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DETERMINANTS OF TIME-VARYING SENSITIVITY OF MENA COUNTRIES TO GLOBAL SHOCKS: A STATE SPACE APPROACH

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Abstract

This paper examines whether the mechanism by which global shocks are transmitted into MENA countries changes over time. Three main questions are investigated by implementing TVC-VAR methodology. 1) Do MENA countries respond differently to global economic shocks? 2) Do the reactions of countries to global economic shocks vary over time? 3) What are the structural factors that determine the sensitivity of a country to global shocks? The responses of countries to shocks, to global GDP and oil price are investigated. The empirical results indicate that the reaction of countries to global shocks differs significantly among MENA countries. Also, the response of an individual country varies over time. Finally, economic factors like the exchange rate regime, monetary policy, transparency of the central bank and institutional quality play significant roles in the reaction of domestic GDP to shocks, to global GDP and oil price. The results of this paper have significant policy implications especially for AGCC countries.

ملخص

يدرس هذا البحث الآلية التي تنتقل عن طريقها تغيير الصدمات العالمية إلي دول منطقة الشرق الأوسط وشمال أفريقيا بمضي الوقت. وهناك سؤالان رئيسان يتم بحثهما من خلال تنفيذ معاملات الارتباط لبارسون و (1: TVC-VAR هل تستجيب دول منطقة الشرق الأوسط وشمال أفريقيا علي نحو مختلف للصدمات الاقتصادية العالمية؟ 2) هل تتفاوت ردود فعل هذه الدول بشأن هذه التغيرات علي مدار الوقت؟ وتشير النتائج التجريبية إلي أن مدي استجابة دول منطقة الشرق الأوسط وشمال أفريقيا لهذه التغيرات الاقتصادية العالمية تتفاوت بصورة ذي بال بين دول منطقة الشرق الأوسط وشمال أفريقيا. كما تتفاوت أيضا استجابة الدولة الواحدة لهذه التغيرات علي مدار الوقت. ولنتائج هذا البحث تضمينات ذات بال لاسيما بالنسبة للدول العربية الأعضاء بمجلس التعاون الخليجي.

1. Introduction

The recent financial crisis once again proved that the economic effect of globalization is increasing and cross-border spillover effects on domestic economies became an incremental part of macroeconomic policy. As indicated by Berument and Ceylan (2008) understanding the nature of this relationship is important, especially for emerging markets, as international capital flows are a significant portion of their economy, whereas they are unable to affect world financial markets.

This paper examines whether the mechanism by which global shocks are transmitted into MENA countries changes over time. In other words, this paper is concerned with three main questions: 1) Do MENA countries respond differently to global economic shocks? 2) Do the reactions of countries to global economic shocks vary over time? 3) What are the structural factors that determine the sensitivity of a country to global shocks? The responses of countries to shocks to global GDP and oil price are investigated. We pay special attention to Arab Gulf Cooperation Council (AGCC) countries since those countries are forming a monetary union in 2010 and country specific properties have many interesting policy implications for the upcoming AGCC Central Bank.

To analyze these questions we implement a novel state-space approach, time-varying coefficient VAR (TVC-VAR) method. We analyze the robustness of our results by implementing the standard Pearson Correlation Coefficient method.

This paper makes a methodological contribution to the literature since the TVC-VAR methodology has not been implemented in an international macro-economy framework before. It does not restrict the coefficients of the VAR system to be constant and the coefficients of the VAR at each time period can be calculated using TVC-VAR. There are two main results for this empirical study. First, different countries react differently to global economic shocks. Second, the response of macroeconomic variables to global shocks is not constant and varies significantly over time. Both the TVC-VAR and Pearson correlation coefficient methods conclude the same results. Thus, we claim that our results are robust to methodology and also robust to selection of indicator of global shocks. We analyze the impact of both a shock to global GDP and a shock to oil prices.

The results of this paper have many policy implications. First, policy makers of the AGCC should take into account the significant differences in responses of different members to global shocks. Second, policy makers should consider the change in the reaction of the economy to global shocks over time. Finally, this paper identifies the structural economic factors that significantly affect how a country reacts to global shocks.

The impact of external factors on the macroeconomic dynamics of small open economies has been extensively studied in the literature. Ahmed and Park (1994) examine the impact of external and country specific shocks on output, inflation and trade balance of OECD countries. Kim (2001) implements a structural VAR methodology to investigate the impact of US monetary policy on remaining G7 countries. Louis et al. (2008), investigates whether the non-oil sectors of AGCC countries have common responses to macroeconomic shocks.

