GCC countries, with hardly any emphasis on the long run factors. For example, Darrat (1985) analyzed the role of money in explaining inflation in Libya, Nigeria and Saudi Arabia, finding that higher money supply and lower real income growth are associated with higher inflation in the three countries. Al-Mutairi (1995) constructed a VAR model to examine the impact of money supply, government expenditure and import prices on inflation in Kuwait. He found that government expenditure plays a dominant role in explaining the variation in the price level, followed by import prices and the money supply. Keran and Al Malik (1979) analyzed the monetary sources for inflation in Saudi Arabia and found, when compared to the U.S., a greater influence of world prices on inflation and a lower influence of domestic monetary developments. Al-Raisi and Pattanaik (2003) examined the pass-through of exchange rate effect to Oman prices and found only a very weak pass-through effect. Specifically, they found that a depreciation of 10 percent in the nominal effective exchange rate (NEER) will increase the CPI by only 0.4 percent.

III. Economic Model and Methodology

Several factors make the domestic price level in the GCC countries highly sensitive to external factors. The GCC countries' tradable sector includes mainly hydrocarbon products, reflecting the region's comparative advantage. The region also has a very open trade system with most consumer products imported from outside the region. Figure 1 compares Saudi Arabia and Kuwait to their five largest trading partners[3] in terms of domestic demand that is met through imports. It shows clearly the dependence of the two countries on imports. While the ratio is high also in Germany and to a lesser extent in Italy and UK, this reflects the importance of imported intermediate inputs and raw materials, while imports are mainly for final consumption or investment in Saudi Arabia and Kuwait (figure 2).

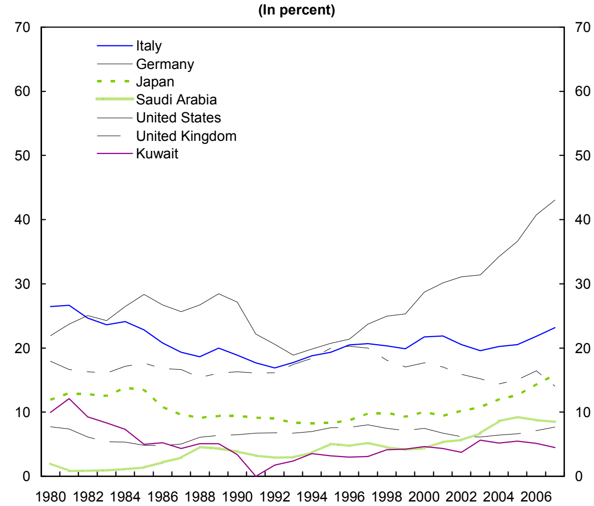
[3] As defined in the INS weights.

Figure 1. Imports to Aggregate Domestic Demand Ratio, 1980–2007
(In percent)



Source: World Economic Outlook.

Figure 2. Non-oil Exports to Aggregate Domestic Demand Ratio, 1980–2007
(In percent)



Source: World Economic Outlook.

In addition, the two countries' flexible labor policies[4] have increased their dependence on foreign labor force, adding to the sensitivity of price levels to external factors. This stems from the fact that inflation in expatriates' home countries and the exchange rate influence the purchasing power of their remittances and hence the level of salaries required to attract them to Saudi Arabia or Kuwait, or to retain them there.

The domestic price level is also affected by the changes in the price of nontradables which largely reflect domestic factors. However, several policies have limited the impact of domestic factors on inflation. The flexible labor policy has mitigated the impact of any shortages in local labor supply and enhanced the supply response of nontradables.[5] The generous subsidies systems, e.g. in education, health services, electricity and water, have also played an important role in limiting the impact of domestic and external factors on nontradables and to a lesser extent on tradables prices. In addition, the monetary discipline embodied in the pegged exchange rate regime has prevented the active use of monetary policy for achieving real sector objectives, and the open capital account has facilitated the dissipation of any excess money supply through capital outflows.

The choice of any economic model to analyze the inflationary process in the GCC region should be guided by these characteristics of the region which emphasize the role of external

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[4] Openness to imported labor has led to a large expatriate work force at all skill levels (represents more than 80 and 60 percent of the total labor force in Kuwait and Saudi Arabia, respectively), mostly from South Asia and other Arab countries.

[5] However, the large influx of expatriates has occasionally created demand pressures on nontradables, especially in the real estate sector, where the supply response is relatively slow.

factors on inflation.[6] Hence, to take into account all factors affecting the domestic price level we will assume that the price level is such that

$$P = f\left(NEER, P^{*}, P^{oil}, M, D\right) \tag{1}$$

P is the domestic price level measured by the CPI, *NEER* is the nominal effective exchange rate and it captures the exchange rate pass-through effect, *P** is the price level in trading partners and captures imported inflation, P^{oil} is the price of oil, included to capture transportation costs, *M* is the nominal money supply and *D* is the aggregate domestic demand.

If one were to assume that only external factors affect inflation in (1), an error correction model (ECM) could be used to assess the long run effect of these factors as well as the short term dynamics such that[7]:

$$\begin{aligned}\Delta p_t &= c + \delta(p_{t-1} - \alpha_1 neer_{t-1} - \alpha_2 p^{*}_{t-1} - \alpha_3 p^{oil}_{t-1}) \\ &\quad + \sum_{i=1}^{k} b_{1i}\Delta p_{t-i} + \sum_{i=1}^{k} b_{2i}\Delta neer_{t-i} + \sum_{i=1}^{k} b_{3i}\Delta p^{*}_{t-i} + \sum_{i=1}^{k} b_{4i}\Delta p^{oil}_{t-i}\end{aligned} \tag{2}$$

where k is the number of lags to be included and the lower case represents the natural logarithm of the variables. With the exception of the NEER which is measured as the foreign currency price per local currency (thus an increase in NEER represents an appreciation of the local currency), all other variables are expected to have a positive impact on inflation. According to relative purchasing power parity (PPP), the effect of both foreign price changes and exchange rate changes on *p* is equal to one. However, there are many reasons that this might, at least in the short run, not hold. These include transportation costs and the presence of non-traded goods in the consumer basket, the price level of which is largely subject to domestic factors such as monetary factors and domestic demand. Hence, estimates based on (2) would be biased and inefficient if money and domestic demand affect the inflationary process.

The monetary stance in Saudi Arabia and Kuwait has been more or less accommodative to money demand as determined by economic activities. Given the pegged exchange rate regime that is furthermore highly credible in light of large foreign reserves and the open capital account, there is little scope for an active role for monetary policy to stimulate or cool economic activities. However, the peg regime does not prevent an occasional limited unanticipated deviation of money supply from money demand (excess money supply).

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[6] Mark-up models to empirically analyze the inflation are unlikely to be appropriate in the context of GCC countries given the unavailability of wages data and the flexible labor market.

[7] For simplicity, we assume the existence of one cointegrating vector.

This deviation could be measured by estimating a money demand equation where the deviation of money supply from long run money demand represents an excess money supply. Assuming that money demand is a function of real GDP, the GDP price deflator and the interest rate and estimating the long run relationship between money demand and these variables, the excess money supply can be then measured as:

$$excm_t = m_t - \hat{m}_t \tag{3}$$

where m is the log of money supply and $\hat{m}$ is the estimated long run money demand.

In the short run, excess aggregate demand, may also exert positive pressures on inflation. Excess demand could be measured through the output gap such that:

$$excd_t = RGDP_t - \overline{RGDP}_t \tag{4}$$

where $RGDP_t$ is the real GDP and $\overline{RGDP}_t$ is the potential GDP. Although it is hard to observe potential GDP, there are different ways to estimate it. De-trending and hp-filters are two common ways to estimate the potential GDP (see appendix 2). However, the large contribution of the oil sector in the GDP of Saudi Arabia and Kuwait affects the accuracy of this measure. This stems from the fact that changes in the real GDP due to changes in the level of oil production, if not translated into higher government expenditures, would not have an impact on domestic demand and hence would not exert inflationary pressures. Alternatively, one could use real non-oil GDP to proxy the output gap. However, the inclusion of oil related activities (refining, petrochemicals) affects its accuracy as a measure for excess domestic demand and the unavailability of a long enough time series hinders using it in the case of Kuwait. To address these concerns, we assess excess domestic demand[8] such that

$$excd_t = d_t - \hat{d}_t \tag{5}$$

where d_t is the real domestic demand (i.e. government and private consumption and investment) and $\hat{d}_t$ is the potential (long run) demand estimated through de-trending or using an hp-filter.

Excess demand (deviation of aggregate demand from its long-run level) could result from several factors. These include expansionary fiscal policy, monetary shocks, and deviation of the real exchange rate from the equilibrium level. Expansionary fiscal policy increases

[8] De Brouwer and Ericsson (1996) used private demand to construct a proxy for the output gap in their estimate for short term inflation dynamic in Australia.

demand directly while an expansionary monetary stance induces private sector demand by lowering the cost of credit. The excess demand variable captures also the impact of any deviation of the real exchange rate from equilibrium. For example, an undervalued real exchange rate stimulates demand for nontradables.

Given all factors discussed above, the general inflation equation could be expressed as[9]:

$$\begin{aligned}\Delta p_t &= c + \delta_1 (p_{t-1} - \alpha_1 neer_{t-1} - \alpha_2 p^*_{t-1} - \alpha_3 p^{oil}_{t-1}) \\ &\sum_{i=1}^{k} b_{1i} \Delta p_{t-i} + \sum_{i=1}^{k} b_{2i} \Delta neer_{t-i} + \sum_{i=1}^{k} b_{3i} \Delta p^*_{t-i} + \sum_{i=1}^{k} b_{4i} \Delta p^{oil}_{t-i} \\ &+ \delta_2 excd_{t-1} + \delta_3 excm_{t-1} + \sum_{i=1}^{k} b_{5i} \Delta gdp_{t-i} + \sum_{i=1}^{k} b_{6i} \Delta m_{t-i} + b_7 D_t\end{aligned} \tag{6}$$

Equation (6) is equation (2) augmented by excess money supply and demand shocks. The first line captures the long run dynamic of the inflation process, while the second and third lines capture the short run dynamic including the impact of domestic factors on inflation. An alternative specification could include money supply as a variable affecting the long run dynamic of the inflation process. We will examine this hypothesis in the empirical analysis. Changes in real GDP and money could be included to capture the impact of supply response and changes in money supply on inflation.[10] D is a dummy variable that could be used to account for specific events such as the invasion of Kuwait in 1990 and the Gulf War in 1991.

