INTERNATIONAL MONETARY FUND

Inflation Dynamics in the Gulf Cooperation Council (GCC): What is the Role of External Factors?

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WP/23/263

2023
DEC

WORKING PAPER

 WP/23/263

IMF Working Paper
Middle East and Central Asia Department

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Authorized for distribution by Ali Al-Eyd
December 2023

ABSTRACT: Inflationary pressures have intensified in the Gulf Cooperation Council (GCC) in 2021-2022, mainly driven by a pick-up in tradable goods inflation. Despite this increase, inflation remained relatively contained as compared to regional comparators. This paper aims to provide a comprehensive analysis of inflation dynamics in the region, with a focus on external factors because of GCC's high reliance on international trade. Using a Global Vector Autoregressive model with quarterly data from 1987 to 2022, we find that external factors such as the imported inflation from main trading partners, mainly driven by China, and nominal effective exchange rate (NEER) are the main drivers of inflation in the GCC region. Additionally, we find that the direct pass-through of international commodity price shocks such as oil and raw agricultural materials is somewhat limited, after controlling for trading partners' inflation, which can be explained by the prevalence of subsidies and administered prices in the region. Overall, since external factors are the main drivers of domestic inflation in the GCC, an increased focus on diversification, promoting food security, and ensuring prudent central bank policies, including through effective liquidity management frameworks, can play a key role in managing this impact.

RECOMMENDED CITATION: F. Fareed, A. Rezghi, and C. Sandoz, 2023, "Inflation Dynamics in the Gulf Cooperation Council (GCC): What is the Role of External Factors?". IMF Working Paper WP/23/263.

JEL Classification Numbers:	E31, E37, F41.
Keywords:	Inflation; external shocks; GCC; panel data; GVAR.
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* "The authors would like to thank Ali Al-Eyd, Amine Mati, and participants of the IMF's Middle East and Central Asia Departmental Seminar and the 2nd Annual Central Bank Conference on Development Economics in the MENA region for all the useful comments and suggestions. Data support from Dalia Aita and Tongfang Yuan is much appreciated.

WORKING PAPERS

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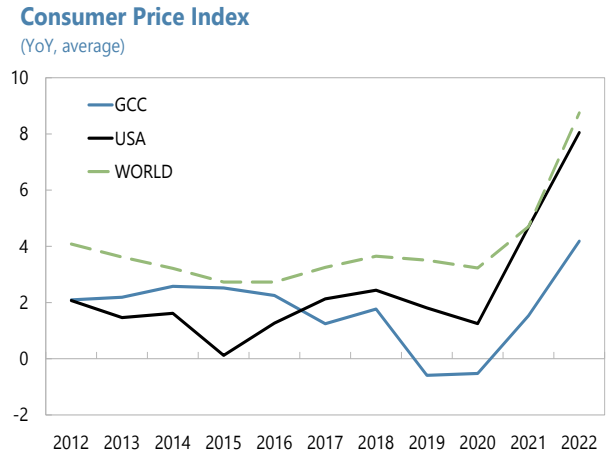
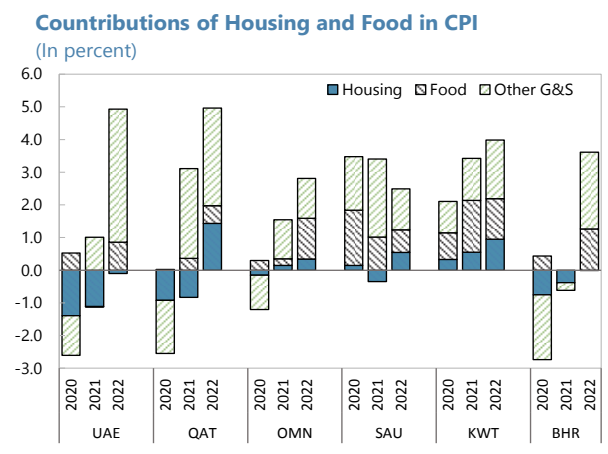
1. Introduction

Following the COVID-19 shock, inflation reached multi-decade highs in many countries as demand recovered from the pandemic, supply chain disruptions persisted, and commodity prices surged, exacerbated by Russia's war in Ukraine and the lingering pandemic. This recent global surge in inflation has led to a renewed interest in identifying the key drivers of inflation dynamics so that policymakers can assess its persistence and design appropriate policies. Although inflation in the GCC region[1] is relatively low as compared to the rest of the world (Text Figure), it has picked up strongly during the pandemic. Given these recent developments in inflation, it is important to accurately diagnose its main drivers and design appropriate policies to preserve price stability and keep inflation expectations anchored, while safeguarding economic activity.



Sources: Country authorities; IMF staff calculations
*MENA's consumer price index excludes Sudan

Inflationary pressures have built up in oil-rich GCC countries from a low base since early 2021. Inflation in the region averaged about 1.5 percent in 2021 and 4.2 percent in 2022, which is a sharp increase as compared to 0.1 percent in 2019. The largest increases were in Qatar and UAE and the lowest for Oman and Saudi Arabia in 2022 (Text Figure). Most of the inflationary pressures have been from tradeable goods, especially from food and transportation, indicating that GCC was not immune to higher global prices during the pandemic. However, even though food inflation has been on an upward trend, it has remained below MENA peers, which can be explained by the prevalence of administered prices, subsidies on certain food products, and stockpiling of basic food items such as wheat in line with the national food security strategies[2] (IMF, 2022a).



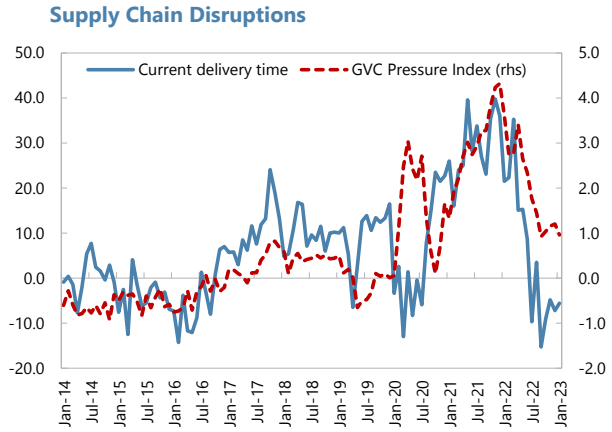
Sources: Country authorities; IMF staff calculations

In the latter half of 2022, inflationary pressures from tradeable sectors started to ease as global inflation began to come down from its recent highs. After reaching 4.4 percent on average in July

[1] GCC countries include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and UAE.

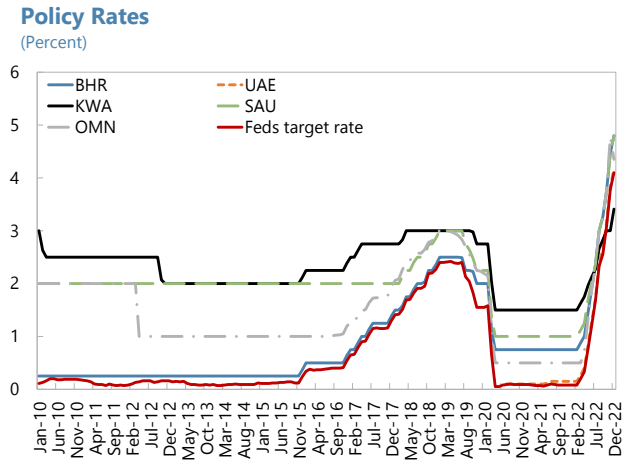
[2] For example, the Saudi Agriculture and Livestock Investment Company that was established to implement a food security strategy is a case in point.

2022, headline inflation in GCC cooled down to 3.9 percent in December 2022 with inflation in tradeable goods declining by 1.3 percentage points.[3] This may come from multiple external factors. First, global headline inflation has come down from its recent highs as energy and food prices have slowed or reversed (IMF, 2023) and supply chain disruptions have eased (Text Figure). Second, the U.S. dollar and GCC currencies reached their highest level since 2000, having appreciated 22 percent against the yen, 13 percent against the Euro, and 6 percent against emerging market currencies since the start of 2022, which may have also influenced inflation dynamics in the region. Third, monetary policy tightening by central banks around the world, including in GCC countries, may have contributed too by reducing money supply and moderating demand. Interest rates in the U.S. rose by 425 basis points over the 7 consecutive moves in 2022, which were broadly followed by GCC countries, given their pegged exchange rate regimes with the U.S. dollar or in the case of Kuwait to an undisclosed basket of currencies tilted towards the U.S. dollar (Text Figure).



Sources: Federal Reserve Bank of Philadelphia, retrieved from FRED; Federal Reserve Bank of New York

Against this backdrop, the main motivation of this paper is to better understand the drivers of inflation in the GCC region with a focus on external factors. Given the structure of the GCC economies and their high dependence on international trade, this paper aims to provide a comprehensive analysis of how external factors such as inflation in main trading partners, nominal effective exchange rate (NEER) variations and commodity prices shocks impact inflation dynamics in the GCC. Using a Global Vector Autoregressive (GVAR) model with quarterly data from 1987Q2 to 2022Q2, this paper aims to quantify the impact of these external factors on inflation and provides policy options.