Berument and Ceylan (2008) examine the reaction of domestic interest rates of a set of MENA countries to the US monetary policy surprises. Thus, many studies investigate the impact of external (global) shocks on developing economies. This paper has two main contributions to the literature mentioned above. First of all, the time variation in the responses of the macroeconomic variables to global shocks has not been investigated for MENA countries in the literature. Second, this paper implements the TVC-VAR methodology in an international macroeconomic framework which has not been employed in the literature before.

The paper proceeds as follows. Section 2 presents the methodology employed in this study. Section 3 introduces the data and implements the TVC-VAR methodology. Section 4 conducts panel data analysis to investigate the structural economic factors that affect the sensitivity of countries to global shocks. Finally, Section 5 concludes.

2. Methodology

The transmission of global shocks can be investigated using VAR as in Kim (2001). Also, the Pearson correlation coefficients between global business cycles and business cycles of MENA countries present the relationship between global shocks and the economic conditions on MENA countries as presented in Baxter and Kouparitsas (2005). Our main empirical analysis uses time-varying coefficient VAR (TVC-VAR) and we also implement the Pearson correlation coefficient methodology to check for the robustness of the TVC-VAR results.

2.1 TVC-VAR Modeling

Following Höppner et al. (2008), we derive the time-varying accumulated impulse responses for each country which allows us to investigate the real effects of global shocks over time. The methodology can be sketched as follows.

Consider the following structural form equation that describes the economy

$$G(L)\, Y_t = e_t \qquad (1)$$

where $G(L)$ is a matrix polynomial in the lag operator L, Y_t is an $n \times 1$ data vector, and e_t is an $n \times 1$ structural disturbance vector. Equation1 leads us to a reduced form VAR

$$Y_t = A_t(L)\, Y_{t-1} + U_t \qquad (2)$$

where $A_t(L)$ is a matrix polynomial in lag operator L and $\text{var}(u_t) = \sum_{u,t}$

The incremental feature of equation 2 is the companion matrix, $A_t(L)$, which contains the coefficients of the VAR. Unlike standard VAR representation the companion matrix is time-dependent and the coefficients of each equation of the VAR system changes over time. An alternative representation of equation 2 shows this feature of our empirical model in a more transparent way.

$$Y_t = A_{0,t} + A_{1,t}\, Y_{t-1} + \ldots + A_{p,t}\, Y_{t-p} + U_t$$

This TVC-VAR setup calls for estimation of the companion matrix and a variance covariance matrix, $\sum_{u,t}$ for every time period, t; where U_t is distributed as $U_t \sim N(0, \sum_{u,t})$.

The time-varying coefficients of the VAR presented above can be estimated using the standard VAR tools. Hamilton (1994) presents that the Kalman filter methodology can be implemented to for estimation of a VAR with time-varying coefficients. Höppner et al. (2008) and Özlale and Özbek (2008) implement the Kalman filter methodology to analyze the time-varying effects of monetary policy and growth shocks respectively. Similarly, Leigh (2008) and Ireland (2007) use the Kalman filter to estimate the time-varying implicit inflation target of the Federal Reserve. The Kalman filter indicates that when a system can be presented in a state space representation then the parameters of the system can be estimated using maximum likelihood. The state space representation is as follows.

$$\zeta_t = F\, \zeta_{t-1} + \nu_t \qquad (3)$$

$$O_t = B'\, X_t + H'\, \zeta_{t-1} + \omega_t \qquad (4)$$

Equation 3 is the state equation which shows the dynamics of the unobservable variables of the system and equation 4 is the observation equation. As a result, and in order to implement the Kalman filter, we need to present the TVC-VAR model of equation 2 as the state space

representation of equations 3 and 4. Hamilton (1994) shows that the state space representation of the TVC-VAR model of equation 2 is:

- Observation Equation:

$$Yt = At \begin{bmatrix} Y_{t-1} \\ \cdot \\ \cdot \\ \cdot \\ Y_{t-p} \end{bmatrix} \quad (5)$$

Or

$$Y_t = A_t X_t + \mathcal{E}_t$$

- State Equation:

$$A_t = A_{t-1} + \eta_t \quad (6)$$

With $\eta_t \sim N(0, \sigma^2_{\omega})$

The lagged variables and the parameter vector appear in multiplicative form in the state equation. Thus, a method that can deal with the nonlinearity should be implemented. Özlale and Özbek (2008) indicate that the nonlinear form of the state-space representation necessitates the use of the extended Kalman filter. The maximum likelihood estimation of TVC-VAR is presented in detail in Hamilton (1994) Ch.13.8. The Kalman filter and maximum likelihood estimation of the parameter of the state space are explained in detail in the Appendix.