This model is similar to Juselius (1992a) model which assumed that the inflationary process in Denmark is driven by the external, internal and monetary sectors. Juselius estimated the deviation from the steady state in each sector separately and then used that along with other possible determinants for inflation to estimate a short run inflation dynamic model. For the external sector she assumed that the PPP hold, based on Juselius (1992). While the model in (6) is similar to Juselius (1992a) in the sense that it takes into account the three sectors in addition to other possible determinants for inflation, it does not assume that the PPP hold and it assesses excess demand differently[11]. This allows for assessing the long run impact of the external factors on the inflationary process conditional on domestic or short term factors while relaxing the PPP assumption[12] which lacks strong supporting empirical evidence.

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[9] For simplicity, we assume the existence of one cointegrating vector.

[10] By including monetary variables in (6), we control for the effect of the monetary stance when we assess the impact of excess demand.

[11] Juselius uses wage inflation to assess excess demand in the internal sector while we use simpler measures (see footnote 6). The assessment for the excess money supply is similar between the two models.

[12] However, the model allows for testing the PPP hypothesis.

The choice of the two countries to be included in the analysis was guided by the likely stability in the inflationary process and the availability of data. Unlike U.A.E. and Qatar, Saudi Arabia and Kuwait's economies did not go through large structural changes during the period we investigate, both having a well developed oil industry and infrastructure and experiencing rather gradual diversification. The availability of relatively long time series data in the two countries is also critical for the long run nature of the analysis we would like to conduct. Moreover, Saudi Arabia and Kuwait were the largest two economies in the GCC region for most of the period we investigate. While short-term factors could result in diverging inflation among the GCC countries, in the long, the similarity in the economic structure of the GCC countries are likely to lead similar inflationary processes.

IV. Data and Estimation

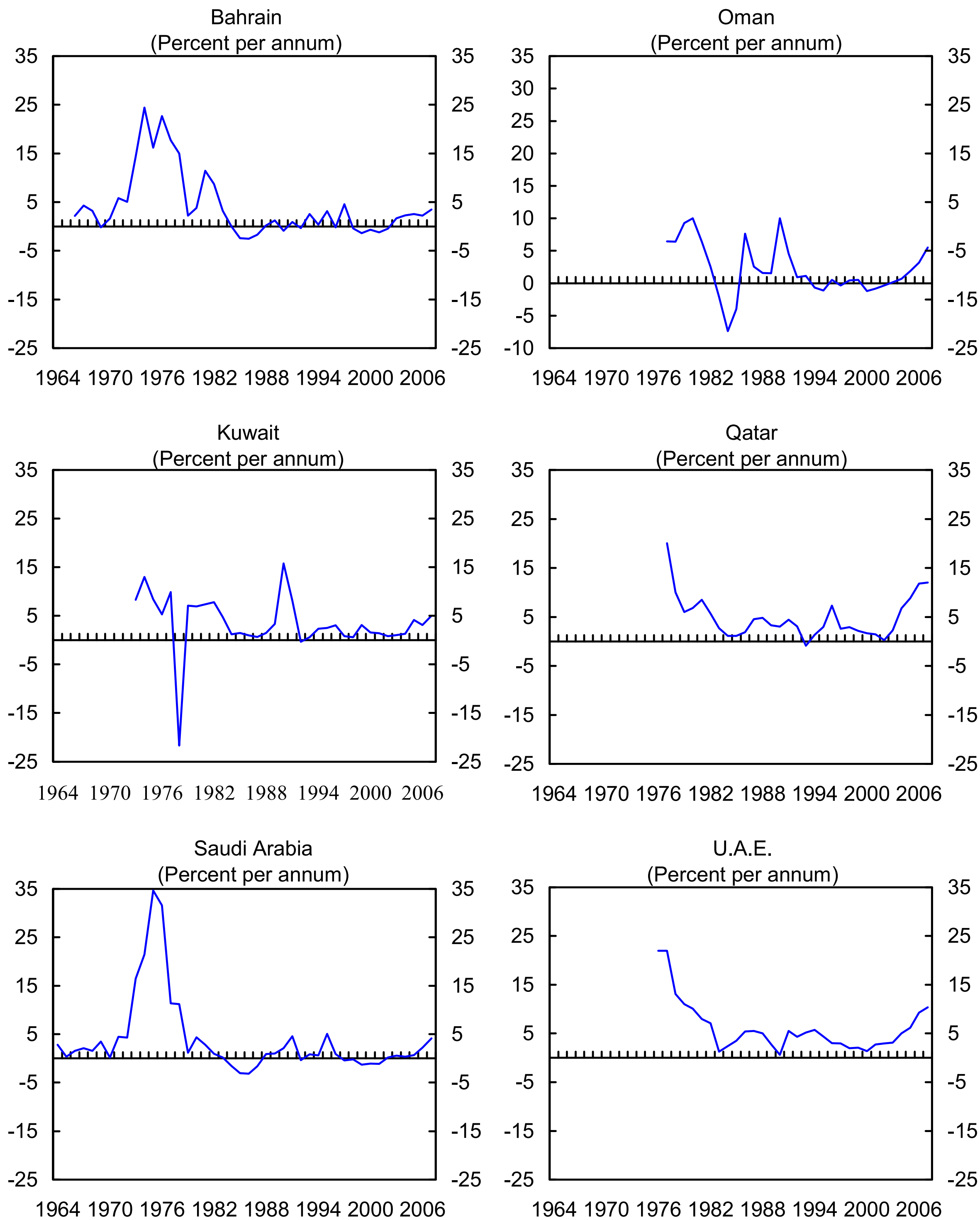
A. Inflationary developments

The GCC region has witnessed two episodes of relatively high inflation; both of them have coincided with oil booms (Figure 3). The first episode was in the 1970s with the first oil boom while the second one started in 2003. With the exception of U.A.E. and Qatar, the second episode has been relatively milder. The Saudi economy experienced very high inflation during the 1970s. Although the level of inflation might be exaggerated by data measurement problems, the trend is consistent with other GCC countries. During the1980s and the 1990s, inflation in Saudi Arabia fluctuated between mild deflation and inflation, reaching 5 percent in 1991 and 1995. Inflation remained steady during the 2000s and started to pick up in 2003, reaching 4.1 percent in 2007 and 10.5 percent year on year in April 2008.

Inflationary trends in Kuwait were similar to those in Saudi Arabia. While the level of inflation in Kuwait was lower during the 1970s, it was on average slightly higher during 1984–2004 (excluding 1990-91 (Gulf War)) than the Saudi level. The sharp deflation in 1978 is likely related to problems with the splicing of a CPI series that started in 1978 on the previous one. This is corroborated by examining the wholesale price index (WPI) inflation which declined by 1 percent only in 1978.[13] Inflation in Kuwait increased significantly during the invasion in 1990 and the liberation and reconstruction in 1991. Like in other GCC countries, inflation started to pick up in 2003 averaging 5 percent in 2007 and reached 10 percent year on year in February 2008.

[13] The decline might reflect, in part, the revaluation of the Kuwaiti dinar by 4 percent against the U.S. dollar in 1978.

Figure 3. GCC: Inflation, 1964–2007



Source: World Economic Outlook.

B. Order of integration

To determine the order of integration for the variables considered in the analysis, unit root tests for the log of the variables (except for the interest rate) and their first difference were conducted to test for the null orders of I(1) and I(2), respectively. Table 1 lists the Augmented Dickey-Fuller (ADF) statistics. As expected, most of variables are I(1). Output gap, interest rate, demand gap, and excess money supply are stationary (I(0)) as expected. Money supply is I(2) in the case of Kuwait.

Table 1. Unit Root Tests 1/

		Saudi Arabia 2/		Kuwait 3/	
Variable	Description	I(1)	I(2)	I(1)	I(2)
p	Consumer Price Index (CPI)	-1.98	-3.12**	-2.03	-3.63**
neer	Nominal Effective Exchange Rate	-2.43	-3.81***	-1.64	-4.00***
p*	Trade Partner's CPI 4/	-2.22	-3.84**	-2.58	-4.52***
p^{oil}	Nominal Oil Prices 5/	-1.35	-6.27***	-1.35	-6.27***
excm	Excess Money	-2.18**	-4.57***	-2.64***	-5.77***
dhp	Excess Demand using demand HP-filter	-4.8***	…	-4.67***	…
dgap	Excess demand using detrending method	-2.17**	…	-1.75*	…
m	Nominal Money Supply (M3)	-.75	-3.05**	2.39	2.1
gdp	Real GDP	-2.54	-3.66***	-0.48	-5.33***
p^{def}	GDP Deflator Index	-1.7	-3.70***	-1.88	-4.81***
r	Interest rate (Federal Fund Rate) 5/	-3.68**	…	-3.68**	…
p^{wpi}	Wholesale Price Index	-3.03**	-3.10**	-1.52	-3.27**

1/ Asterisks *, **, and *** denote rejection at the 10, 5 and 1 percent significance level, respectively.

2/ The sample for Saudi Arabia is from 1966–2007 (annual) except for excess demand which is from 1981–2007. A dummy variable is added in testing unit root of p and m for Saudi Arabia to count for possible structural change from 1966 to 1980. Unit root test without dummy for the period 1980-2007 indicate that p is I(1). The WPI sample is from 1985-2007.

3/ The data sample for Kuwait is from 1974–2007 (annual) for all variables except excess demand which is from 1979–2007.

4/ For p*, we include a trend in the ADF test .

5/ The sample period is 1966–2007.

C. Estimates of the inflation model (Saudi Arabia)

We start by examining a model where money supply is included in the error correction vector to assess the long run impact of money. This resulted in non-sensible signs for the coefficient of the variables examined[14] and model selection criteria not in favor of including it, both in the case of Saudi Arabia and Kuwait[15]. Juselius (1994) suggested using real money to overcome the I(2)[16] problem or estimating the excess money supply from a money demand function. While real money is I(1), including it does not solve the previous problems.[17] Alternatively, we use excess money supply to assess the impact of money and since it is

[14] For example, a negative impact for trading partners' inflation and money supply on inflation.