Sources: Haver Analytics, Country authorities; and IMF staff estimates

Our findings suggest that external factors play the most important role in explaining inflation dynamics in the GCC. According to our estimations, domestic inflation in the GCC is mainly driven by imported inflation from its main trading partners, which has been recently pushed upwards in 2022 by rising global oil and food prices, supply chain disruptions, and tighter labor markets globally. Results show that a one standard deviation shock to trade partner's inflation (i.e. an increase of about 0.8 percentage points) increases inflation by about 0.3 percentage points in the GCC, on average, over a one-year time period. Moreover, we find that changes in the nominal effective

[3] UAE is excluded from the sample here. Inflation in tradeable sector has not been reported for that country because of revisions of the CPI basket and inconsistency in historical data by product.

exchange rate also have a significant impact on inflation. The appreciation of the NEER, in line with that of the USD, appears to shield GCC countries against inflationary pressures. A one standard deviation shock to NEER (i.e. an appreciation of about 1.7 percent) dampens inflation by about 0.16 percentage points on average over a one year time period. Lastly, our estimates suggest that the direct passthrough of increasing oil prices and raw agricultural materials is statistically insignificant after controlling for the indirect impacts on trading partners' economies. This can perhaps be explained by the prevalence of administered prices on basic food items, subsidies in the region, and food security strategies along with the ongoing economic diversification efforts.

The rest of the paper is structured as follows. Section 2 provides some stylized facts about the GCC economy and the recent trends in inflation. Section 3 provides a snapshot of the existing literature. Section 4 lays down our empirical strategy and provides a discussion of our main findings. Section 5 then concludes with a discussion of policy options.

2. Stylized Facts

This section provides a discussion on how common external factors such as international trade, NEER, monetary policy shocks, and international food and energy prices shape inflation dynamics in the region. It also provides descriptive statistics on the economic structure of GCC economies and how it may influence and interact with their inflation dynamics. Finally, it discusses the relevance of each factor as a potential driver of inflation in the region.

2.1. Trade Openness and Inflation Dynamics in GCC's main trading partners

First, it is important to note that GCC countries are highly reliant on trade and import most of their consumption goods. Trade openness is about twice as high as in advanced economies. Moreover, in addition to being net oil exporters, they have a high import penetration (50 percent of GDP against 30 percent in advanced economies) with imports representing 45 percent of trade flows (Table 1)

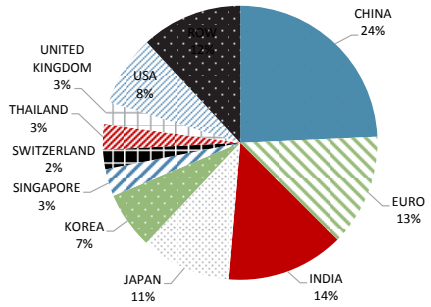
Table 1. Characteristics of GCC Economies

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE	AEs	EMs
Openness = $\frac{Exp+Imp}{GDP}$	1.47	0.95	0.91	0.91	0.62	1.79	0.6	0.49
Import penetration = $\frac{Imp}{GDP}$	0.68	0.43	0.42	0.38	0.29	0.8	0.3	0.24
Share of imports = $\frac{Imp}{Exp+Imp}$	0.46	0.46	0.46	0.41	0.46	0.45	0.5	0.49

Sources: IMF; Haver Analytics.

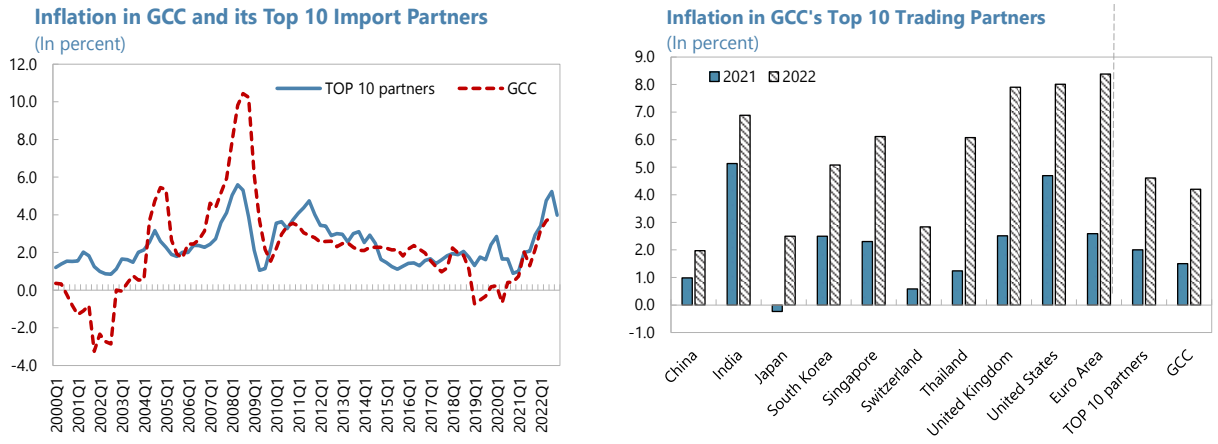
Inflation in the GCC has broadly followed a similar trend as observed in its main trading partners historically (Text Figure and Figure 1). While inflation in the GCC increased by 1.6 percentage points in 2022 compared to 2021, it rose by 2.6 percentage points in its top ten trading partners, mostly driven by the Euro Area, India, Japan, and the U.S. (Figure 1). In those countries, inflation soared to multi-decade highs fueled by volatile international energy and food prices. In the Euro Area, international energy and food prices account for about 75 percent of the increase in headline inflation and 30 percent of core inflation (Toscani & McGregor, 2022). In Japan, the picture is similar despite a relatively low level of inflation at 2.5 percent in 2022. It has recently accelerated, with more widespread price increases mainly due to pass-through from the rise in import prices and Japan's core inflation (i.e., excluding fresh food) recording levels not seen in four decades (IMF, 2023). Given the high correlation between inflation in the GCC and its main trading partners, we expect that inflation abroad will be one of the main drivers of inflation in the region.

Top 10 GCC Import Partners



Sources: Direction of Trade Statistics; IMF staff calculations

Figure 1. Inflation in GCC and its Top Trading Partners



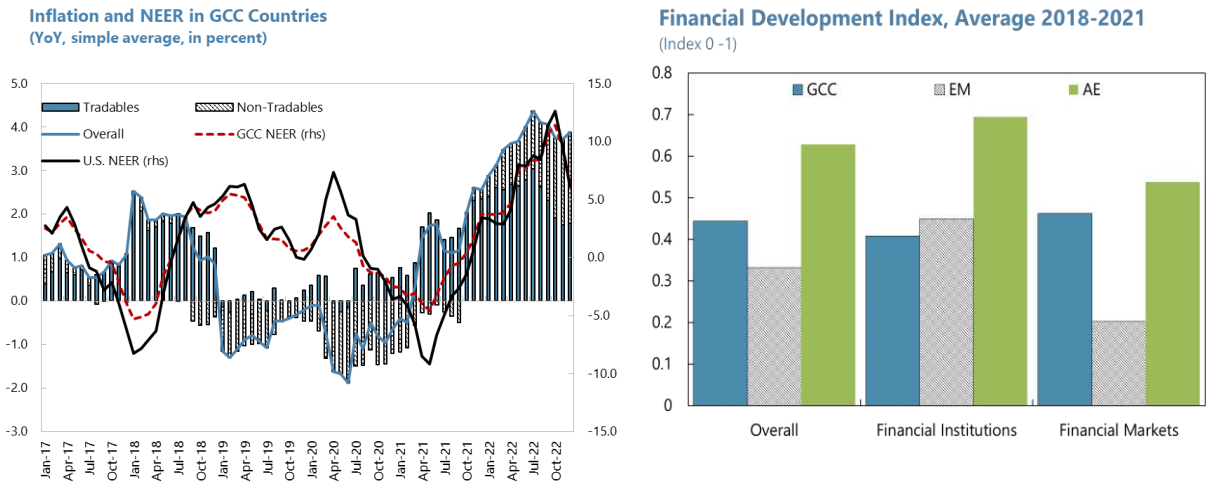
Sources: Country authorities; IMF staff calculations

2.2. Exchange Rate Regime and Monetary Policy in GCC countries

Monetary policy in the region is anchored by fixed exchange rate regimes of the domestic currency against the U.S. dollar – or in the case of Kuwait, to an undisclosed basket of currencies tilted towards the U.S. dollar – and open capital accounts (IMF, 2022b). In 2022, the U.S. dollar strengthened against nearly every other major currency as the Federal Reserve aggressively hiked interest rates. The U.S. NEER appreciated over 12 percent, hitting a 20-year high in October 2022. In recent years, changes in NEER and inflation in GCC have been positively correlated (Figure 2).

Previous studies have linked the appreciation of NEER to playing an important role in explaining inflation dynamics in countries such as Saudi Arabia (IMF, 2022c).
Moreover, interest rates in GCC rose following the Fed hikes in 2022 which may have contributed to moderate domestic demand and inflationary pressures. However, the monetary policy transmission channel is expected to be relatively weak in GCC countries. Literature has documented well the limited pass-through of policy rates to retail rates in GCC countries,[4] partly due to relatively underdeveloped financial and capital markets[5] (Figure 2). Moreover, liquidity swings due to oil price volatility potentially affect the implementation of monetary policy, with liquidity imbalances reducing the pass-through of policy rates to bank lending rates. Recent estimates ((IMF, 2022b) suggest that when U.S. rates rise by 100 basis points, GCC banks' liability rates rise by about 40 basis points and their asset rates by close to 35 basis points. Furthermore, a 100 basis points hike in the U.S. Fed rate when real oil prices are below $45/barrel reduces non-hydrocarbon GDP growth only by about 0.3 percent in GCC, and the effect of U.S. Fed tightening on growth is negligible when oil prices are high (IMF, 2022c).