We calculate the impulse responses in order to investigate how the responses of macroeconomic variables to global shocks change over time. The VAR format provides a convenient way of examining the response of the system from an initial steady state to a positive, one-standard-deviation impulse in specified economic shocks at date 1. The impulse response functions can be defined as follows:

$$\frac{\partial Y_{t+s}}{\partial u_t} = A^s \quad (7)$$

where A is the companion matrix, Y_{t+s} is s-period ahead variable, and u_t is the shock to Y_t. The time-varying accumulated impulse responses of macroeconomic variables of each country are calculated and compared following Höppner et al. (2008).

Another significant feature of the VAR methodology is the identification of the model. Höppner et al. (2008) use Cholesky decomposition as in Sims (1980) to achieve identification of the model. The order of the variables is important in employing the VAR since the Cholesky decomposition imposes a recursive contemporaneous casual structure on the VAR models. Variables higher in the order are assumed to cause contemporaneous changes in variables lower in the order. Variables lower in the ordering are assumed to affect variables higher in the ordering only with a lag. (Ito and Rose, 2008). Thus, the global shock variable (world output, spot oil price) is ordered first because global variables might have significant contemporaneous effects on the country-specific macroeconomic factor. Kose et al. (2003) use the growth rate of world output as a measure of global shock. For the macroeconomic variables that represent the individual economy, we implement the reduced form structure that has been used extensively in the literature. Studies like Sims (1980), Famer (1987) and Canova (2005) employ reduced form VAR models which include real activity (real GDP), inflation, measure of interest rate and money. Also, exchange rate is included in the system since it is closely related to international shocks.

Thus, the macroeconomic variables of the VAR system consist of these variables in the order specified above. The VAR system of equation 2 is:

$$Y_t = \begin{bmatrix} Global_t \\ GDP_t \\ Interest_t \\ Money_t \\ Exchange_t \end{bmatrix}$$

2.2 Pearson Correlation Coefficients

Many studies like Frankel and Rose (1998) and Imbs (2006) employ the Pearson correlation coefficient to determine the time-varying relationship between cyclical GDP components of two countries. We calculate the time-varying correlation between global GDP cycles and individual MENA countries' GDP cycles to examine how response of macroeconomic conditions of the country to global shocks changes over time. To be able to implement the methodology first we calculate the cyclical components of both global and MENA country GDPs. Flood and Rose (2009) use four different trending methods to calculate business cycle deviations from trend: the Hodrick-Prescott filter, the Baxter-King band-pass filter, the fourth difference linear model and construct trends by regressing output on linear and quadratic time trends as well as quarterly dummies. They conclude that differences across detrending techniques tend to be small. Thus, we employ the well-known Hodrick-Prescott filter to calculate business cycles of each country. We detrend the natural logarithm of GDP of each country by subtracting the Hodrick-Prescott trend:

$$ADP_{i,t}^{H,P} = ADP_{i,t} - \hat{ADP}_{i,t}^{H,P}$$

Following Flood and Rose (2009), we calculate the correlation coefficients using twenty quarterly observations (5 years) of data. The correlation coefficients are defined as:

$$\rho_{i,G,\tau} = \frac{1}{T-1}\sum_{t=1}^{\tau}\left(\frac{y_{i,t}-\bar{y}_{i,\tau}}{\sigma_{G,\tau}}\right)\left(\frac{y_{G,t}-\bar{y}_{G,\tau}}{\sigma_{G,\tau}}\right) \qquad (8)$$

where $\rho_{i,G,\tau}$ is the sample correlation coefficient estimated between output for country *i* and global factor *g*. $\bar{y}$ and σ denote the corresponding sample mean and standard deviation respectively.

3. Empirical Results of TVC-VAR

We apply the TVC-VAR methodology to a standard six-variable VAR as in Höppner et al. (2008) and Kim (2001). The country specific variables are GDP, consumer prices, interest rate (money market rate or t-bill rate as in Berument and Ceylan (2008)), aggregate money supply and exchange rate. All variables are in log differences. The frequency of the data is quarterly and the source of the data is the International Financial Statistics (IFS). The global variables are added to the VAR. The variables are ordered in the following order: global variable and country specific variables. The Augmented Dickey-Fuller tests for all variables indicate that the log differences of all variances are stationary[1]. Höppner et al. (2008) indicates that TVC-VAR methodology is robust to alternative lag selections. They present the estimation results to a lag order of four. Since there is no statistical criterion is available for the choice of the lag order in the TVC-VAR case we implement the methodology with a lag order of four. The maximum

[1] The unit root test statistics are not displayed for the sake of compactness.

likelihood estimation of the parameters of the state-space requires selection of initial values of each parameter. We follow Hamilton (1994) and use the OLS estimates of the parameters as initial values.