[15] We also examined changes in money supply and lagged money supply.

[16] Money supply is I(2) in the case of Kuwait.

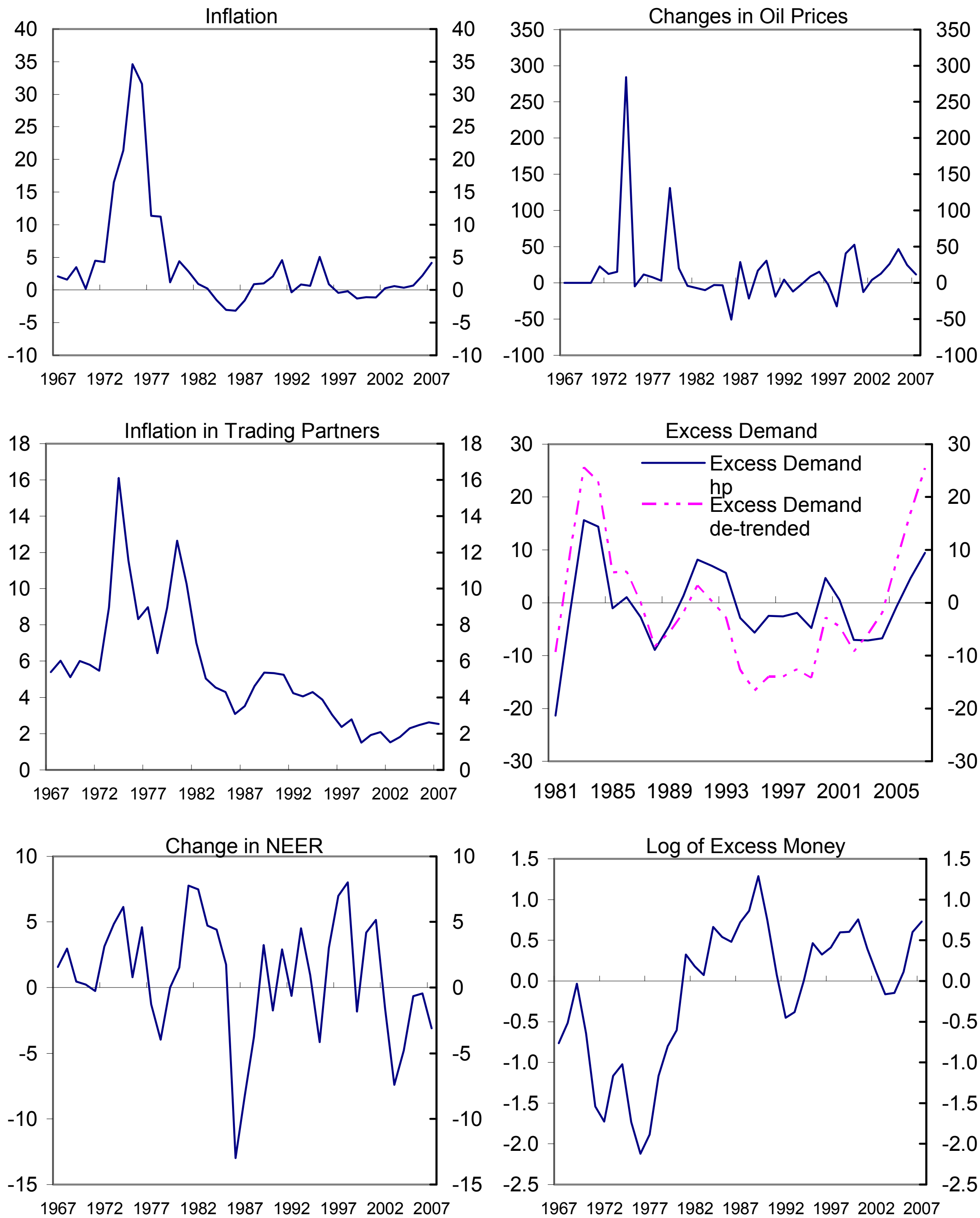
[17] Khan and Schimmelpfennig (2006) suggested using credit as a proxy for money supply. The use of the credit to GDP ratio produces weak model selection criteria.

stationary, it could be included in the short term dynamics[18]. Appendix 3 provides details for the estimation of excess money supply for Saudi Arabia and Kuwait.

As discussed in the previous section, the use of the real GDP or non-oil GDP to proxy demand shocks might provide a less accurate measure for excess demand given the large share of oil GDP and oil related activities in the non-oil GDP. Alternatively, we use a "demand gap" to assess demand shocks. The data for demand is available from 1981. While using demand would come at the cost of losing about 15 years of data, the gain from enhancing the accuracy is likely to be high. In addition, starting from 1981 would help avoid the period of the 1970s during which very high inflation might reflect data problems or structural breaks in the data generating process, given the significant stability in the price level since then. Moreover, the fact that the 1960s and 1970s witnessed different exchange systems (Bretton Woods) argues for avoiding a structural break in the relation between inflation and the NEER. Figure 4 shows the inflation in Saudi Arabia and its theoretical determinants. The co-movements of Saudi inflation and trading partners' inflation are clear from the figure. The figure also indicates that the volatility of the NEER is relatively high and that the recent level of domestic demand is significantly higher than its trend.

[18] Juselius (1992a) and Sekine (2001) used excess money supply in estimating the short term dynamic of inflation.

Figure 4. Saudi Arabia: Inflation and its Theoretical Determinants, 1967–2007 (in percent)



Sources: Country authorities; and Fund staff estimates.

Table 2 summarizes the cointegration test for Saudi Arabia and Kuwait. It indicates the existence of one cointegrating vector.[19] Table A1 (Appendix 1) summarizes the results from the ECM. It shows that the long run inflation equation could be written [20]

$$p = 2.4 - 0.194 \cdot neer + 0.833 \cdot p^{*} + 0.015 \cdot p^{oil} - 0.024 \cdot t$$

[-2.62] [3.46] [0.69]

Table 2. Cointegration Test for Inflation Equation 1/ 2/

	Null Hypothesize					
	r=0		r≤1		r≤2	
	Trace Stat. (95% C.V.)	Max Stat. (95% C.V.)	Trace Stat. (95% C.V.)	Max Stat. (95% C.V.)	Trace Stat. (95% C.V.)	Max Stat. (95% C.V.)
Saudi Arabia	68.73* (47.86)	45.76* (27.58)	22.97 (29.80)	14 (21.13)	8.98 (15.49)	8.89 (14.26)
Kuwait	74.72* (47.86)	45.91* (27.58)	28.81 (29.80)	18.63 (21.13)	10.19 (15.49)	9.18 (14.26)

1/ ECM in both countries has two lags. ECM is linear with interecept and no trend. Sample period for Saudi Arabia is 1966–2007 and for Kuwait 1974–2007. War dummy is introduced for Kuwait data.

2/ Asterisks * indicate rejection of the hypothesize at 95% C.V. Critical values in ( ).

[19] Cointegration tests for the period 1980–2007 indicate the existence of two cointegrating vectors at 5 percent significance level and one at a 1 percent significance level. These different results could be due to the fact that Eigenvalue and Trace statistics tests have tendency to over reject the null hypothesis due to small sample bias, i.e. suggest more cointegrating vectors as the sample size falls, or the number of variables or lags increases Gregory (1994).

[20] Numbers in [ ] are t-statistics.

While the short term inflation equation could be written as

$$\Delta p_t = -0.590 \cdot (p + 0.194 \cdot neer - 0.833 \cdot p^* - 0.015 \cdot p^{oil} - 2.4 + 0.024 \cdot time)_{t-1}$$

[-5.68] [2.62] [-3.46] [-0.69]

$$+ 0.025 \cdot Excd_{t-1} + 0.011 \cdot Excm_{t-1}$$

[0.66] [1.70]

$$- 0.43 \cdot \Delta p_{t-1} - 0.046 \cdot \Delta p_{t-2} - 0.077 \cdot \Delta neer_{t-1} + 0.05 \cdot \Delta neer_{t-2} + 2.20 \cdot \Delta p^*_{t-1} + 0.29 \cdot \Delta p^*_{t-2}$$

[-2.39] [-0.23] [-1.12] [0.66] [3.94] [0.41]

$$- 0.006 \cdot \Delta p^{oil}_{t-1} - 0.004 \cdot \Delta p^{oil}_{t-2} - 0.241 \cdot \Delta gdp_{t-1} - 0.25 \cdot \Delta gdp_{t-2} + 0.094 \cdot \Delta m_{t-1} + 0.153 \Delta m_{t-2}$$

[-0.49] [-0.29] [-2.89] [-3.39] [1.73] [1.82]

$$- 0.315 + 0.007 \cdot time$$

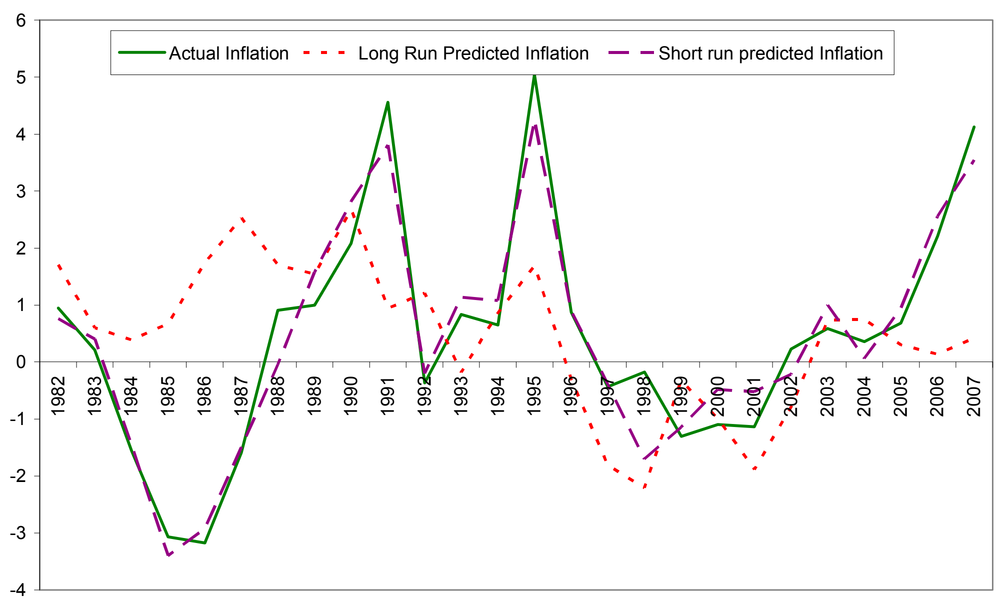
[-4.50] [4.22]