Figure 2. GCC Inflation, NEER and Financial Market Development



Note: An increase in the exchange rate means an appreciation.
Sources: Country authorities, IMF Financial Development Index, World Development Indicators, IMF staff calculations.
Financial Development Index summarizes how developed financial institutions and financial markets are in terms of their depth (size and liquidity), access (the ability of companies and individuals to access financial services), and efficiency.

2.3. Food and Oil Prices in GCC countries

The impact of international commodity price shocks seems to have been relatively muted in the GCC during the Covid-19 episode. A year since Russia's invasion of Ukraine, global prices of oil and food items have remained elevated after retreating from their record highs in early 2022 (Figure 4). Prices of food items went up by about 11.4 percent between April 2021 and December 2022, whereas fuel prices (i.e., gasoline and diesel) also skyrocketed as Brent Spot reached a record high of 110 USD

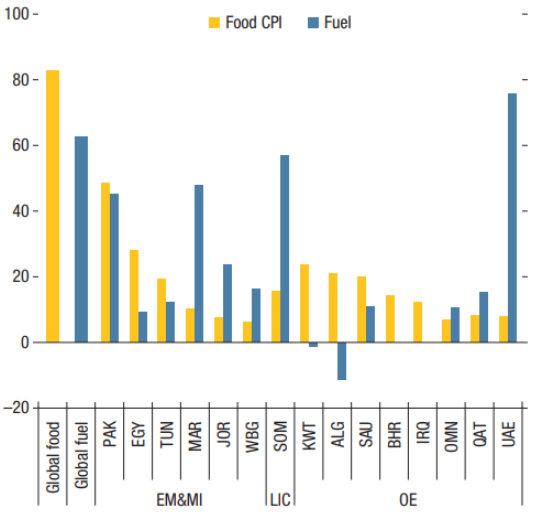
[4] See Espinoza and others (2012); (Adedeji et al., 2019); and IMF (2022b).

[5] Please note that financial and capital markets in GCC countries, particularly in Saudi Arabia and UAE, have shown strong performance during the pandemic and continue to further develop. For example, see the IMD World Competitiveness Ranking for 2023 for details.

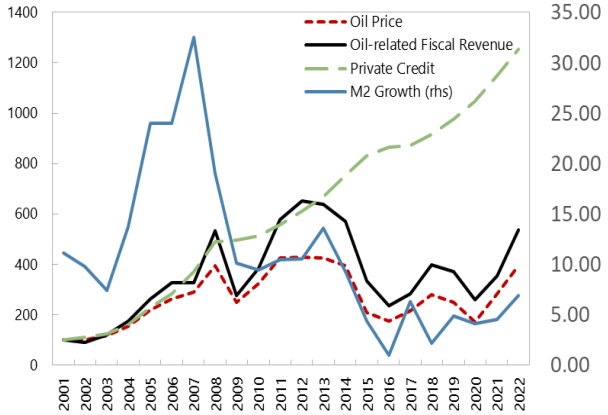
in June 2022. Within the GCC, food inflation increased from 2.2 percent (y/y) in April 2021 to 6 percent (y/y) in June 2022, which is relatively subdued as compared to MENA countries (Figure 3). This can perhaps be attributed to two factors. First, several countries in the GCC have introduced or extended some measures such as administered prices and subsidies on food items, gasoline, water, and electricity, along with stockpiling of basic food items to tackle international price variations (World Bank, 2022; IMF, 2022b). For example, retail sales prices of gasoline and diesel have been almost two times lower in GCC than
G20 countries on average, as of April 2022 (Figure 4).[6] Secondly, the lower weight of food in GCC's CPI basket, in line with their consumption patterns, seems to have played an important role too.

Figure 3. Commodity Prices, Oil-related Fiscal Related and Money Supply

Domestic versus Global Food and Fuel Price Inflation
(Percent change from 2019 to June 2022)



Growth of Money Supply, Oil Price, Oil-related Fiscal Revenue, and Private Credit
(2001=100, GCC simple average otherwise indicated)



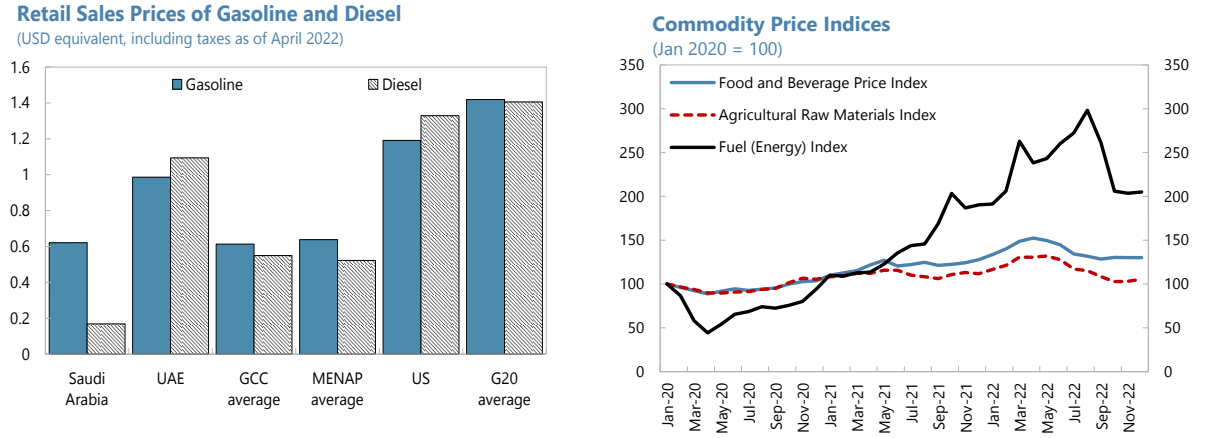
Sources: IMF, International Financial Statistics database, WEO database; Global Petrol database; World Bank Commodity Price database latest data as of June 2022; and IMF staff calculations.
Note: Global food commodities include cereals, fats, and oils, and other food. Global fuel prices are UK Brent crude oil USD price. Domestic fuel refers to average retail price for gasoline octane 95 in USD. Fuel price inflation for BHR and IRQ is zero. Country abbreviations are International Organization for Standardization country codes. CPI = consumer price index; EM&MI = emerging market and middle-income economies; LIC = low-income country; MENA = Middle East and North Africa; OE = oil exporters; USD = U.S. dollar.

Lastly, GCC countries rely heavily on oil as their primary source of fiscal revenues and exports, with the oil sector contributing about 36 percent to their overall GDP. As of 2021, oil accounted for about 64 percent of GCC's total government revenues. In the past, high oil revenues and spending booms have been linked to a surge in inflation. While the surge in revenues boosted GDP growth, the rapid

[6] In the UAE, the pass-through of international oil prices into domestic fuel prices is much higher since the reforms of fossil fuel subsidies in 2015. The UAE's fuel subsidies have been removed to ease pressure on the state's budget, and prices are set each month based on global prices. However, diesel prices were frozen by the Fuel Price Committee after the onset of the coronavirus pandemic in 2020. The controls were removed in March 2021 to reflect the movement of the market. In August 2022, the levels are close to the ones observed in G20 countries, and much higher than in other GCC or MENA countries.

increase in liquidity resulted in an expansion in credit and aggregate demand (Kandil & Morsy, 2011). However, the volatility of money has significantly declined since 2008 (Figure 3). As GCC economies remain committed to maintain fiscal discipline, most of recent oil revenues have been invested through SWFs, preventing a surge in domestic liquidity. Alongside enhance liquidity management frameworks, this seems to have helped limit the impact of higher oil revenues on domestic liquidity conditions.

Figure 4. International Fuel Prices and Commodity Indices



Sources: Globalpetrolprices.com, Haver Analytics, Country authorities; and IMF staff estimates

3. Literature Review

The global rise in inflationary pressures has led to a renewed interest among policymakers to discern the underlying drivers of inflation and devise appropriate policies to ensure that inflation does not become entrenched (Hall et al. 2023; Ture & Khazaei 2022 ; Gopinath and Gourinchas 2022). On this current surge of inflation, Minasyan et al. (2023) study inflation dynamics in the Western Balkans region and find that rising commodity prices, exchange rate developments, and price regulations explain much of the heterogeneity in inflation dynamics. Similarly, IMF (2022a) analyzes inflation dynamics in ten MENA countries and finds that external price pressures, mainly from oil and food prices, are among the main drivers of domestic inflation. However, to the best of our knowledge, this paper is one of the first attempts to provide a comprehensive analysis of the drivers of inflation for the whole GCC region, with a specific focus on external factors, to better understand how multiple shocks of Covid-19 pandemic, commodity prices surge, and supply chain disruptions to the global economy have impacted the region.

There have been several empirical studies in the past that have evaluated the determinants of inflation in GCC countries by looking at both supply and demand side pressures (Hasan & Alogeel 2010; Kandil & Morsy 2011; Murshed & Nakibullah, 2015, among others). These studies have looked at several factors including import cost pass-through, exchange rate, oil price, government spending, money supply, U.S. monetary policy, and remittance outflows, as well as other factors. Among these factors, import cost has been shown to be one of the most significant determinants of inflation in GCC. For instance, Kandil & Morsy (2011) find that inflation in trading partners is the highest contributor to inflation among foreign factors. Murshed and Nakibullah, (2015) also find a similar role for inflation in trading partners, while other domestic factors have limited effect. As understanding the transmission of external shocks into inflation is key for the GCC region, this paper

looks at the effects of global or regional macroeconomic shocks distinguishing between demand and supply shocks.