The TVC-VAR methodology is first implemented for the AGCC countries. The AGCC countries are of interest because they are set to form a monetary union in 2010. The next section briefly describes the AGCC countries. Then other MENA countries are investigated.

3.1 Characteristics of the AGCC Countries

The AGCC countries include: Bahrain, Kuwait, Qatar, Oman, Saudi Arabia and the United Arab Emirates (UAE). In this section we provide a brief description of the AGCC countries and provide our motivation to investigate the money-price relationship in these countries. As stated in Hebous (2006), the AGCC aims at supporting the economic integration among its six members since its establishment in 1981. The AGCC formed a customs union in 2003 and AGCC members agreed on launching a common currency by 2010 at the Muscat summit in December 2001.

Even though joining a monetary union has many benefits like promoting trade, reducing country risk and lowering transaction costs, there are major shortcomings for member countries. One of the costs is that a member country loses its ability to conduct a national monetary policy that best fits its economic conditions. Hebous (2006) argues that although the AGCC states have similar economic structures, share a common language and cultural similarities, there are significant challenges to the monetary union. To name a few, the choice of the future exchange rate regime and the convergence criteria might cause serious problems for the union.

Table 1 displays the main economic indicators of the AGCC states. The GDP for the AGCC members as a whole is about 725 billion US dollar in 2006. GDP varies significantly among countries. For example, Saudi Arabia is the biggest economy with a GDP of 356.63 billion which constitutes 49 percent of the AGCC GDP. The second largest economy is UAE with a 22 percent share in the total GDP for all members, while the smallest economy is Bahrain (2.18 percent). The GDP growth rates are relatively high in the AGCC region, for example 10 and 9.4 percent in Kuwait and Qatar respectively. Saudi Arabia is the largest country in terms of population with 23.68 million of all AGCC 34.63 million population.

All AGCC countries are oil-dependent economies. The share of oil production in GDP is highest in Qatar (62.2 percent) and lowest in Bahrain (23.2 percent).

The rate of inflation significantly varies among the member states and the average inflation rate of the AGCC region as a whole is relatively low (5.76 percent). The percentage of government expenditure in GDP is similar in most of the states except for Saudi Arabia where 23.29 percent of GDP is government expenditures.

As a result, the AGCC countries have many economic similarities and differences. All AGCC states are open and highly oil-dependent economies that implement a fixed exchange rate regime pegged to the US dollar. The member states are integrated at many levels with the establishment of a customs union in 2003 and the agreement to introduce a single currency by 2010. For a successful implementation of the monetary union, the dynamics behind the monetary systems of each country should be understood. Specifically, money-price relationship should be investigated thoroughly in the AGCC countries since monetary policy implications highly depend on the transmission mechanisms of monetary policy.

3.2 TVC-VAR Analysis of AGCC Countries

AGCC countries are investigated separately; they are forming a monetary union and country specific feature of transmission of global shocks might have interesting policy implications for the AGCC monetary union. From TVC-VAR estimates we derive an impulse response function

for every point of time over the whole sample period. We display the one-period ahead response of each country's GDP to a shock of a global variable. To enable comparison, Figure 1 presents responses of GDP[2] (industrial production) of all AGCC countries to a shock of global GDP and oil price.

Figure 1 shows that the responses of AGCC countries vary both among themselves and in time. Figure 2 demonstrates how Bahrain's GDP reacts to global shocks over time. The reaction varies significantly over time. Figure 3 shows the reaction of Kuwait's GDP to global shocks over time compared to Bahrain, response of GDP to a global shock is smoother in Kuwait. Yet the time variation of the coefficient is high. Figure 4 shows that Oman's GDP reacts differently to global shocks over time. Figure 5 demonstrates the response of Qatar's GDP to US GDP and oil price shocks. The impact of global shocks on Qatar's GDP is significantly different over time, but after 1990 the response is smoother and does not change over time as drastically as during the pre-1990 period. Figure 6 shows that Saudi Arabia's GDP reacts differently to global shocks over time compared to other AGCC countries the reaction of UAE to global shocks is less volatile.[3]

3.2.1 Analysis of Different Responses of AGCC Countries

Figures 1 to 7 present the response of GDP of AGCC countries to global GDP and oil price shocks. Although the figures represent the cross-country and time-dependent variation of the effect of shocks on these economies, a statistical study is required. Table 1 displays the descriptive statistics and the test statistics of the null hypothesis that the mean and variance of each country is equal. There are two main results that we deduce from Table 1. First, the test statistics reject the null hypotheses. Thus, the response of different AGCC countries to global GDP and oil price shocks are significantly different from each other. This result has significant policy implications for the monetary unification among these countries. Also, there is significant time-variation in the response of each AGCC countries to global shocks. As a result, Figures 1-7 and Table 2 present that the sensitivity of AGCC countries to global shocks varies significantly in time and also among these countries.