All variables are significant and have the expected signs, except oil prices and excess demand which are insignificant. The results indicate that the main driving force for inflation is trading partners' inflation. A one percent increase in trading partners' price level results in a 0.83 percent increase in the price level in Saudi Arabia. The impact of the second driving force, the pass-through effect, is relatively moderate. A one percent increase in the NEER (appreciation) results in a 0.19 percent decline in the price level in Saudi Arabia.
This moderate pass-through effect is consistent with the empirical evidence in other countries (see Mishkin 2008). For example, Gagnon and Ihrig (2004) estimated the pass-through effect for 20 industrial countries using data spanning from 1971 through 2003 and found that it ranged from 0.02 (Sweden) to 0.53 (Greece) and averaged 0.23. Campa and Goldberg (2006) found similar results for a different set of countries. The insignificance of oil prices could be due to the authorities' policy of pricing domestic refined oil products. During periods of low oil prices the authorities raise domestic refined oil products prices (reduce subsidies) to compensate for low oil exports. On the other hand, in 2006, while international oil prices were increasing, the authorities reduced domestic gasoline prices to help cope with the impact of the sharp correction in the stock market and as a way to share rising oil wealth[21].

[21] We also examined including commodity price index in the analysis but it did not yield significant results

The results also indicate that the speed of adjustment is relatively high.[22] It takes about 9 months to eliminate one-half of the deviation from long-run equilibrium. The results indicate that domestic factors play a relatively limited role in driving the inflation. In addition to excess money supply, lagged increases in money supply create inflationary pressures. The negative impact of growth in real GDP on inflation might reflect the impact of the increase in nontradable supply on inflation. While relative PPP implies the coefficients of *neer* (α_1) and p^* (α_2) to be -1 and 1, respectively, the results do not support the PPP assumptions and a test for the PPP hypothesis was strongly rejected (see table A.4 in Appendix 1). Figure 5 shows the long run and short run predicted inflation compared to the actual level of inflation. The model tracks actual inflation well. Diagnostic tests for the residuals suggest the absence of serial correlation and that the normality hypothesis is not rejected (see table A.4).

Figure 5. Saudi Arabia: Actual inflation and Predicted Long- and Short-Run Inflation



Sources: Authorities data; and Fund staff estimates.

Table 3 summarizes the results for alternative specifications and shows that the results related to trading partners' inflation and pass-through effect are robust to alternative specifications. These include removing the time trend from the model[23] (model 2), using real

[22] The speed of adjustment is the number of periods (years) required to reduce one-half of a deviation from the long-run equilibrium. It is calculated as log (0.5)/log(1+δ_1), see Rogoff (1996).

[23] The time trend was included to account for the possibility of a trend in the cointegration relationship. As figure 4 shows, the inflation in Saudi Arabia appears to be declining slightly faster than its trading partners. This might capture the impact of improved credibility due to the peg. Table 3 shows that including the time trend enhances the results. It also improves the cointegrating graph.

money instead of nominal money to estimate excess money supply (model 3), using de-trending instead of hp-filter to estimate excess demand (model 4), changing the period to 1966–2007 and 1968-2007 and using real GDP (models 5 and 6)[24] or real non-oil GDP (model 7) to proxy excess demand (output gap), and using the WPI[25] instead of the CPI (model 8). Models 2 and 4 indicate that excess demand is significant and that 1 percent excess demand increases inflation by 0.1 percent in the short run. Despite the small size of the excess demand coefficient, the large level of excess demand, induced by strong public and private spending, over the last few years has contributed to the recent inflationary pressures. As it is clear from figure 4, excess demand in 2007 was about 10 percent using hp-filter method and about 30 percent using de-trending method. This along with a monetary stance that is accommodative to money demand as determined by economic activities explains, in part, the recent inflationary trends. The relatively larger impact for trading partners' inflation during 1966–2007 period could be due to the high (exaggerated) inflation during the 1970s, which coincided with high inflation in trading partners. This might have inflated the impact of trading partners' inflation as indicated by the fact that the coefficient of p^* which is greater than one.[26] The results for the 1966–2007 period might also have been affected by the unavailability of demand data for that period and the use of a GDP-based output gaps instead.

[24] The results were also robust to shorter sub-samples.

[25] The results from WPI should be interpreted cautiously since WPI series is stationary. However, this could be due to the short time series.

[26] It is hard to explain why trading partners' inflation would have an impact that is higher than one in an open economy with a very low and stable tariff system.

Table 3. Comparing Alternative Models 1/

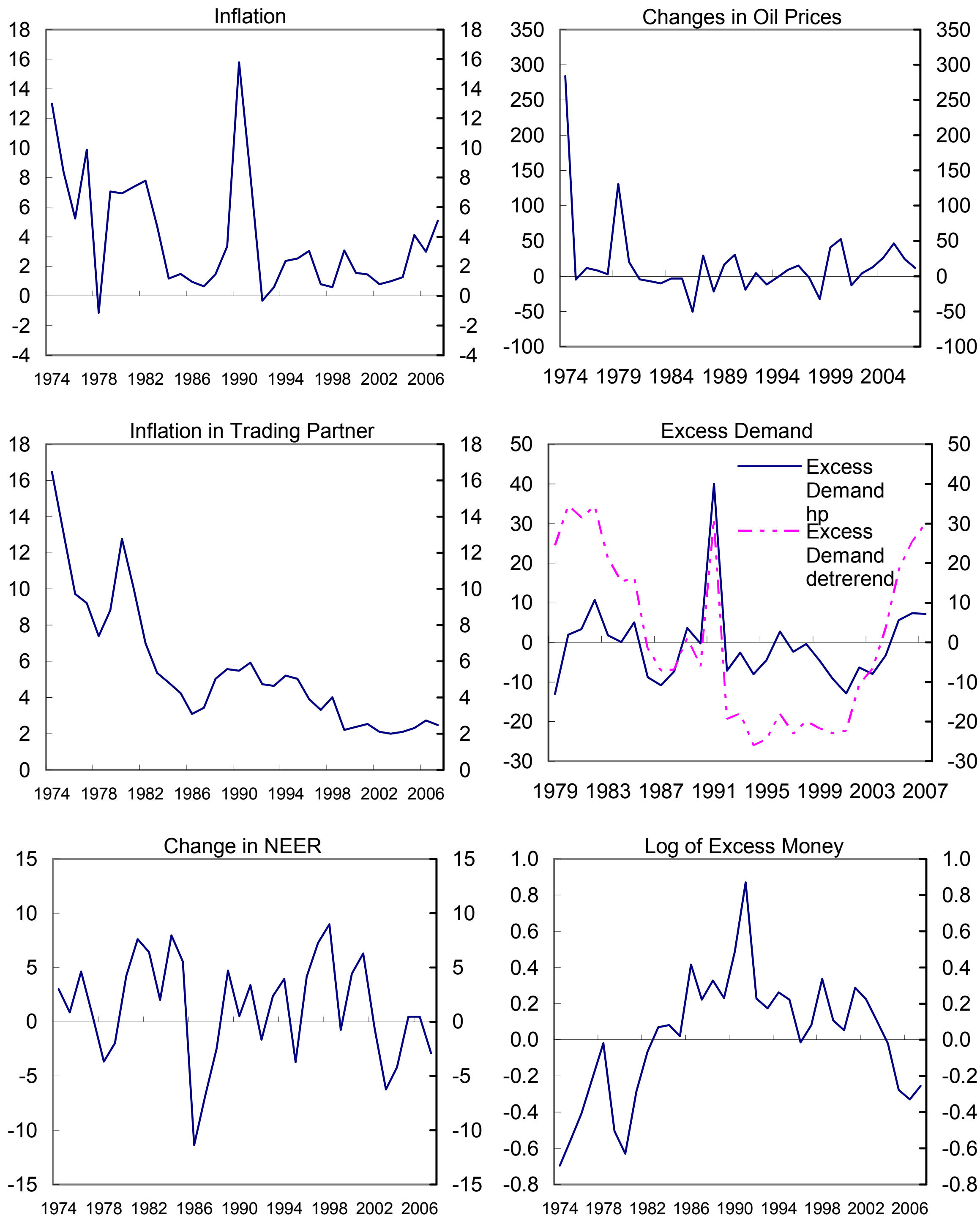
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Long Run Equation:								LWPI
p (-1)	1	1	1	1	1	1	1	1
neer (-1)	0.19350	0.19961	0.13332	0.13987	0.31658	0.24097	0.24149	0.15632
	[2.61963]	[2.25839]	[1.62643]	[1.34722]	[0.85267]	[1.00551]	[0.83079]	[4.57231]
p^* (-1)	-0.83295	-0.87421	-0.57863	-1.05107	-1.61082	-1.23633	-1.36629	-0.60067
	[-3.46133]	[-11.3910]	[-8.14562]	[-11.1059]	[-8.48956]	[-14.6809]	[-11.1491]	[-27.4123]
p^{oil} (-1)	-0.01519	0.04259	-0.03776	0.11116	0.30563	0.10008	0.24927	0.00890
	[-0.69371]	[1.85169]	[-2.42154]	[3.36565]	[3.64115]	[2.39244]	[3.53475]	[1.12484]
Time	*0.02437*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*
C	-2.452129	-1.782503	-2.529352	-0.951558	-0.119679	-0.730966	-0.612016	-2.600233
Adjustment Coefficient	-0.590394	-0.361197	-0.534635	-0.300281	-0.112342	-0.190323	-0.162462	-1.441352
	[-5.68420]	[-5.17454]	[-5.36155]	[-4.24144]	[-3.03323]	[-5.79043]	[-4.09513]	[-4.51772]
Short Run Dynamic:	D(*p*)	D(*p*)	D(*p*)	D(*p*)	D(*p*)	D(*p*)	D(*p*)	D(*p*)
C	-0.314956	-0.129049	-0.10126	-0.126769	-0.130668	-0.162296	-0.124083	-0.084913
	[-4.49995]	[-5.31386]	[-5.34172]	[-4.48097]	[-3.14471]	[-5.78769]	[-3.80184]	[-3.58535]
Time	*0.007442*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*
	[4.22018]							
	DHP	*DHP*	*DHP*	*DGAP*	*GDPHP*	*GDPHP*	*Non-oil GDPHP*	*DHP*
Excess Demand	0.025416	0.090185	0.042683	0.090918	-0.312685	-0.238264	-0.098587	-0.037301
	[0.66390]	[2.17321]	[1.20254]	[2.19200]	[-3.57515]	[-3.87781]	[-3.20756]	[-0.41593]
	Nominal		*Real*	*Nominal*		*Real*	*Nominal*	*Nominal*
Excess Money Supply	0.010846	0.013282	0.015311	0.01212	-0.009593	-0.002008	0.00843	-0.233302
	[1.69759]	[1.75175]	[1.64750]	[1.42205]	[-0.94785]	[-0.18736]	[0.84302]	[-1.83716]
Sample Period:	**1981–2007**	**1981–2007**	**1981–2007**	**1981–2007**	**1966–2007**	**1966–2007**	**1968–2007**	**1985–2007**
R-squared	0.927232	0.880717	0.877816	0.845329	0.9344	0.956001	0.949124	0.878525
Adj. R-squared	0.797867	0.701792	0.72231	0.613323	0.891617	0.927306	0.912124	0.779136
Sum sq. resids	0.00073	0.001196	0.001226	0.001551	0.01391	0.009329	0.010787	0.002588
F-statistic	7.167548	4.922273	5.644878	3.64356	21.84067	33.31586	25.65169	8.839259
Log likelihood	99.35656	92.93164	92.6193	89.55425	99.46681	107.2552	104.4235	64.71878
Akaike AIC	-6.33512	-5.917818	-5.970715	-5.658019	-4.280349	-4.679755	-4.483258	-5.211312
Schwarz SC	-5.512518	-5.143605	-5.24489	-4.883806	-3.597862	-3.997268	-3.758116	-4.713921