Other studies have differentiated between short-run and long-run inflationary factors in the GCC. According to Hasan and Alogeel, (2010), inflation in Kuwait and Saudi Arabia is driven mainly by trading partners' inflation in the long term. On the other hand, demand and money supply shocks affect inflation in the short run. The exchange rate pass-through effect and oil prices also have a significant but minor impact on inflation. In another study, Basher and Elsamadisy (2012) find that GCC inflation is primarily driven by the money supply in both the short and the long run. While in the long run, foreign prices and nominal effective exchange rates explain inflation better. In our framework, we also investigate short-run and the long-run effects of various shocks on inflation in GCC through impulse response functions.

Finally, changes in U.S. short-term interest rates have also been known to impact consumer prices in GCC countries. Prasad & Espinoza (2012) use a PVAR setup and find that U.S. monetary policy tightening decreases global commodity prices resulting in lower inflation in the GCC. According to Cevik and Teksoz (2013), bank lending rates influence non-hydrocarbon output and consumer prices, but the exchange rate channel is ineffective. We apply a different framework on a most recent sample period to investigate how U.S. business cycles and short-term interest rates impact inflation in GCC countries.

4. Data and Methodology

4.1. Data

In order to construct the database for our analysis, we start by updating Raissi and Mohaddes's (2020) database using 35 years of quarterly data (1987Q2-2022Q2) from International Financial Statistics (IFS), Haver, and Bloomberg. The following variables are used in the model: real GDP $(y_{i,t})$, inflation rate $(\pi_{i,t})$, money supply7 $(m_{i,t})$, short-term nominal interest rate $(r_{i,t})$, nominal exchange rate $(e_{i,t})$, oil price $(p_{i,t}^{oil})$, agricultural material price8 $(p_{i,t}^{mat})$, global oil production $(q_{i,t})$, and delivery time $(deliv_t)$9 as a proxy for supply chain disruptions. The interest rate is the conversion of the annual rate $R_{i,t}$ to quarterly rates using $r_{i,t} = 0.25\ ln\left(1 + \frac{R_{i,t}}{100}\right)$. $y_{i,t}$, $m_{i,t}$, $e_{i,t}$, $p_{i,t}^{oil}$, $p_{i,t}^{mat}$, and $q_{i,t}$ have been logarithmically transformed and the inflation rate is calculated as the first difference of the natural logarithm of $\mathrm{CPI_{i,t}}$.

4.2. Model description

GCC countries are small open economies with an exchange rate regime pegged to the U.S. dollar. Due to the absence of an independent monetary policy in this environment, any disruptions in the

[7] We use Broad Money indicator in IFS database as our money supply variable.

[8] The data for this variable comes from the agricultural raw materials index of the IMF's Primary Commodity Prices monthly data. This index tracks the prices of various industrial input materials, such as timber, cotton, wool, rubber, and hides. It is also highly correlated with the food price index that is only available from 1992.

[9] Current Delivery Time from the Federal Reserve Bank of Philadelphia reports the change in delivery time compared to the previous month for reporting manufacturing firms. For more information refer to: https://www.philadelphiafed.org/surveys-and-data/regional-economic-analysis/manufacturing-business-outlook-survey

global trade environment can significantly impact aggregate supply and demand in GCC countries, leading to changes in price levels and inflation rates. Their limited domestic markets and significant reliance on exports and imports for economic growth and domestic consumption can further exacerbate this vulnerability.

Because of the recent developments in inflation around the world and to investigate the spillover of global inflation to the region, we use a Global VAR (GVAR) model. The GVAR model incorporates regional and global inflationary pressures as well as domestic factors such as money supply and real output. The model consists of 23 countries/regions covering about 90 percent of the world's GDP. GCC and Euro area enter the model as a block, rather than considering each country within these two regions individually.[10] Treating GCC countries as a single economic block can be justified due to their implementation of policies aimed at enhancing economic and financial integration. According to Cashin, Mohaddes, and Raissi (2012), GCC countries have open capital accounts, and their exchange rates are pegged to the U.S. dollar. Moreover, they have a flexible labor market, which further strengthens the rationale for using this region as a unit in our model. Table 2 in the Annex lists all the countries and regions of the model.

Our GVAR model, based on Nguyen et al. (2017), comprises five endogenous domestic variables $x_{i,t}$ for each country, namely real output ($y_{i,t}$), inflation rate ($\pi_{i,t}$), money supply growth ($dm_{i,t}$), short-term interest rate ($r_{i,t}$), and the nominal exchange rate ($e_{i,t}$). Since GCC countries do not have an independent monetary policy, we exclude $r_{i,t}$ from the GCC model, but the weighted average of trade partners' interest rate enters in the GCC model.[11] Furthermore, the nominal exchange rate does not enter U.S. and GCC models, as all exchange rates in the model are units of foreign currency per U.S. dollar.

A weighted average of trade partners' domestic variables enters each country model as foreign variables $\mathrm{x}^{*}_{\mathrm{i,t}}$. In other words, the foreign variables are constructed as follows:

$$\mathrm{x}^{*}_{\mathrm{i,t}} = \sum_{j=0}^{22} w_{ij,t} x_{j,t}$$

The variable $w_{ij,t}$ represents the trade share of country j for country i at time t. It is computed using the following formula:

$$w_{ij,t} = \frac{T_{ij,t} + T_{ij,t-1} + T_{ij,t-2}}{T_{i,t} + T_{i,t-1} + T_{i,t-2}}$$

[10] Each block is constructed by taking a weighted average of variables of the countries in the block, using PPP-GDP as the weight.

[11] Trade partners' interest rate still will affect variables in the GCC block as an exogenous variable. Having the interest rate as an endogenous variable in the GCC model will not change the result significantly.

where $T_{ij,t}$ is the bilateral trade of country i with country j during year t defined as the average of exports and imports of country i with country j, and $T_{i,t} = \sum_{j=0}^{22} T_{ij,t}$. Table 3 in the Annex presents the trade weights for selected countries in the model over 2019 - 2021.[12]

Consistent with prior research on GVAR models, we adopt the assumption that foreign variables exhibit weak exogeneity with respect to each country's model. Specifically, we assume that these variables can influence the endogenous domestic variables but are themselves immune to such influences. Given the importance of the U.S. economy for the world, the weak exogeneity assumption for foreign variables in the U.S. model does not hold and therefore, we only allow for the spillover of foreign inflation $\pi_{i,t}^{*}$ to the U.S. economy. Lastly, because of the possible high correlation between $e_{i,t}$ and $e_{i,t}^{*}$, we follow Pesaran et al. (2004) and exclude $e_{i,t}^{*}$ from all models except for the U.S. and the GCC.

The final set of variables in our model comprises of global variables g_{it}, which include the growth rate of oil prices dp_t^{oil}, the growth rate of agricultural materials prices dp_t^{mat}, the world oil production q_t^{oil}, and delivery time $deliv_t$. All global variables are endogenous to the U.S. economy but exogenous to every other model. In line with the approach of Cashin, Mohaddes, and Raissi (2012), we incorporate the assumption that the GCC's model will impact global oil production, which makes us exclude this variable from the GCC model. This assumption is justifiable since the GCC countries have a considerable share in global oil production and export, with most of the GCC countries being the major contributors to the Organization of the Petroleum Exporting Countries (OPEC) allocations. Table 4 summarizes all the variables in the model.[13]

4.3. Testing the Weak Exogeneity Assumption

To test the weak exogeneity assumptions, we follow the procedure in Johansen (1992) and conduct 178 tests on the foreign and global variables for each country unit. F-statistics show that only 7 of them fail at the 5 percent significance level. Table 6 summarizes the results alongside the 95 percent critical values. Among the tests that fail the exogeneity assumption, money supply growth and delivery time for the Euro area are the most expected ones given the size of this region in the global economy. Oil price also fails the exogeneity tests in Canada as it is one of the major world oil producers. Given the assumed level of significance, it is possible to expect as many as 9 rejections, which would represent 5 percent of the 178 tests, even if the weak exogeneity assumption is always true. In summary, the evidence presented here substantiates our approach of treating the foreign and global variables in the individual VARX* models as being weakly exogenous.

4.4. Model Specifications

After discussing the construction of variables and determining which ones will be used in each country model $VARX^{*}$, this section now provides more details about these models. First, we need to

[12] If we also include the omitted countries, sum of each column equals one. Countries presented in Table 2 comprise over 90 percent of GCC's trade share.