3.3 Other MENA Countries

The World Bank definition of the MENA countries is used to identify the MENA countries. Turkey is also included in the MENA country list since it is practically in the MENA region and has significant economic relationships in the region. The IFS database does not contain enough observations or variables for Djibouti, Egypt, Iraq, Lebanon, Libya, Morocco, Syria, and Yemen. Thus, those countries are not investigated.

Figure 12 shows the response of Turkey's GDP to US GDP and oil price shocks Similar to the AGCC countries, the remaining MENA countries respond differently to global shocks over time. Also, the reaction of each country is different from other MENA countries.

3.3.1 Analysis of Different Responses of Other MENA Countries

Figures 7-12 present the response of MENA countries' GDP to shocks in global GDP and oil price. Table 2 displays the descriptive statistics and the test statistics of the null hypothesis that the mean and variance of each country is equal. We conclude that the response of MENA countries to global and oil price shocks are significantly different from each other. Also, there is significant time-variation in the response of each of the MENA economies to global shocks.

To sum up, Figures 8-12 and Table 3 present that the sensitivity of MENA countries to global shocks varies significantly in time and also among MENA countries.

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[2] Industrial production is not available in quarterly frequency for AGCC countries. We used a linear estimation methodology and derived quarterly industrial production using oil production and CPI.

[3] CPI data is not available for UAE. Thus the TVC-VAR is estimated as a system of 5 equations.

4. Panel Data Analysis of the Determinants of Cross-Country Differences to Global Shocks

After determining the significant differences across countries to global shocks, the natural way to proceed is to study the factors that cause this variation. Determination of these factors have significant policy implications. To be able to study the determinants of sensitivity to global shocks, a panel dataset is constructed with time-varying impulse responses of countries and significant structural economic factors. In other words, the effect of the exchange rate regime, inflation targeting, the transparency score of the central bank and institutional quality on the sensitivity to global shocks is investigated. The exchange rate regime is determined using the classification of Edwards and Levy-Yeyati (2003).

Time-varying central bank transparency score of each country is from Dincer and Eichengreen (2009). We use the Polity IV institutional quality measure as employed by Acemoglu and Johnson (2005)[4]. Table 3 displays the recent structural parameter of each country.

Table 4 indicates that the structure of each country is significantly different. Table 5 investigates the impact of these differences on the sensitivity to global shocks. The following regression specification is estimated:

$$Sensitivity_{i;t} = \beta_1 fix_{i;t} + \beta_2 IT_{i;t} + \beta_3 Transparency_{i;t} + \beta_4 Quality_{i;t} + \epsilon_{i;t} \quad (9)$$

where fix and IT are dummy variables that take the value 1 if the country adopts fixed exchange rate regime and inflation targeting respectively. Transparency is the score of Dincer and Eichengreen (2009) and quality is the institutional quality measure of Polity IV.

Table 5 indicates that a country adopting a fixed exchange rate regime and inflation targeting is more susceptible to global GDP shocks. The coefficients of these two variables are significant and positive for the global GDP. Transparency is negatively correlated to sensitivity to global shocks (meaning that more transparent countries are less affected by shocks to global GDP). Finally, institutional quality does not have an effect on the coefficient that relates domestic GDP to global GDP shocks. As a result, Table 4 shows that a country should be more transparent and should not adopt a fixed exchange rate regime to be able to defend its economy against global GDP shocks. The results about inflation targeting are in line with the findings of Flood and Rose (2009). Their theoretical and empirical analyses show that IT can be associated with greater business cycle synchronization. Inflating targeting allows output to move while stabilizing prices so that business cycle synchronization can end up higher.

The third column of Table 4 presents the determinants of the sensitivity of domestic GDP to changes in oil price. Contrary to the case of shocks to global GDP, the coefficients of the variables fix, IT and Transparency are negative. Also, institutional quality plays a significant role and the sensitivity of countries with high institutional quality is more sensitive to oil price shocks. These results are mostly affected by the fact that most of the countries we investigate in this study are oil producers and oil price shocks have positive effects in those countries since oil revenue increases. As a result this section identifies possible factors that determine the sensitivity of a country to global GDP and oil price shocks. We conclude that the structural economic factors like the exchange rate regime, monetary policy, transparency of the central bank and institutional quality play significant roles in the reaction of domestic GDP to shocks to global GDP and oil price.