Sources: Authorities data; and Fund staff estimates.
1/ T-statistics in [ ].

D. Estimates of the inflation model (Kuwait)

As for Saudi Arabia, we use excess demand instead of a GDP-based output gap to proxy demand shocks. Data for demand are available from 1979. While using demand would come at the cost of losing about 5 years of observations, it is likely to enhance accuracy. Starting from 1979 would help avoid the problem arising from the splicing of the two CPI series in 1978. Given that money is I(2), we use only excess money with no lagged changes for money supply. Figure 6 shows the inflation in Kuwait and its theoretical determinants. As was the case for Saudi Arabia, the co-movements of Kuwait's inflation and trading partners' inflation are very clear. The relatively high inflation in 1990–91 reflects the impact of the invasion in 1990 and the war in 1991 and we will use a dummy variable to account for that. As was the case for Saudi Arabia, the figure shows relatively high excess demand in 2007.

Figure 6. Kuwait: Inflation and its Theoretical Determinants, 1974–2007 (in percent)



Sources: Country authorities; and Fund staff estimates.

Table A2 (appendix 1) summarizes the results from the ECM. All variables are significant and have the expected signs. From table A2 the long run inflation equation could be written as

$$p = 1.53 - \underset{[-2.42]}{0.15} \cdot neer + \underset{[50.89]}{0.78} \cdot p^{*} + \underset{[3.16]}{0.055} \cdot p^{oil}$$

while the short term inflation equation could be written as

$$\Delta p_t = \underset{[-5.31]}{-0.592} \cdot (p - 1.53 + \underset{[2.42]}{0.15} \cdot neer - \underset{[-50.89]}{0.78} \cdot p^{*} - \underset{[-3.16]}{0.055} \cdot p^{oil})_{t-1} + \underset{[3.04]}{0.10} \cdot Excd_{t-1} + \underset{[1.78]}{0.032} \cdot Excm_{t-1}$$

$$+ \underset{[1.03]}{0.203} \cdot \Delta p_{t-1} - \underset{[-1.53]}{0.204} \cdot \Delta p_{t-2} - \underset{[-0.23]}{0.012} \cdot \Delta neer_{t-1} - \underset{[-1.56]}{0.086} \cdot \Delta neer_{t-2} + \underset{[4.34]}{1.11} \cdot \Delta p^{*}_{t-1} + \underset{[0.42]}{0.12} \cdot \Delta p^{*}_{t-2}$$

$$+ \underset{[0.36]}{0.004} \cdot \Delta p^{oil}_{t-1} - \underset{[-0.75]}{0.009} \cdot \Delta p^{oil}_{t-2} + \underset{[2.85]}{0.067} \cdot \Delta gdp_{t-1} + \underset{[0.25]}{0.005} \cdot \Delta gdp_{t-2} - \underset{[-2.79]}{0.034} + \underset{[3.68]}{0.055} \cdot D$$

The results indicate that the main driving force for inflation is the trading partners' inflation followed by the pass-through effect. The size of the impact of trading partners' inflation and the pass-through effect is very close to that of Saudi Arabia, confirming the similarity between the two economies. The results also indicate that the speed of adjustment is relatively high and close to that of Saudi Arabia. Both excess demand and excess money supply are significant. Demand that exceeds the long run (trend) level by 1 percent increases inflation by 0.1 percent in the short run. Similarly money supply in excess of equilibrium money demand by 1 percent increases inflation by 0.03 percent in the short run. Given the recent increase in domestic demand, the model suggests that part of the inflation in the last few years was driven by strong domestic demand. Figure 7 shows the long run and the short run predicted inflation compared to the actual level of inflation. The model tracks the inflation path very well.

Table 4 summarizes the results from alternative specifications including using real money instead of nominal money to estimate excess money supply (model 2),[27] using de-trending instead of hp-filter (model 3), changing the period to 1974–2007 (models 4) and using WPI instead of CPI. The results are quite robust to these different specifications. Using de-trending produces slightly better results. Adding 1974–78 observations to the sample and

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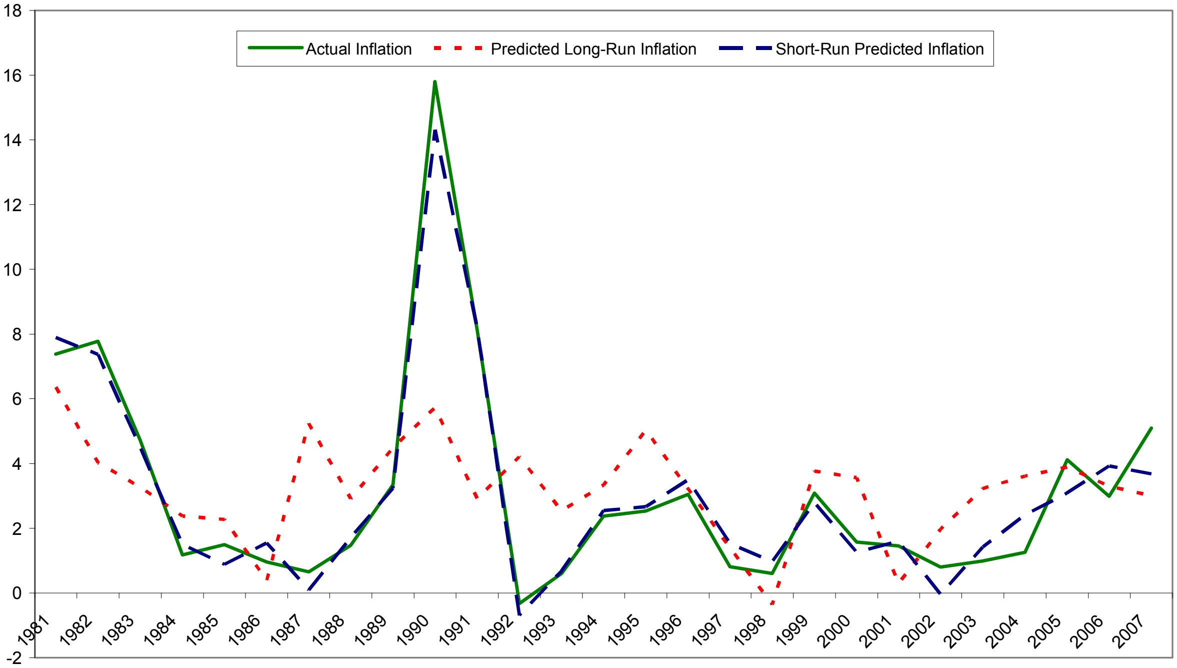
[27] Given that real money supply is I(1), changes in real money supply were included in this model to ensure comparability with the model for Saudi Arabia. However, the results are not sensitive to that.

using WPI inflation in 1978 to address the problem of linking the two CPI series[28] does not alter the results, but produces less favorable results as indicated by model selection criteria. Oil prices variable is insignificant in the WPI model and model selection criteria suggest removing it. As it was the case for Saudi Arabia the PPP assumption was strongly rejected based on log likelihood ratio test.

Figure 7. Kuwait: Actual Inflation and the Predicted Long-run and Short-run Inflation



Sources: Authorities data; and Fund staff estimates.

[28] This is done by using the inflation rate implied by the WPI index to calculate the CPI index for 1977. The CPI index for 1974–76 was obtained by using the inflation rate implied by the pre 1978 CPI series.