[13] We conducted unit root tests on all variables for the countries, confirming that they are all either $\mathrm{I}(0)$ or $I(1)$.

determine the lag orders for the endogenous and exogenous variables. We will use the Akaike Information Criterion (AIC) to do this, setting the maximum number of lags for endogenous variables to 2 and the maximum number of lags for exogenous variables to 1 for all models except for GCC and US, where we allow for 2 lags of exogenous variables. Based on the specific lag numbers for each country model, denoted by p_i for endogenous variables and q_i for exogenous variables, we can define the $VARX^*(p_i, q_i)$ model as follows:

$$\boldsymbol{\Phi_i}(L, p_i)x_{it} = \boldsymbol{a_{i0}} + \boldsymbol{a_{i1}}t + \boldsymbol{\Gamma_i}(L, q_i)\boldsymbol{g}_t + \boldsymbol{\Lambda_i}(L, q_i)x_{it}^* + \boldsymbol{u_{it}} \quad (1)$$

For $t = 1,2,\dots,T$. $\boldsymbol{a_{i0}}$ and $\boldsymbol{a_{i1}}$ are vectors of intercepts and coefficients on the linear trend. $\boldsymbol{\Phi_i}(L, p_i) = I - \sum_{i=1}^{p_i} \boldsymbol{\Phi}_i L^i$, $\boldsymbol{\Gamma}_i(L, q_i) = \sum_{i=0}^{q_i} \boldsymbol{\Gamma}_i L^i$, and $\boldsymbol{\Lambda_i}(L, q_i) = \sum_{i=0}^{q_i} \boldsymbol{\Lambda_i} L^i$ are the matrix lag polynomial of the coefficients for domestic, global, and foreign variables.[14] Lastly, $\boldsymbol{u_{it}}$ is the vector of idiosyncratic country-specific shocks which are serially uncorrelated.

We can solve each country model using error correction after finding the number of long-run cointegrating relationships between the variables. To test for cointegration, Johansen's maximal eigenvalue and trace statistics, as developed in Pesaran, Shin, and Smith (2000), are utilized. These tests assume weakly exogenous I(1) regressors, restricted trend coefficients, and unrestricted intercepts. The tests are conducted with null hypotheses of no cointegration, one cointegrating relation, and so on. The number of cointegrating relations is determined based on the trace test statistics for all models except for Canada, Korea, and Turkey. For these three models, we reduce the number of cointegrating relationships to make sure that the GVAR is stable, and the persistence profiles developed by Lee and Pesaran (1993) show an acceptable speed of convergence. Table 5 presents the number of lags and the number of cointegrating relations for each country model.[15]

4.5. Solving the GVAR Model

For all countries, we estimate equation (1) in its error-correction form after finding the number of lag orders and cointegrating relations using Smith and Galesi's (2014) toolbox. While all country models are estimated independently, the GVAR model is treated as a holistic system where all variables, even those that are exogenous to specific country models, are considered endogenous to the global model. Let us define $\boldsymbol{A_i}(L, p_i, q_i) = \boldsymbol{\Phi}_i(L, p_i) - \boldsymbol{\Lambda_i}(L, q_i)$, $\boldsymbol{z_{it}} = \left(x_{it}', x_{it}^{*\prime}\right)'$, $\boldsymbol{\psi_{it}} = \boldsymbol{a_{i0}} + \boldsymbol{a_{i1}}t + \boldsymbol{\Gamma}_i(L, q_i)\boldsymbol{g_t} + \boldsymbol{u_{it}}$, and rewrite the country model as follows:

$$\boldsymbol{A_i}(L, p_i, q_i)\boldsymbol{z_{it}} = \boldsymbol{\psi_{it}}$$

For $i = 0,1,\dots,N$.

Using trade linkages and the definition of $x_{it}^* = \sum_{j=0}^{N} w_{ij}x_{jt}$, where w_{ij} are trade weights between country i and j, we have $\boldsymbol{z_{it}} = W_i x_t$. We can then rewrite the previous equation as follows:

[14] To simplify the illustration of the model, we assume that global variables are exogenous to the country model i.

[15] To ensure the robustness of our findings, we conducted a range of sensitivity analyses using different specifications, variables, and sample periods. Despite these variations, our main results regarding the significant role of external factors such as trade partners' inflation and exchange rates remained qualitatively the same.

$$\boldsymbol{A_i}(L,s)W_i x_t \;=\; \boldsymbol{\psi_{it}}$$

Where $s = max(p_0, p_1, \dots, p_N, q_0, q_1, \dots, q_N)$. By stacking all country models, we finally have the GVAR model which we can solve recursively:

$$G(L,s)\boldsymbol{x}_t = \boldsymbol{\psi_t}$$

where $\boldsymbol{G(L,s)} = (\boldsymbol{A_0}(L,s)\boldsymbol{W}_0, \boldsymbol{A_1}(L,s)\boldsymbol{W}_1, \dots, \boldsymbol{A_N}(L,s)\boldsymbol{W}_N)'$and $\boldsymbol{\psi_t} = (\boldsymbol{\psi_{0t}}, \boldsymbol{\psi_{1t}}, \dots, \boldsymbol{\psi_{Nt}})'$.[16]

5. Results

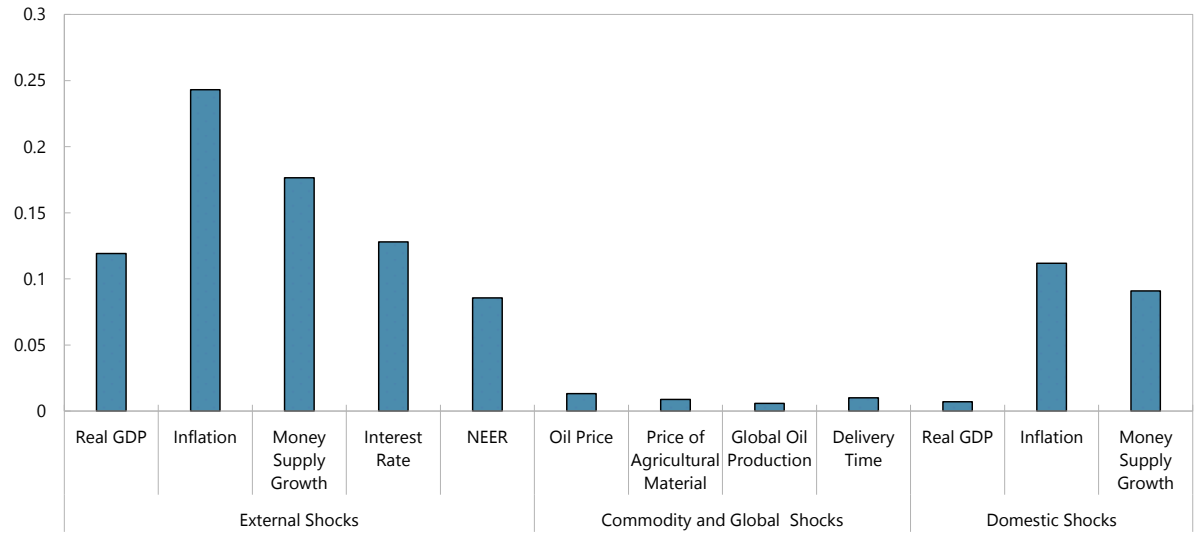
First, this section presents the generalized forecast error variance decomposition (GFEVD) to quantify the importance of each shock. Then, the impulse response function (IRF) of inflation in GCC countries show the impact of various external and domestic shocks. To evaluate the effects of these shocks, we use generalized impulse response functions (GIRF), which allow us to analyze the impact of shocks without imposing any specific identification assumptions. This approach is particularly useful when the underlying economic model is complex. Shocks are not orthogonalized in this approach. Instead, GIRF considers shocks to an individual error and integrates out the effect of other shocks using the historical correlations of shocks. Finally, we show how shocks to different trade partners inflation impact inflation dynamics in the GCC.

5.1. How important are external factors: Forecast error variance decomposition (GFEVD)?

Overall, we find that external factors account for about 80 percent of variation in inflation in the GCC. Figure 5 presents the GFEVD of GCC's inflation, which quantifies the relative importance of shocks that originate within the GCC and those that originate outside of it. Our results indicate that shocks to trade partners' inflation and exchange rate play a significant role. Additionally, changes in trade partner's real output, money supply and interest rates are other external factors that influence GCC's inflation. Finally, shocks to domestic money supply explain 10 percent of variation in inflation in GCC, while shocks to domestic GDP have a muted impact.

[16] For more details on how to solve GVAR refer to section 5 of Pesaran, Schuermann, and Weiner (2004).

Figure 5. GFEVD of Inflation over 10 Quarters



Sources: IMF staff calculations.

5.2. Main drivers of GCC's inflation: Generalized impulse response functions

GIRFs confirms that external factors play a major role in impacting inflation dynamics in the GCC. We find that trading partners' inflation has a significant impact on inflation in the GCC. Our estimates suggest that a one standard deviation shock to trade partner's inflation (i.e. an increase of about 0.8 percentage points) increases inflation by about 0.3 percentage points in the GCC, on average, over a one-year time period (Figure 6). Given that GCC countries are highly reliant on international trade, when a trade partner experiences inflation, the cost of importing goods from that country increases. As a result, the prices of goods may increase directly or indirectly through more expensive consumption goods and higher domestic production costs, which generate inflationary pressures in the economy.

The exchange rate fluctuations also seem to be an important driver of inflation in the GCC. An appreciation of the nominal effective exchange rate (NEER) has a dampening effect on inflation. When the NEER in the GCC appreciates, their currencies become stronger relative to others, making imported goods cheaper for consumers and businesses. Our estimates suggest that a one standard deviation shock to NEER (i.e. an appreciation of about 1.7 percent) dampens inflation by about 0.16 percentage points on average over a one year time period (Figure 6). In 2022, the NEER appreciation seems to have significantly reduced inflationary pressures imported from abroad, and the slowdown in inflation would have been even stronger without the World Cup organized in Qatar and the potential subsequent raise of inflation in non-tradeable sectors in 2022Q4. However, exchange rate depreciation relative to major trading partners could reinforce the increase in import prices and the inflationary effect of external shocks pressures in the future, given that shocks are symmetric in the GVAR model.