[4] Acemoglu and Johnson (2005) use the constraint on executive variable in Polity IV as a measure of institutional quality. They explain the variable as follows: A seven category scale, from 1 to 7, with a higher score indicating more constraint. A score of 1 indicates unlimited authority; a score of 3 indicates slight to moderate limitations; a score of 5 indicates substantial limitations; a score of 7 indicates executive parity or subordination. Scores of 2, 4, and 6 indicate intermediate values.

5. Conclusion

This paper examines whether the mechanism by which global shocks are transmitted into MENA countries changes over time. Three main questions are investigated by implementing TVC-VAR and Pearson correlation coefficients: 1) Do MENA countries respond differently to global economic shocks? 2) Do the reactions of countries to global economic shocks vary over time? 3) What are the structural factors that determine the sensitivity of a country to global shocks?

The responses of countries to global GDP and oil price shocks are investigated. The empirical results indicate that the reaction of MENA countries to global shocks differs significantly among MENA countries. Also, the response of an individual country varies over time. Finally, economic factors like the exchange rate regime, monetary policy, transparency of the central bank and institutional quality play significant roles in the reaction of domestic GDP to global GDP and oil price shocks. The results of this paper have significant policy implications especially for AGCC countries. The paper contributes to the literature by implementing a novel methodology which has not been implemented in the international macroeconomics literature. The empirical results identify the underlying economic factors that affect the sensitivity of a country to global shocks.

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Figure 1: Response of AGCC Countries to US GDP Shock