Table 4. Kuwait: Comparing Alternative Models 1/

	Model 1	Model 2	Model 3	Model 4	Model 5
Long Run Equation:					LWPI
p (-1)	1	1	1	1	1
neer (-1)	0.151403	0.160207	0.207545	0.123418	0.186421
	[2.41881]	[4.62188]	[3.47078]	[1.86502]	[1.62223]
p^* (-1)	-0.784288	-0.750785	-0.829833	-0.801091	-0.933541
	[-50.8870]	[-89.1691]	[-52.6992]	[-47.3708]	[-23.8789]
p^{oil} (-1)	-0.054615	-0.017295	-0.007039	-0.010434	NO
	[-3.16361]	[-3.11569]	[-0.30785]	[-0.93785]	
C	-1.534589	-1.83293	-1.736302	-1.489011	-1.28461
Adjustment Coefficient	-0.592508	-0.733497	-0.600839	-0.413733	-0.26666
	[-5.31008]	[-3.42920]	[-7.92281]	[-2.34475]	[-1.95805]
Short Run Dynamic:	D(*p*)	D(*p*)	D(*p*)	D(*p*)	D(*p*)
C	-0.033611	-0.028934	-0.033677	-0.021166	-0.043346
	[-2.78949]	[-2.40911]	[-4.01593]	[-0.92413]	[-1.27569]
WAR Dummy	0.055218	0.057169	0.058059	0.099228	0.099508
	[3.67973]	[3.22344]	[5.42865]	[3.58267]	[3.07772]
	DHP	*DHP*	*DGAP*	*GDPHP*	*DGAP*
Excess Demand	0.101456	0.129361	0.101061	0.003895	0.040121
	[3.03783]	[3.71021]	[6.66722]	[0.05986]	[1.03893]
	Nominal	*Real*	*Nominal*	*Nominal*	*Nominal*
Excess Money Supply	0.031926	0.041703	0.043225	-0.031954	0.022236
	[1.78252]	[1.37302]	[2.89778]	[-1.25552]	[0.72608]
Sample period	**1979–2007**	**1981–2007**	**1979–2007**	**1974–2007**	**1979–2007**
R-squared	0.962193	0.97145	0.978899	0.851911	0.808743
Adj. R-squared	0.921477	0.92577	0.956175	0.729956	0.655738
Sum sq. resids	0.001057	0.00076	0.00059	0.005229	0.007373
F-statistic	23.63201	21.26634	43.07723	6.985425	5.285712
Log likelihood	102.8564	103.1332	111.0209	94.10228	75.66013
Akaike AIC	-6.275455	-6.380238	-6.858634	-4.943893	-4.475724
Schwarz SC	-5.561774	-5.564341	-6.144953	-4.256829	-3.8572

1/ T-statistics in [ ].

Sources: Authorities data; and staff estimates.

While the results for Saudi Arabia and Kuwait are consistent with the assumption that external factors are the main driving forces for inflation in the two countries, one could ask why the impact of the pass-through effect is relatively moderate and significantly smaller than trading partners' inflation.[29] This could be due to the fact that while changes in the price level of trading partners are usually permanent,[30] changes in exchange rates are not. Hence, exporters, aiming at protecting their market share in the Saudi and Kuwaiti markets, might be willing to absorb part of the exchange rate impact by adjusting their profit mark-ups "price to market" instead of raising prices as they believe that exchange rate changes are transitory. Similarly importers in Saudi Arabia and Kuwait, who exert some monopolistic power due to agency laws, and retailer, might also adjust their profit mark-ups to preserve their market share[31] since today's market share determines tomorrows' profits. In addition, competition induced by globalization along with stable and low global inflation enhances the scope for containing the impact of changes in the exchange rate through substitutions. Cross-border production (production happens in several stages in a number of different countries) limits the pass-through impact on the final products. Moreover, subsidies especially for basic commodities in Saudi Arabia and Kuwait, which are particularly affected by changes in exchange rates, limit the impact of the pass-through effect.[32] The fact that a large part of the Saudi and Kuwaiti labor market participants are government employees, along with the stickiness of private sector wages, at least in the short run, suggests that changes in the NEER would have large income effects that have an opposite effect on the price of nontradables. For example, an appreciation of the NEER would reduce import prices and hence the CPI tradables components, but will allow consumers with a given riyal or dinar budget to spend more on both tradables and nontradables which would push the prices of the latter. The increase in nontradables prices would offset part of the decrease in the CPI due to the NEER appreciation and hence limits the pass-through effect. Finally, many economists (e.g. Mishkin (2008), John Taylor (2000)) have argued that the establishment of a strong nominal anchor in many countries in recent years has created a stable and predictable monetary policy environment. This has reduced the sensitivity of domestic prices to nominal shocks and led to the very low and declining pass-through of exchange rate to inflation (Box 1).

The relatively strong trading partners' inflation impact is consistent with recent empirical evidence. For example, Wang and Wen (2007) examined a sample of 18 OECD countries and found that the cross-country correlation of inflation averaged 0.57. The correlation was

[29] The restriction of equal NEER and trading partners' inflation coefficients ($\alpha_1 = -\alpha_2$) was rejected based on log likelihood ratio test for the two countries.

[30] With the exception of Japan, inflation in trading partners was always positive.

[31] Several studies have pointed out that distribution costs make up an important component of the retail price of imported goods (Burstein, Neves, and Rebelo, 2003; Campa and Goldberg, 2005).

[32] While subsidizing tradable commodities limits the pass-though effect, it has a fiscal cost, could create market distortion, and may encourage wasteful consumption.

even higher for a G7 sample with an average of 0.62 (the minimum value is 0.26 (between Germany and the U.S.), the maximum is 0.92 (between France and Italy)).[33] They also found that country pairs with higher cross-country correlations in inflation also tend to have higher correlations in output. Vigfusson et. al. (2007) examined the exchange rate and inflation[34] pass-through to export prices and found that 1 percent change in the NEER (of the exporting countries) leads to 0.26, 0.24, 0.47 and 0.16 percent changes in the exports prices for the European Union, Japan, Asia NIEs and the U.S., respectively, while 1 percent change in the producer price index leads to 0.75, 0.35, 1.01 and 0.72 percent changes in the exports prices for the European Union, Japan, Asia NIEs and the U.S., respectively.

[33] They used quarterly data spanned from 1950s' to 2004.

[34] Using producer price index.

Box I. Empirical Evidence on Exchange Rate Pass-through

There is strong empirical evidence, from case studies of highly open economies, of weak and declining pass-through effect (Mishkin 2008). (See for example Lafleche, 1996/1997; Cunningham and Haldane, 2000; Gagnon, 2004; Burnstein, Eichenbaum, and Rebelo, 2007). For example, recent empirical analysis by the Hong Kong Monetary Authority indicates that the long run exchange rate pass-through in Hong Kong, which shares with Saudi Arabia and Kuwait the openness of the economy and the exchange rate regime, is about 0.2 (Yam 2008). After Sweden and the United Kingdom's withdrawal from the Exchange Rate Mechanism of the European Monetary System in September 1992, both countries experienced low inflation despite large depreciation in their currencies. The U.S. dollar NEER has depreciated by more than 30 percent since 2002 but the inflation has remained low during the same period. The riyal NEER appreciated by an annual average of 3.9 percent during 1972-76 period while inflation averaged 21.7 percent. In 2002, 2003 and 2004, the riyal NEER depreciated by 2, 7 and 5 percent respectively, while inflation was 0.2, 0.6 and 0.4 percent respectively.

Episodes of a strong correlation between currency depreciation and high inflation have been associated with unstable and weak nominal anchors. For example, until the past decade, several Latin American countries faced a combination of chronically high inflation and exchange rate depreciation (Mishkin 2008) [1]. Following the breakup of the Bretton Woods System, Sweden's currency depreciated by an average of 5 percent per year between 1973 and 1985 against the deutsche mark, and its annual inflation rate was on the order of 4 percentage points higher than German inflation over the same period.

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[1] For example, the Mexican peso depreciated by an average of 31 percent per year against the dollar between 1977 and 1995, while the Mexican inflation rate averaged about 30 percent per year higher than the U.S. inflation rate.

V. Conclusions

Both foreign and domestic factors influence the inflationary processes in Saudi Arabia and Kuwait. External factors play a dominant role given the dependence of the Saudi and Kuwaiti economies on imports and foreign labor to meet domestic demand of tradables and nontradables. In the long run, the main driving force for inflation in Saudi Arabia and Kuwait is trading partners' inflation. Recent inflationary pressures have been largely driven by rising trading partners' inflation. The experience of the last two decades provides indication that this would be a temporary deviation, reflecting supply constraints in food and other commodities. The slide of the U.S. dollar and the rapidly rising domestic demand in Saudi Arabia and Kuwait since 2003, and to a lesser extent the expansionary monetary stance imported from the U.S. through the dollar peg have also contributed to the recent inflationary pressures.

Given that the authorities have no control over trading partners' inflation, the limited pass-through effect, and projected global oil prices, containing inflationary pressures under the peg regime would have to be based on containing domestic demand and addressing nontradable supply bottlenecks, especially in the real estate sector. Containing inflation through expanding the subsidy system has to be balanced with the fiscal and efficiency cost of subsidies. In any case such domestic factors should play only a temporary role. Similarly, the slide in the U.S. dollar is unlikely to become a permanent fixture. The experience of the last four decades indicates that changes in the NEER have centered around zero in the long run (see Figure 4).

The similarity between the inflationary processes in Saudi Arabia and Kuwait suggests that the cost associated with the planned monetary union would be limited. The other four GCC countries share with Saudi Arabia and Kuwait the dependence on imports and foreign labor to meet domestic demand and have similar trading partners weights (see table A3 in Appendix 1). In addition, domestic demand in all GCC countries depends highly on government spending from oil revenues. Changes in oil prices and revenues and other global or regional shocks are likely to have on average similar impact on domestic demand given the similarity between these countries, including in the government spending response to higher revenues. Similarly, the impact on investors and consumers' confidence is likely to be similar.

REFERENCES

Al-Mutairi, Naief, 1995, "Examining the causes of inflation in Kuwait: an application of a vector autoregression model", OPEC Review.

Al Raisi, Ali, and Sitikantha Pattanaik, 2003, "Pass-Through of Exchange Rate Changes to Domestic Prices in Oman," Central Bank of Oman Occasional Paper No. 2005–1.