Our findings also suggest that the pass-through of international oil and food prices on domestic prices in the GCC seems to be limited. Our estimates show that a rise in international oil and raw agricultural material prices is not translated, on average, into an increase in domestic inflation. Both these results are statistically insignificant (Figure 6).This could be explained by the small share of

raw commodities in CPI basket, the prevalence of regulated prices, particularly on oil and some basic food products in some countries, for example in Saudi Arabia covering several items: wheat flour, barley, some types of bread and infant milk (the latter recently replaced by targeted programs) and in Bahrain covering meat (lamb and beef) and flour, amounting to about 0.3 percent of GDP in 2020[17](IMF, 2022b). Additional, relatively low weight of food in the CPI basket, and ongoing efforts to expand domestic production of agriculture and food products might also have contributed to limiting the passthrough of international oil and food prices.

Our results also highlight that the impact of supply chain disruptions on inflation in the GCC is limited. We use the U.S. delivery time – a measure of the change in delivery time compared to the previous month for reporting manufacturing firms in the U.S. – as a proxy to track the extent of disruptions on supply chains. The results indicate that the impact of an increase in U.S. delivery time on GCC's inflation is statistically insignificant which is surprising given the significant impact of other external factors (Figure 6).[18] This limited impact of global supply chain disruptions, something that was also observed during the Covid-19 pandemic in the region, can perhaps be explained by a combination of GCC specific factors that may have acted to offset supply chain driven inflation. First, the GCC economies have diversified their sources of imports over time, reducing their dependence on any single country or region. This has potentially allowed them to mitigate the effects of disruptions in any one country or region. Second, the GCC has invested heavily in their infrastructure, including their transportation and logistics networks, which has made it easier to transport goods and raw materials domestically and regionally. Finally, the GCC region was relatively less hit hard by the Covid-19 pandemic and the governments did not have to impose lengthy national lockdowns. This allowed businesses and supply chains to continue operating, preventing the type of disruptions that might have led to significant price increases over a long period.

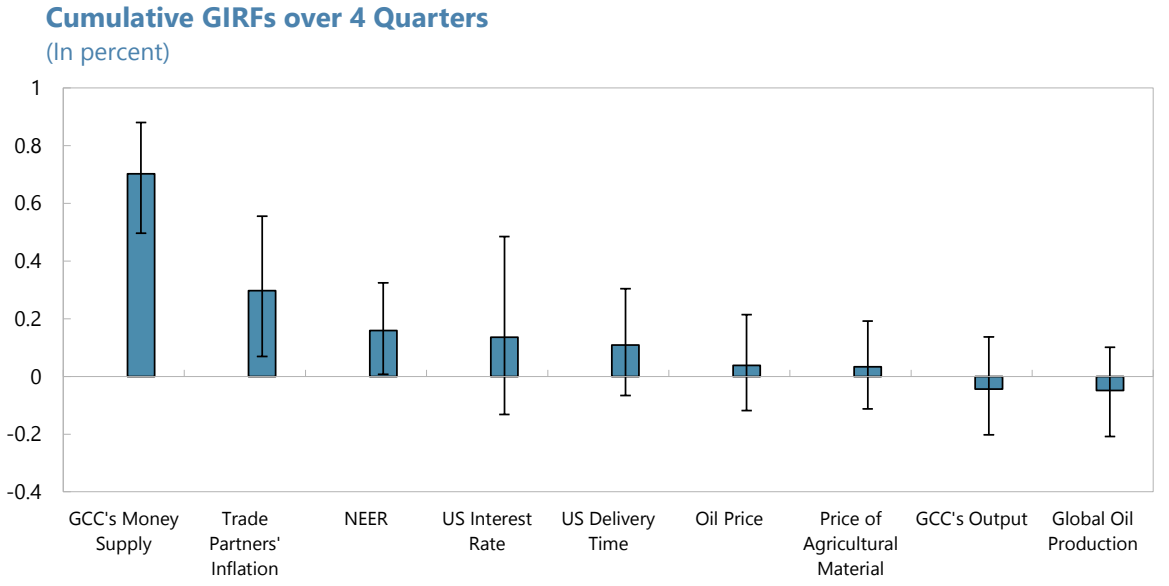
Among other external factors, we find that an increase in the US interest rate does not have a significant effect on inflation in GCC (Figure 6). This observation is particularly intriguing given the fact that exchange rates in GCC countries are pegged to the US dollar and domestic rates follow the US rates closely. Thus, one would expect to find a dampening role for an increase in interest rates, whether through the standard domestic monetary transmission channels or the indirect effect of monetary shocks on trade partners' inflation. One possible explanation for this result could be attributed to the limited depth of financial markets in GCC, where an increase in interest rate does not translate to lower aggregate demand in the economy.[19]

[17] Several countries in the region also had a prudent stockpile policy, which provided for sufficient stocks of wheat during the pandemic.

[18] The IRFs provided in Annex II provide results with quarterly frequency which show that there is some lagged impact on domestic inflation for a certain quarter which is statistically significant. However, using the year long period, results are not statistically significant.

[19] In addition, VAR models have limitations when it comes to explaining the impact of interest rates on inflation, a challenge commonly referred to as the "price puzzle" as highlighted by Sims (1992).

Figure 6. GIRFs of Inflation to 1 S.D. Shock to External and Domestic Variables



Note: The error bands depict the 16th and 84th percentile. All columns are showing percentage point changes, except for NEER, global oil production, and GCC's output which are percent changes. The GIRFs are cumulated over 4 quarters.

Certain domestic factors also explain inflation dynamics in the GCC. Our findings suggest that a pickup in money growth has a positive and significant impact on domestic inflation. A one standard deviation shock to money growth (i.e. an increase of about 1.5 percentage points) is positively associated with a 0.7 percentage points increase in inflation over a one year period (Figure 6). Given that GCC countries have pegged exchange rate regimes and do not have independent monetary policies, there are different ways that money supply has been impacted in the GCC in the past, including through the government spending channel, net-capital flows fluctuations, interest rate channel, and through reserve requirements (Basher and Elsamadisy, 2012).[20]

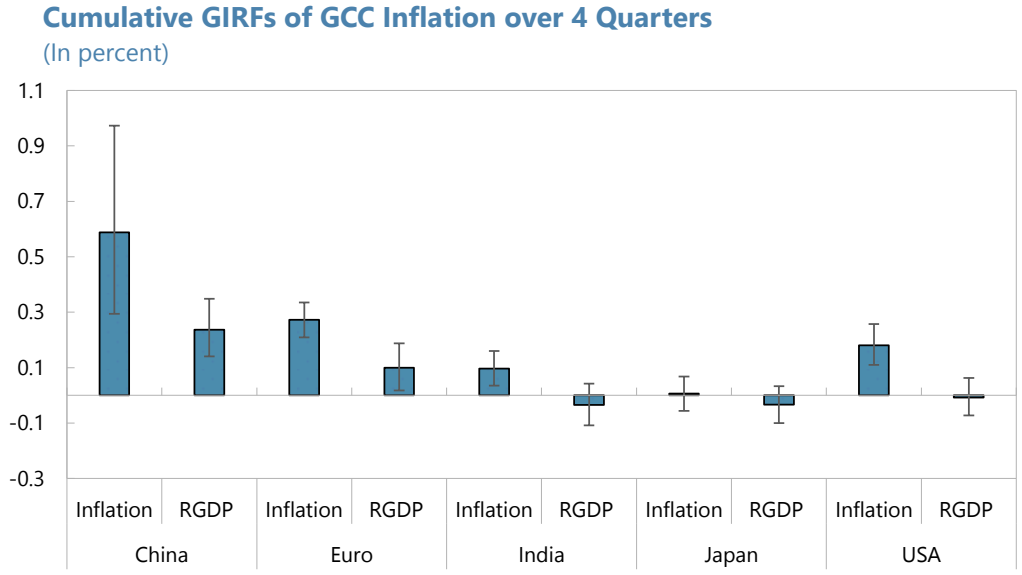
5.3. How do shocks to different trade partners inflation impact inflation dynamics in the GCC?

According to the results discussed earlier, a shock to inflation in all GCC trade partners can lead to an increase in the inflation rate in the GCC. In this section, we examine in more detail the role and significance of shocks to inflation and real output in the major trading partners of the GCC, namely China, the Euro area, India, Japan, and the US. As Figure 7 shows, an increase in the inflation rate in almost all major trading partners results in an increase in the inflation rate in the GCC, on average, over a one-year time period. Among the GCC's trading partners, shocks to China and the

[20] According to Basher and Elsamadisy (2012), money supply can change in GCC in several ways. First, government oil revenues are generated in foreign exchange, money supply in the past has been essentially capturing the monetization of government spending on domestic economy. Secondly, money supply also incorporates the interest rate channel as the effect of changes in Federal funds rate is transmitted to domestic money supply through identical changes in domestic interest rates. Thirdly, the money supply also captures the impact of net capital flows in GCC countries as, for example, an inflow of capital may cause an increase in domestic money supply."

Euro area have a greater impact. Despite having a sizable trade share with GCC, shocks to inflation and output growth in Japan do not have a significant effect on the region's inflation and it can be explained by the composition of trade flows. Bilateral trade flows between Japan and GCC countries are highly concentrated around few products. While exports are exclusively oil and related-oil products, about 70 percent of imports are cars, tractors, and trucks. Although trade flows with the US are relatively large and more diversified, its role in influencing the GCC is surprisingly limited, indicating that the indirect effects of the U.S. on the GCC are relatively small.