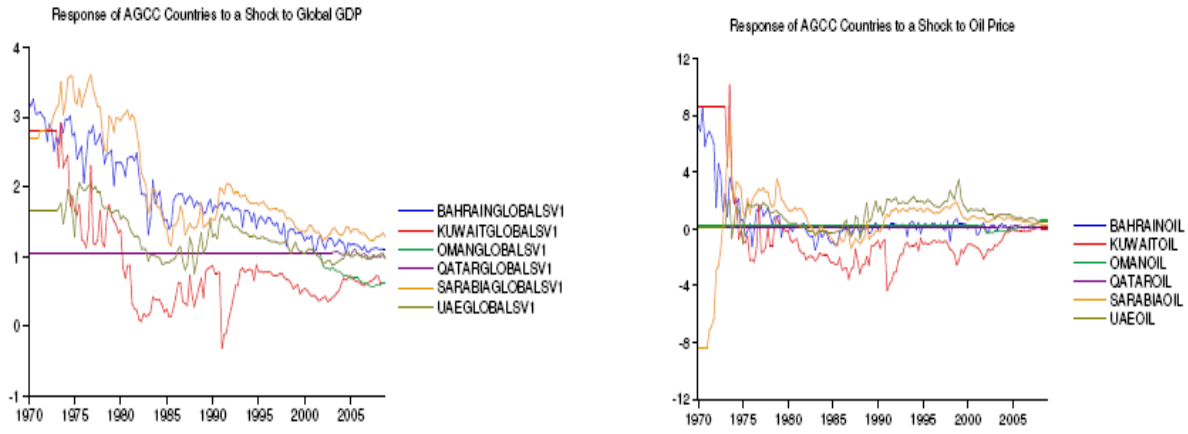


Figure 2: Response of GDP of Bahrain to US GDP and Oil Price Shocks

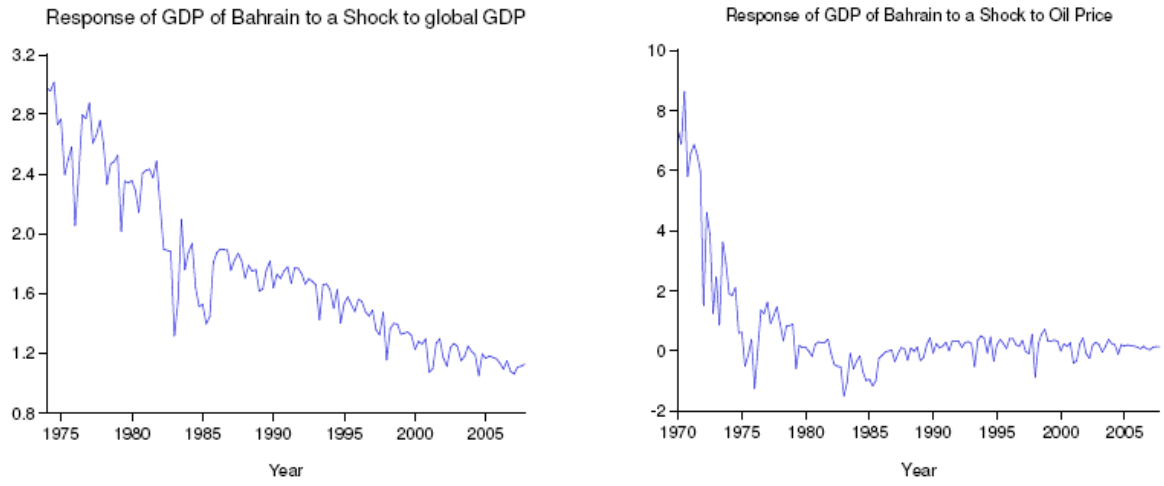


Figure 3: Response of GDP of Kuwait to US GDP and Oil Price Shocks

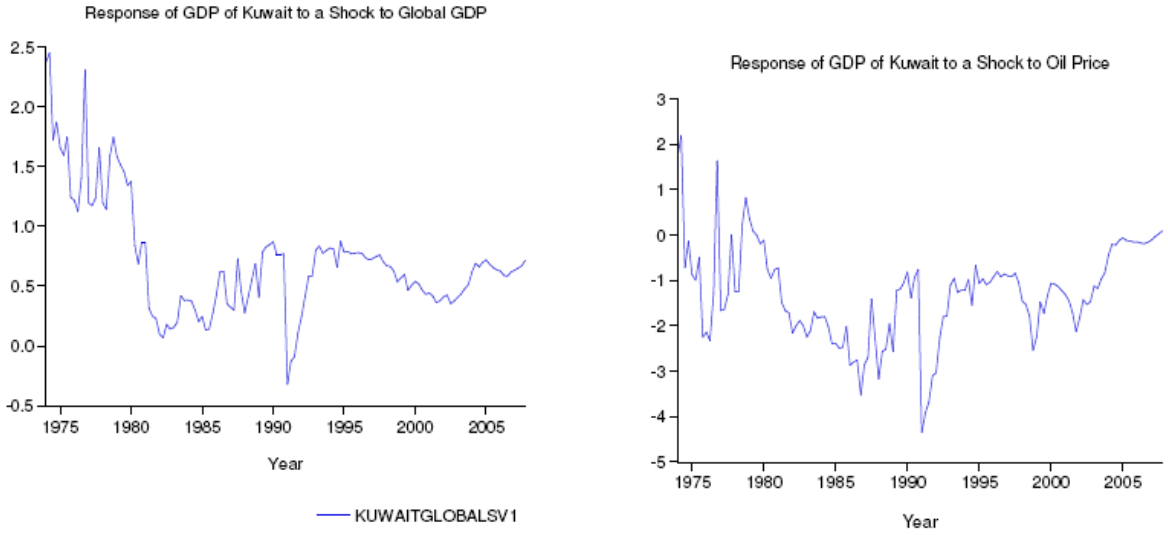


Figure 4: Response of GDP of Oman to US GDP and Oil Price Shocks

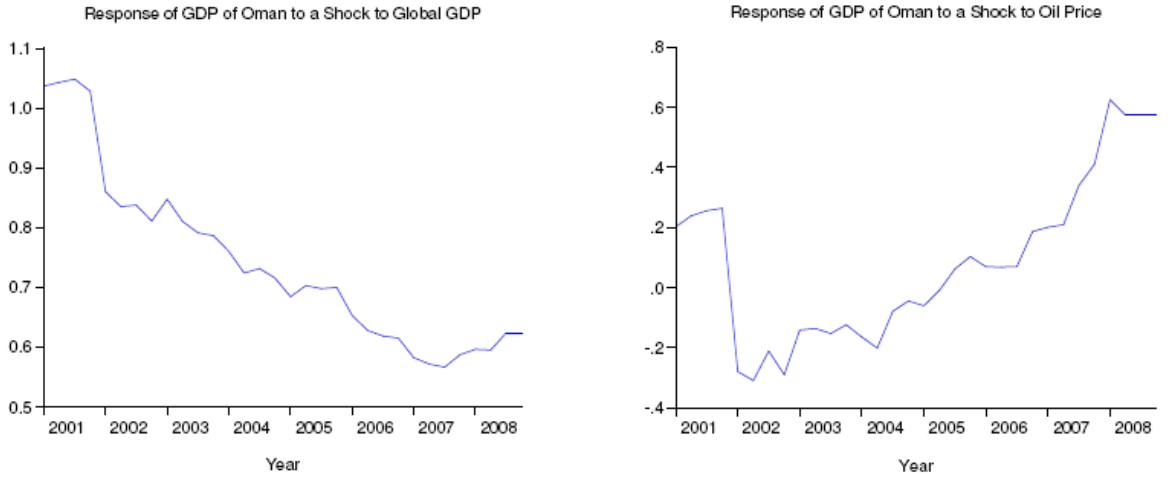