Burstein, Ariel, Joao Neves, and Sergio Rebelo, 2003, "Distribution Costs and Real Exchange Rate Dynamics during Exchange-Rate-Based Stabilizations." *Journal of Monetary Economics* 50 (September) pp. 1189-1214.

Burstein, Ariel, Martin Eichenbaum, and Sergio Rebelo, 2007, "Modeling Exchange Rate Pass-through after Large Devaluations," *Journal of Monetary Economics*, Vol. 54 (March), pp. 346–68.

Campa, José Manuel, and Linda Goldberg, 2005, "Exchange Rate Pass-through into Import Prices," *Review of Economics and Statistics*, Vol. 87 (November), pp. 679–90.

Campa, José Manuel, and Linda Goldberg, 2006, "Distribution Margins, Imported Inputs, and the Insensitivity of the CPI to Exchange Rates" *Federal Reserve Bank of New York*.

Cunningham, Alastair, and Andrew Haldane, 2000, "The Monetary Transmission Mechanism in the United Kingdom: Pass-Through and Policy Rules", Central Bank of Chile Working Paper No. 83. Santiago: Central Bank of Chile.

Darrat, Ali, 1985, "The Monetary Explanation of Inflation: The Experience of three Major OPEC Economies," *Journal of Economics and Business*, Vol. 37, pp. 209–21.

De Brouwer, Gordon and Neil Ericsson, 1998, "Modeling Inflation in Australia," *Journal of Business and Economic Statistics*, Vol. 16, pp. 433–49.

Diouf, Astou, 2007, " Modeling Inflation for Mali," IMF Working Paper 07/295 (Washington: International Monetary Fund).

Gagnon, Joseph , and Jane Ihrig, 2004, "Monetary Policy and Exchange Rate Pass-through," *International Journal of Finance and Economics*, Vol. 9 (October), pp. 315–38.

Gregory, Allan, 1994, "Testing for cointegration in linear quadratic models". *Journal of Business and Economic Statistics* 4: pp. 347–360.

Juselius, Katarina, 1992, "On the Empirical Verification of the Purchasing Power Parity and the Uncovered Interest Rate Parity". *Nationaløkonomisk tidskrift*, 130, pp. 57–66.

Juselius, Katarina, 1992a, "Domestic and Foreign Effects on Prices in an Open Economy: The Case of Denmark," *Journal of Policy Modeling*, Vol. 14, pp. 401–28.

Juselius, Katarina, 1994, "On the Duality Between Long-Run Relations and Common trends in the I(1) versus I(2) Model: An Application to Aggregate Money Holding," *Econometric Reviews*, Vol. 13(2), pp. 151–78.

Keran, Michael and Ahmed Al Malik, 1979,"Monetry Sources of Inflation In Saudi Arabia," Federal Reserve Bank of San Francisco Economic Review, San Francisco.

Khan, Mohsin and Axel Schimmelpfennig, 2006, "Inflation in Pakistan: Money or Wheat?," IMF Working Paper 06/60 (Washington: International Monetary Fund).

Laflèche, Thérèse, 1996/1997, "The Impact of Exchange Rate Movements on Consumer Prices", Bank of Canada Review (Winter), pp. 21–32.

Lim, Cheng Hoon, and Laura Papi , 1997, " An Econometric Analysis of the Determinants of Inflation in Turkey," IMF Working Paper 97/170 (Washington: International Monetary Fund).

Leo, Bonato, 2007, "Money and Inflation in the Islamic Republic of Iran," IMF Working Papers 07/119, International Monetary Fund.

Mishkin, Frederic, 2008, "Exchange rate pass-through and monetary policy", At the Norges Bank (Central Bank of Norway) Conference on Monetary Policy "Jarle Bergo Colloquium: Globalization and Monetary Policy", Oslo.

Rogoff, Kenneth, 1996, "The Purchasing Power Parity Puzzle**",** *Journal of Economic Literature*, Vol. 34, No. 2 (June), pp. 647–668 .

Skine, Toshitaka, 2001, "Modeling and Forecasting Inflation in Japan," IMF Working Paper 01/82 (Washington: International Monetary Fund).

Taylor, John, 2000, "Low inflation, pass-through, and the pricing power of firms", European Economic Review Volume 44, Issue 7, June 2000, pp. 1389–1408.

Urzua, Carlos, 1996, "On the correct use of omnibus tests for normality". Economics Letters 53, pp. 247–251.

Vigfusson, Robert, Nathan Sheets, and Joseph Gagnon, 2007, "Exchange Rate Pass-Through to Export Prices: Assessing Some Cross-Country Evidence", International Finance Discussion Papers, Board of Governors of the Federal Reserve System.

Wang, Pengfei and Yi Wen, 2007, “Inflation dynamics: A cross-country investigation”, Journal of Monetary Economics. Vol. 54, Issue 7, pp. 2004–31.

Yam, Joseph, 2008, “Exchange rate pass-through to domestic inflation,” Viewpoint (April), Hong Kong Monetary Authority.

Appendix 1. Detailed ECM Results

Table A1. Saudi Arabia: Vector Error Correction Estimates 1/

Long Run Equation:				
p (-1)	1			
neer (-1)	0.193503 [2.61963]			
*p** (-1)	-0.83295 [-3.46133]			
p^{oil} (-1)	-0.015192 [-0.69371]			
t	0.02437			
C	-2.452129			
Adjustment coefficient	-0.590394 [-5.68420]	-0.29976 [-0.59112]	-0.146682 [-2.81524]	-0.352519 [-0.11693]
Short Run Dynamic:	D(*p*)	D(*neer*)	D(*p**)	D(p^{oil})
D(*p* (-1))	-0.426935 [-2.38712]	0.674566 [0.77253]	-0.057502 [-0.64092]	0.047198 [0.00909]
D(*p* (-2))	-0.046071 [-0.22511]	-0.400145 [-0.40046]	-0.121144 [-1.17998]	0.097514 [0.01642]
D(*neer* (-1))	-0.076536 [-1.12178]	0.82224 [2.46841]	0.02256 [0.65915]	-0.684718 [-0.34576]
D(*neer* (-2))	0.052052 [0.65559]	-0.708183 [-1.82691]	-0.026664 [-0.66946]	-1.242781 [-0.53928]
D(*p** (-1))	2.19899 [3.94399]	-7.487908 [-2.75075]	0.579738 [2.07279]	9.679396 [0.59811]
D(*p** (-2))	0.288106 [0.41400]	8.000537 [2.35473]	0.133669 [0.38290]	10.15454 [0.50272]
D(p^{oil} (-1))	-0.006189 [-0.49728]	0.017723 [0.29167]	0.004724 [0.75672]	-0.769907 [-2.13129]
D(p^{oil} (-2))	-0.004191 [-0.28875]	-0.041379 [-0.58389]	-0.006129 [-0.84170]	-0.76952 [-1.82648]
C	-0.314956 [-4.49995]	-0.179664 [-0.52577]	-0.003172 [-0.09034]	-3.125865 [-1.53869]
t	0.007442 [4.22018]	0.00467 [0.54243]	0.000153 [0.17247]	0.082024 [1.60253]
DHP(-1)	0.025416 [0.66390]	0.029103 [0.15571]	0.011968 [0.62322]	0.890744 [0.80164]
EXCM(-1)	0.010846 [1.69759]	0.027831 [0.89226]	0.00017 [0.05304]	0.262364 [1.41484]
D(LRGDP(-1)) 2/	-0.241897 [-2.88765]	0.688252 [1.68282]	0.022634 [0.53862]	0.475622 [0.19561]
D(LRGDP(-2))	-0.254532 [-3.38752]	-0.457277 [-1.24651]	-0.066389 [-1.76136]	-2.189804 [-1.00408]
D(LNM3(-2)) 3/	0.093719 [1.73405]	0.183189 [0.69425]	0.044988 [1.65936]	0.182607 [0.11641]
D(LNM3(-1))	0.153114 [1.81560]	-0.346162 [-0.84074]	0.050919 [1.20363]	0.118933 [0.04859]
R-squared	0.927232	0.749014	0.961036	0.604763
Adj. R-squared	0.797867	0.302816	0.891767	-0.097879
Sum sq. resids	0.00073	0.017398	0.000184	0.614927
S.E. equation	0.009006	0.043968	0.004518	0.261391
F-statistic	7.167548	1.678657	13.87399	0.860698
Log likelihood	99.35656	58.13069	117.2935	11.78413
Akaike AIC	-6.33512	-3.163899	-7.714882	0.401221
Schwarz SC	-5.512518	-2.341298	-6.892281	1.223822
Mean dependent	0.004174	0.001005	0.034478	0.026637
S.D. dependent	0.020031	0.052658	0.013732	0.249467

Sources: Authorities data and Fund staff estimates.
1/ Sample 1980–2007, t-statistics in [ ].
2/ Log of real GDP.
3/ Log of money supply.