Figure 7. GIRFs of Inflation to 1 S.D Shock to Inflation and Output of a Trading Partner



Note: The error bands depict the 16th and 84th percentile. The GIRFs are cumulated over 4 quarters.

6. Conclusion

The paper offers an in-depth analysis of inflation dynamics in the GCC region. Our findings reveal that GCC countries are highly open to trade and that external factors explain about 80 percent of their inflation dynamics on average. Trading partners' inflation is one of the main determinants. A one standard deviation shock to trade partner's inflation (i.e. about 0.8 percentage points) increases inflation by about 0.3 percentage points on average over a one-year time period. Among GCC's trading partners, shocks to China and the Euro area have the greatest impacts on GCC's inflation.

Variations in the nominal effective exchange rate are also an important determinant of GCC inflation. Our estimates suggest that a one standard deviation shock to NEER (i.e. an appreciation of about 1.7 percent) dampens inflation by about 0.16 percentage points on average over a one year time period. Similarly, during the Covid-19 pandemic, an appreciation of the NEER seems to have shielded GCC economies against global inflationary pressures. However, given that NEER variations significantly impact the price of tradeable goods, the high pass-through can make GCC countries vulnerable to USD volatility in the case of a depreciation.

We also find that the direct pass-through of international oil and agricultural raw materials prices on domestic prices in the GCC is limited after controlling for trading partners' inflation, mainly because

of small share of raw commodities in CPI basket, government interventions and diversification efforts. Strengthening diversification efforts and promoting food security would allow governments to gradually remove fuel and food price subsidies, while providing targeted support to the most vulnerable. However, Nusair (2019) and Alsamara et al. (2018) find asymmetric effects of oil price and import cost shocks on consumer prices in GCC countries. Further work would be useful to better understand the asymmetric response to shocks on oil and food prices and see if it explains the insignificance of our results.

While domestic factors seem to play a limited role in explaining price dynamics in the GCC countries, our findings suggest that money growth has a positive and significant impact on domestic inflation. A one standard deviation shock to money growth (i.e. an increase of about 1.5 percentage points) is positively associated with a 0.7 percentage points increase in inflation over a one year period. GCC central banks can play a role, albeit limited, in managing money growth and controlling inflation through macroprudential measures, reserves requirement and further enhancing liquidity management frameworks.

This paper examined the role of external factors in driving inflation dynamics in the GCC, but it does not fully capture all the dimensions of openness of those countries. For instance, GCC countries are highly reliant on expatriate labor, which account for about 75 percent of the employed population in Saudi Arabia, and the proportion is even higher for some other GCC countries (Rebei and Troug, 2023). An extension of the paper could look at the impact of domestic and foreign labor market conditions on GCC inflation. Tight labor market abroad may generate substantial growth in domestic nominal wages and may bring additional inflationary pressures in the domestic economy. Another extension of the paper could look at housing markets and discuss how increase in home values impact GCC inflation dynamics.

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Annex I. Model Specification

A. Countries and Regions in the Model

Table 2. Countries and Regions in the GVAR Model

GCC*	Euro Area*	Latin America	Rest of the World	
Bahrain	Austria	Brazil	Australia	Sweden
Kuwait	Belgium	Mexico	Canada	Switzerland
Oman	Finland		China	Turkey
Qatar	France	**Emerging Asia**	India	United Kingdom
Saudi Arabia	Germany	Korea	Indonesia	United States
UAE	Italy	Malaysia	Japan	
	Netherland	Philippines	Norway	
	Spain	Singapore	New Zealand	
		Thailand	South Africa	

Notes: GCC and Euro Area countries enter the model as regions.

B. Trade Weights

Table 3. Trade Weights – Averages Over 2019 - 2021

Country	BRAZIL	CHINA	EURO	GCC	INDIA	JAPAN	KOREA	SINGAPORE	SWITZERLAND	THAILAND	TURKEY	UK	USA
BRAZIL	0	0.04	0.02	0.015	0.014	0.01	0.012	0.007	0.007	0.011	0.016	0.006	0.02
CHINA	0.354	0	0.194	0.233	0.156	0.279	0.317	0.184	0.079	0.227	0.115	0.119	0.172
EURO	0.171	0.159	0	0.135	0.127	0.1	0.093	0.099	0.467	0.078	0.448	0.448	0.156
GCC	0.035	0.058	0.037	0	0.198	0.073	0.072	0.048	0.038	0.059	0.067	0.027	0.018
INDIA	0.027	0.031	0.026	0.138	0	0.014	0.025	0.031	0.042	0.032	0.031	0.017	0.027
JAPAN	0.03	0.101	0.04	0.109	0.03	0	0.093	0.064	0.025	0.146	0.018	0.021	0.059
KOREA	0.028	0.094	0.028	0.068	0.035	0.067	0	0.057	0.009	0.036	0.03	0.013	0.041
SINGAPORE	0.016	0.028	0.015	0.035	0.043	0.024	0.025	0	0.021	0.043	0.004	0.011	0.018
SWITZERLAND	0.012	0.01	0.093	0.026	0.036	0.011	0.005	0.018	0	0.022	0.024	0.042	0.024
THAILAND	0.012	0.032	0.011	0.029	0.02	0.048	0.016	0.04	0.015	0	0.006	0.006	0.015
TURKEY	0.011	0.008	0.042	0.021	0.013	0.003	0.009	0.003	0.011	0.004	0	0.022	0.007
UNITED KINGDOM	0.017	0.029	0.139	0.026	0.026	0.016	0.012	0.02	0.08	0.014	0.073	0	0.035
USA	0.189	0.19	0.187	0.084	0.158	0.183	0.177	0.134	0.152	0.133	0.097	0.146	0

C. Model Variables

Table 4. Variables Included in the Country VARX* Model

The U.S. Model		The GCC Model		Others	
Endogenous	**Exogenous**	**Endogenous**	**Exogenous**	**Endogenous**	**Exogenous**
$y_{US,t}$	–	$y_{GCC,t}$	$y^*_{GCC,t}$	$y_{i,t}$	$y^*_{i,t}$
$\pi_{US,t}$	$\pi^*_{US,t}$	$\pi_{GCC,t}$	$\pi^*_{GCC,t}$	$\pi_{i,t}$	$\pi^*_{i,t}$
$dm_{US,t}$	–	$dm_{GCC,t}$	$dm^*_{GCC,t}$	$dm_{i,t}$	$dm^*_{i,t}$
$r_{US,t}$	–	–	$r^*_{GCC,t}$	$r_{i,t}$	$r^*_{i,t}$
–	$e^*_{US,t}$	–	$e^*_{GCC,t}$	$e_{i,t}$	–
dp^{mat}_t	–	–	dp^{mat}_t	–	dp^{mat}_t
dp^{oil}_t	–	–	dp^{oil}_t	–	dp^{oil}_t
q^{oil}_t	–	–	–	–	q^{oil}_t
$deliv_t$	–	–	$deliv_t$	–	$deliv_t$

D. Lag Order Selection and Cointegrating Relations

Table 5. Lag Orders of VARX* Models with the Number of Cointegrating Relations

Country	# Cointegrating relations	VARX* Order		Country	# Cointegrating relations	VARX* Order	
		p	q			p	q
AUSTRALIA	2	2	1	NORWAY	2	2	1
BRAZIL	3	2	1	NEW ZEALAND	2	2	1
CANADA	3	1	1	PHILIPPINES	2	2	1
CHINA	1	2	1	SOUTH AFRICA	3	1	1
EURO	2	2	1	SINGAPORE	3	2	1
GCC	1	2	2	SWEDEN	2	2	1
INDIA	3	1	1	SWITZERLAND	2	2	1
INDONESIA	3	2	1	THAILAND	2	2	1
JAPAN	3	2	1	TURKEY	2	2	1
KOREA	2	2	1	UNITED KINGDOM	2	2	1
MALAYSIA	2	2	1	USA	6	2	2
MEXICO	3	2	1				

E. Weak Exogeneity Test

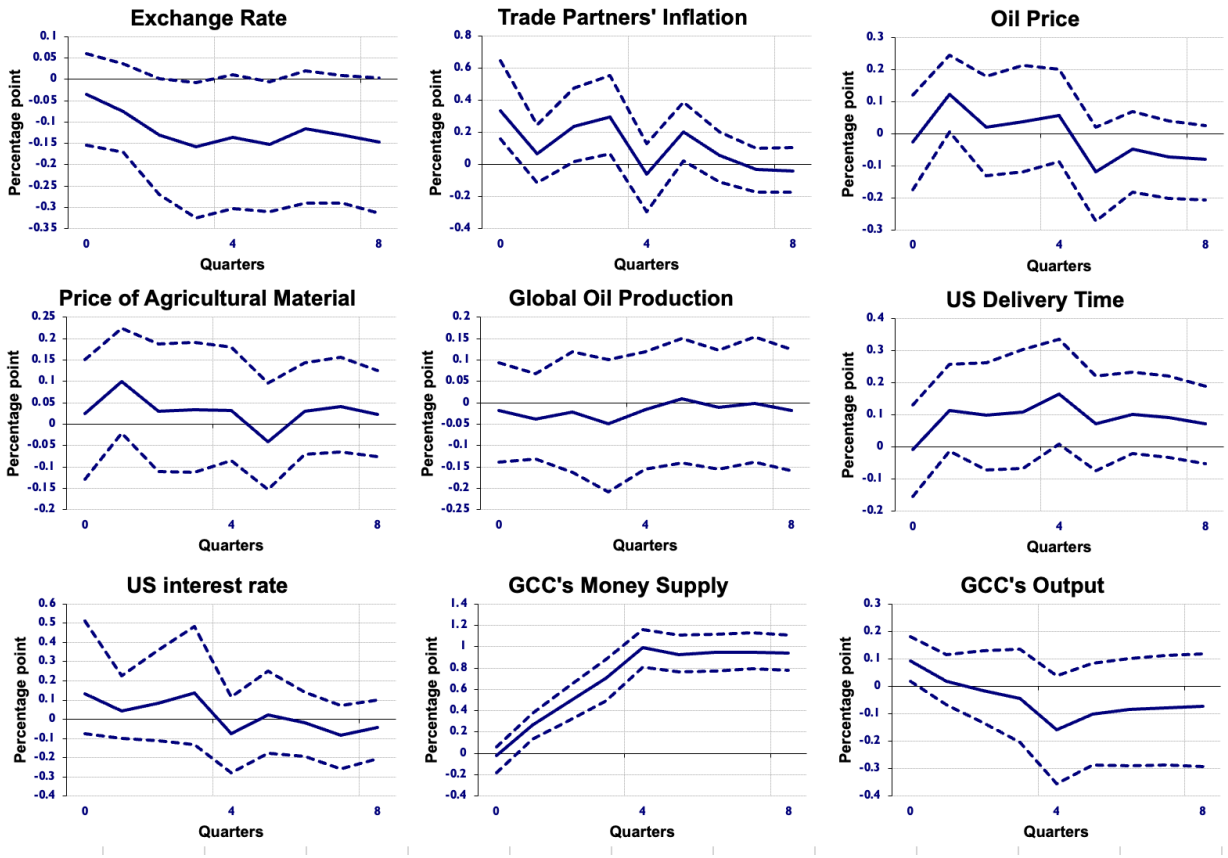
Table 6. F-Statistics for Weak Exogeneity Tests

Country	F test	Critical Value	$y^*_{i,t}$	$\pi^*_{i,t}$	$dm^*_{i,t}$	$r^*_{i,t}$	$e^*_{i,t}$	dp^{oil}_t	dp^{mat}_t	$deliv_t$	q^{oil}_t
AUSTRALIA	F(2,108)	3.08	0.12	2.57	1.11	1.41		0.22	0.55	0.36	2.50
BRAZIL	F(3,107)	2.69	0.56	0.84	1.70	0.71		0.32	0.79	1.41	1.05
CANADA	F(3,112)	2.69	0.24	1.39	0.99	2.52		2.99*	1.79	1.84	1.16
CHINA	F(1,109)	3.93	2.68	0.07	0.29	0.21		0.16	1.18	2.49	3.87
EURO	F(2,108)	3.08	1.02	0.73	3.66*	0.66		1.40	2.99	5.49*	0.34
GCC	F(1,113)	3.93	0.12	0.54	0.51	0.02	0.17	0.06	0.07	0.21	
INDIA	F(3,112)	2.69	2.15	1.04	1.03	0.38		1.31	0.21	0.37	1.55
INDONESIA	F(3,107)	2.69	0.11	0.55	3.71*	0.73		0.41	0.42	0.37	0.52
JAPAN	F(3,107)	2.69	0.51	0.57	0.14	2.46		0.86	2.00	0.86	0.99
KOREA	F(2,108)	3.08	0.71	0.12	0.18	0.11		0.28	0.52	1.37	0.53
MALAYSIA	F(2,108)	3.08	0.36	0.77	0.57	1.75		0.14	0.09	1.04	0.69
MEXICO	F(3,107)	2.69	0.53	0.27	1.34	2.48		0.13	0.91	0.90	1.57
NORWAY	F(2,108)	3.08	0.51	1.67	0.00	0.13		0.31	0.11	0.14	0.48
NEW ZEALAND	F(2,108)	3.08	0.41	0.95	0.15	0.25		2.22	1.87	0.94	0.18
PHILIPPINES	F(2,108)	3.08	0.20	2.12	1.33	0.52		0.05	0.11	0.66	0.68
SOUTH AFRICA	F(3,112)	2.69	1.97	0.14	0.11	0.45		0.27	0.70	1.16	2.75*
SINGAPORE	F(3,107)	2.69	0.36	0.67	0.41	0.48		3.52*	2.60	0.49	1.29
SWEDEN	F(2,108)	3.08	0.36	0.12	0.22	0.25		1.76	0.31	0.02	1.20
SWITZERLAND	F(2,108)	3.08	0.17	0.43	1.52	0.08		1.88	1.69	3.10*	1.14
THAILAND	F(2,108)	3.08	0.14	0.53	0.51	0.18		0.69	0.21	0.36	0.04
TURKEY	F(2,108)	3.08	1.15	0.04	0.70	1.22		0.23	1.08	0.92	1.72
UK	F(2,108)	3.08	0.46	0.10	0.21	0.81		1.13	3.03	1.32	0.87
USA	F(6,110)	2.18		0.23				1.01			

Note: * denotes statistical significance at the 5 percent level.

Annex II. Impulse Response Functions

Figure 8. GIRF of GCC Inflation (annualized) to 1 S.D Domestic and External Shocks

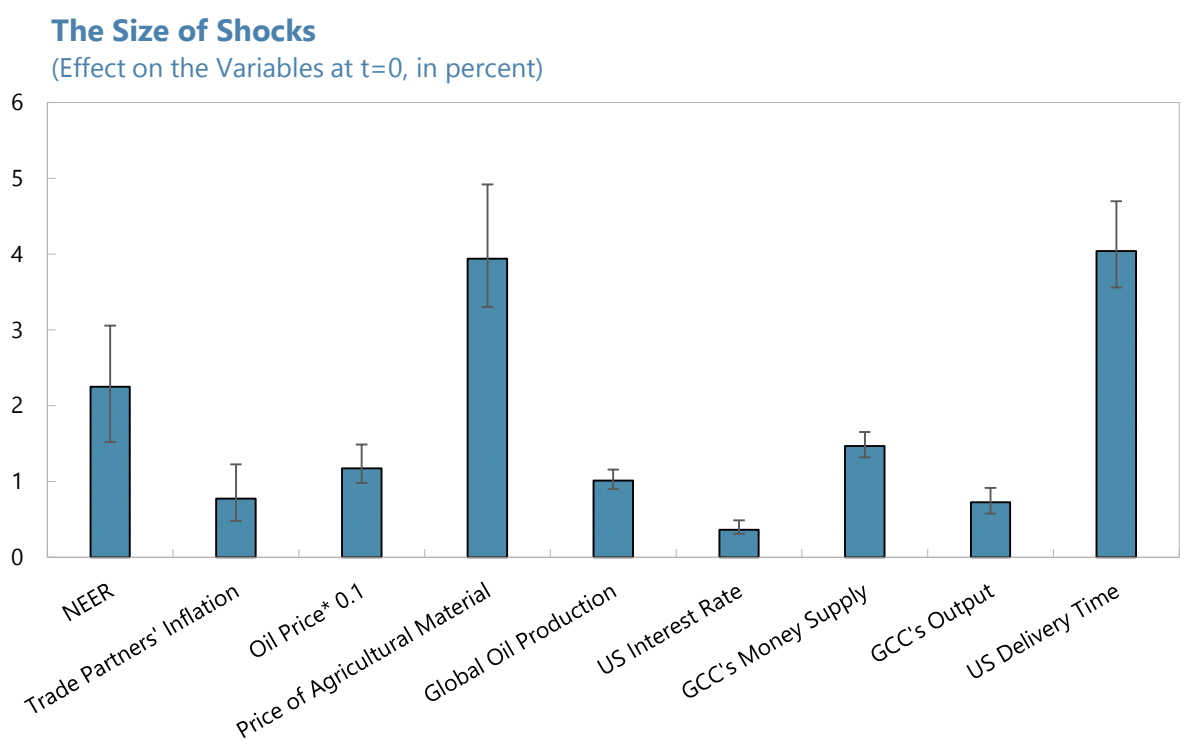


Note: The error bands depict the 16th and 84th percentile. Shock to trade partner's exchange rate means an appreciation in GCC's NEER.

Annex III. Magnitude of Shocks

Figure 9 displays the immediate response of each variable to a one standard deviation shock. Specifically, a one standard deviation shock to the exchange rate of trade partners is equivalent to a 2.2 percent appreciation of GCC's NEER. Meanwhile, a one standard deviation shock to global oil production and real output in GCC leads to a 1 percent and 0.7 percent increase, respectively. Moreover, a one standard deviation shock to trade partner's inflation, oil price, price of agricultural material, U.S. interest rate, and U.S. delivery time increases these variables on impact by 0.8 percent, 12 percent, 4 percent, 0.4 percent, 1.5 percent, and 4 percent, respectively.

Figure 9. Immediate Effects of 1 S.D. Shock on Each Variable



Note: The error bands depict the 16th and 84th percentile. All columns are showing percentage point changes, except for NEER, global oil production, and GCC's output which are percent changes. The size of the oil shock is scaled by 0.1. An increase in NEER shows appreciation. The interest rate is annualized.

PUBLICATIONS