Table A2. Kuwait: Vector Error Correction Estimates 1/

Long Run Equation:				
p (-1)	1			
neer (-1)	0.151403			
	[2.41881]			
*p** (-1)	-0.784288			
	[-50.8870]			
p^{oil} (-1)	-0.054615			
	[-3.16361]			
C	-1.534589			
Adjustment coefficient	-0.592508	-0.003937	0.241539	-7.56748
	[-5.31008]	[-0.00615]	[2.43666]	[-2.35899]
Short Run Dynamic:	D(*p*)	D(*neer*)	D(*p**)	D(p^{oil})
D(*p* (-1))	0.20304	-0.01742	0.086511	7.442559
	[1.03025]	[-0.01540]	[0.49412]	[1.31356]
D(*p* (-2))	-0.203842	0.625303	-0.19929	-2.306084
	[-1.53019]	[0.81789]	[-1.68398]	[-0.60213]
D(*neer* (-1))	-0.011773	0.34038	-0.03549	-1.255112
	[-0.22909]	[1.15404]	[-0.77735]	[-0.84948]
D(*neer* (-2))	0.086135	-0.392767	-0.104462	2.085534
	[1.55784]	[-1.23775]	[-2.12668]	[1.31199]
D(*p** (-1))	1.114126	-1.159752	0.847367	12.18812
	[4.33977]	[-0.78714]	[3.71539]	[1.65134]
D(*p** (-2))	0.122405	1.927071	-0.195959	-5.347953
	[0.41933]	[1.15029]	[-0.75566]	[-0.63726]
D(p^{oil} (-1))	0.004699	0.053402	0.008163	-0.014246
	[0.35529]	[0.70351]	[0.69476]	[-0.03747]
D(p^{oil} (-2))	-0.00907	0.058972	1.93E-05	-0.158032
	[-0.74859]	[0.84811]	[0.00180]	[-0.45369]
C	-0.033611	-0.056639	0.019985	-0.491584
	[-2.78949]	[-0.81907]	[1.86708]	[-1.41911]
DHP(-1)	0.101456	-0.258983	-0.01857	1.12096
	[3.03783]	[-1.35118]	[-0.62588]	[1.16747]
EXCM1(-1)	0.031926	0.037905	-0.014121	0.914035
	[1.78252]	[0.36876]	[-0.88745]	[1.77507]
D(LRGDP(-1))	0.067182	0.018313	-0.001365	1.199911
	[2.85357]	[0.13554]	[-0.06527]	[1.77278]
D(LRGDP(-2))	0.004569	0.029962	-0.01822	-0.002355
	[0.25304]	[0.28914]	[-1.13584]	[-0.00454]
WAR	0.055218	0.00219	0.002993	-0.747305
	[3.67973]	[0.02543]	[0.22451]	[-1.73220]
R-squared	0.962193	0.49619	0.940851	0.449072
Adj. R-squared	0.921477	-0.046375	0.877152	-0.144234
Sum sq. resids	0.001057	0.034807	0.000834	0.873449
S.E. equation	0.009016	0.051744	0.00801	0.259207
F-statistic	23.63201	0.914526	14.77027	0.756898
Log likelihood	102.8564	53.93167	106.1703	8.814861
Akaike AIC	-6.275455	-2.780833	-6.512163	0.441796
Schwarz SC	-5.561774	-2.067152	-5.798482	1.155477
Mean dependent	0.031397	0.012984	0.043245	0.02973
S.D. dependent	0.032175	0.050585	0.022852	0.24232

Sources: Authorities data; and Fund staff estimates.
1/ Sample 1979-2007, t-statistics in [ ].

Table A3. GCC: Selected Trading Partner Weights

	Saudi Arabia	Kuwait	Qatar	U.A.E.	Bahrain	Oman
United States	20.2	14.4	15.3	11.8	23.3	13.7
Japan	12.8	14.4	11.8	8.4	8.8	14.6
Germany	8.4	10.2	8.9	7.8	8.5	7.1
United Kingdom	7.6	7.2	9.0	9.2	7.2	8.3
China	6.2	5.6	3.9	5.5	4.9	3.2
Italy	5.7	7.3	7.7	5.3	5.5	4.3
Korea	4.7	3.6	5.5	4.7	3.5	3.6
France	4.5	4.9	7.2	6.5	7.6	4.9

Source: INS.

Table A4. PPP Assumption and Residual Tests

	Saudi Arabia			Kuwait		
1- PPP Assumption (LR test)	Chi-square Statistic	P-value	Conclusion	Chi-square Statistic	P-value	Conclusion
Null hypothesis: PPP holds	6.93	0.0313	Reject the null	28.21	0.0000	Reject the null
2- Residual Serial Correlation LM Tests						
Null Hypothesis: no serial correlation at lag order h						
Lags	LM-Statistic	P-value	Conclusion	LM-Stat	P-value	Conclusion
1	20.39251	0.2031	Fail to reject the null	26.03687	0.0535	Fail to reject the null
2	16.21565	0.438	Fail to reject the null	19.45255	0.2459	Fail to reject the null
3	16.05634	0.449	Fail to reject the null	10.70245	0.8275	Fail to reject the null
3- Normality Test joint (Jarque-Bera) 1/						
Null Hypothesis: residuals are multivariate normal	Chi-square Statistic	P-value	Conclusion	Chi-square Statistic	P-value	Conclusion
	62.65	0.223	Fail to reject the null	55.1877	0.4675	Fail to reject the null

1/ The residual normality test is the multivariate extension of the Jarque-Bera normality test, which compares the third and fourth moments of the residuals to those from the normal distribution. We use the method for the test suggested by Urzua (1996).

Appendix 2. Calculating Demand Gap Series

Demand or output gap is usually included to capture the effect on inflation of deviation of demand (output) from potential. The potential output can be estimated by either a trend or by a Hodrick-Prescott filter. The calculation of each method is as follow:

1. De-trending:

A series X can be de-trended by running a regression of X on a constant and time i.e. X is assumed to grow at constant rate equal to the coefficient of time variable. The predicted X, $\hat{X}$, is then subtracted from the actual X to get the deviation from it's long run growth. That is:

$$\begin{aligned} X &= \beta_1 + \beta_2 * time \\ Gap_{\det rend} &= \log(X) - \log(\hat{X}) \end{aligned} \qquad \text{(A2.1)}$$

2. HP-Filter:

This method was developed by Hodrick-Prescott using the exponential smoothing of the series. The gap is then measured by subtracting the smoothed series from the actual which measure the cyclical component of the series. That is:

$$Gap_{HP} = \log(X) - \log(\hat{X}^s) \qquad \text{(A2.2)}$$

where $\hat{X}^s$ is the predicted series using exponential smoothing.

Appendix 3. Money Demand Equation and Excess Money Supply

This appendix presents the estimation of money demand equation and how excess money is constructed. Table A5 shows the cointegration test using the nominal money supply, real GDP, GDP deflator, and interest rate. It shows that the null of no cointegration is strongly rejected in favor of at least one cointegration relationship for Kuwait data. Trace test indicates that there might be two integrated relationship while max test indicates that it is only one cointegration. For Saudi, the trace test rejects the null that there is no cointegration. However, the maximum eigenvalue test indicates that there is no cointegration relationship but the test statistics are really close and can be rejected at 1 percent significance level. Testing for more than one cointegration is highly rejected in both tests.

Table A5 also shows the standardized eigenvectors and adjustment coefficients for both Saudi and Kuwait. The estimated cointegrating vector for money demand in nominal terms is given in the standardized eigenvectors shown in the table, that is:

$$\begin{array}{llr} \textit{Saudi}: & m = 19.64 - .12 * t + 3.814 * gdp + 1.10 * p - 23.221 * r & \\ & \qquad\qquad\qquad\quad [4.55] \qquad [1.92] \qquad [-4.70] & \text{(A3.1)} \\ \textit{Kuwait}: & m = -6.96 + 0.768 * gdp + 1.553 * p - 0.354 * r & \\ & \qquad\qquad\quad [4.55] \qquad [13.23] \qquad [-0.22] & \end{array}$$

Given the money demand equation, the excess money supply then could be estimated as, $excm = m - \hat{m}$ where m is the nominal money supply and $\hat{m}$ is the estimated money demand from equation (A3.1). Another way to estimate the money demand that overcome the I(2) problem in Kuwait data is to use real money supply (see Juselius (1994)). Using real money will result in the following long run real money demand function:

$$\begin{array}{llr} \textit{Saudi}: & rm = -11.70 - 0.094 \cdot time + 3.20 * gdp - 17.30 * r & \\ & \qquad\qquad\quad [-3.51] \qquad\quad [7.49] \qquad [-3.51] & \\ \textit{Kuwait}: & rm = -3.31 + .406 * gdp - 4.66 * r & \text{(A3.2)} \\ & \qquad\qquad\quad [2.00] \qquad [-2.31] & \end{array}$$

Where *rm* is the money supply in real term. Excess money supply is then equal to real money supply minus the estimated real money demand. The estimated excess money supply based on nominal or real money supply suffers from the noise introduced by the oil GDP. It is likely that the money demand function is more stable with non-oil GDP. However, the unavailability of data restricts using it. Hence, the money demand function provides only a proxy for the excess money supply.

Table A5. Cointegration Test for Money Demand Equation 1/

	Null Hypothesize					
	r=0		r≤1		r≤2	
	Trace Stat. (95% C.V.)	Max Stat. (95% C.V.)	Trace Stat. (95% C.V.)	Max Stat. (95% C.V.)	Trace Stat. (95% C.V.)	Max Stat. (95% C.V.)
Saudi Arabia	71.83*	31.00	40.84	18.41	22.43	17.05
	(63.88)	(32.12)	(42.92)	(25.82)	(25.87)	(19.39)
Kuwait	62.73*	31.74*	31.00*	20.50	10.50	10.28
	(47.86)	(27.58)	(29.80)	(21.13)	(15.49)	(14.26)

Saudi Arabia

Standardized eigenvectors					Standardized adjustment Coefficients:				
Var	m	gdp	p	r	Equ.				
	1.000	-3.814	-1.100	23.221	m	-0.048	0.059	-0.053	-0.450
	0.191	1.000	-1.059	3.974	gdp	0.024	-0.006	0.032	-0.321
	1.215	-3.050	1.000	-22.944	p	-0.054	0.403	0.023	0.021
	0.046	-0.077	0.080	1.000	r	-0.030	-0.010	0.015	-0.032

Kuwait

Standardized eigenvectors					Standardized adjustment Coefficients:				
Var	m	gdp	p	r	Equ.				
	1.000	-0.768	-1.553	0.354	m	-0.155	0.025	0.000	0.001
	2.166	1.000	-6.871	0.215	gdp	0.198	0.022	0.005	0.029
	-0.458	-0.261	1.000	-7.080	p	0.132	0.068	-0.003	-0.001
	0.130	-0.379	-0.394	1.000	r	0.005	0.006	0.000	-0.009

1/ Sample size from 1966–2007 for Saudi Arabia while it is from 1974–2007 for Kuwait. The vector auto regression has 2 lags on each variable for Saudi Arabia while it has 1 lag for Kuwait which is based on SIC criteria. ECM has an intercept for both countries and a trend in the case of Saudi Arabia. War dummy variable is introduced for Kuwait. A break from 1966–1980 is introduced for Saudi Arabia. Asterisks * indicate rejection of the hypothesize at 95% C.V.