Figure 5: Response of GDP of Qatar to US GDP and Oil Price Shocks

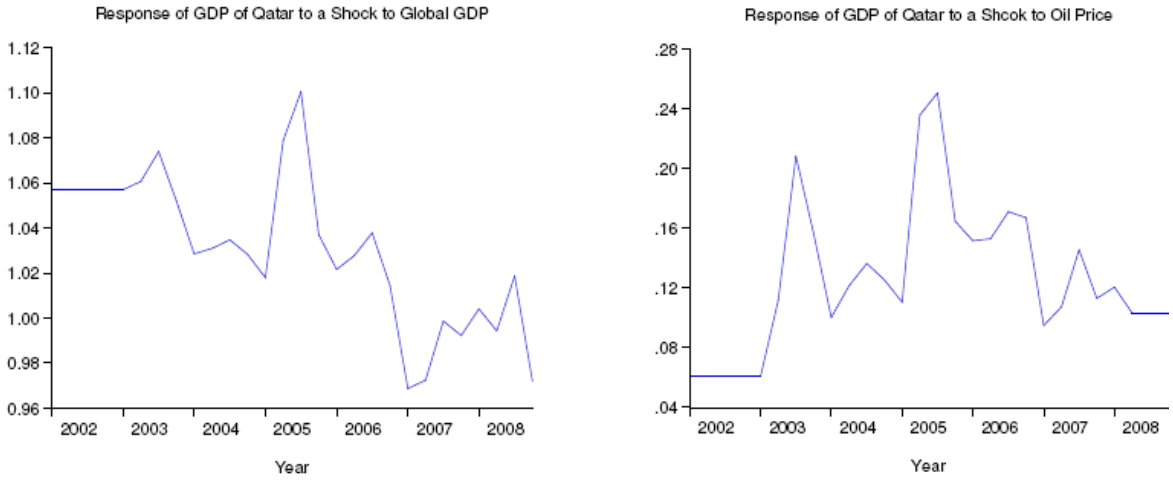


Figure 6: Response of GDP of Saudi Arabia to US GDP and Oil Price Shocks

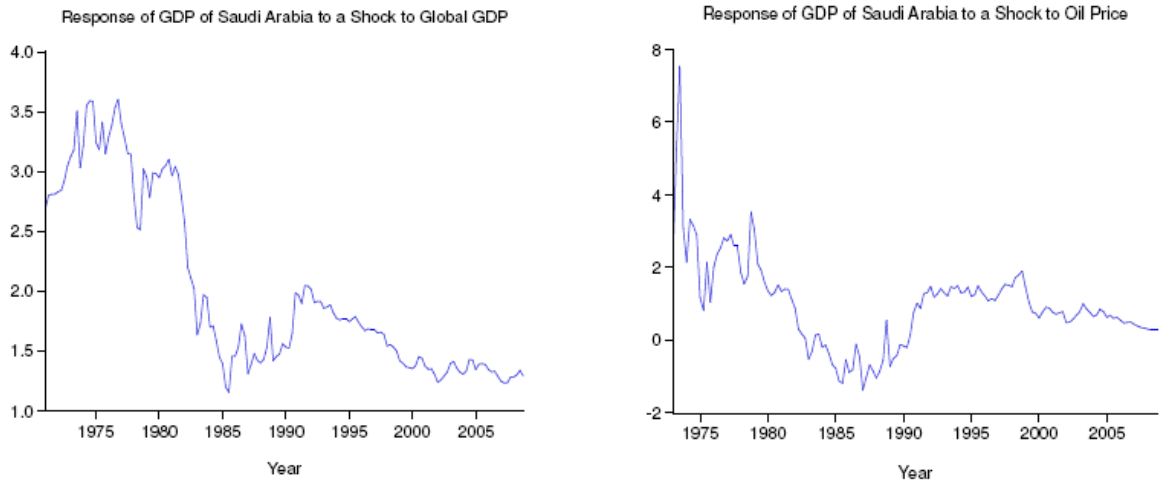


Figure 7: Response of GDP of UAE to US GDP and Oil Price Shocks

Figure 8: Response of GDP of Algeria to US GDP and Oil Price Shocks

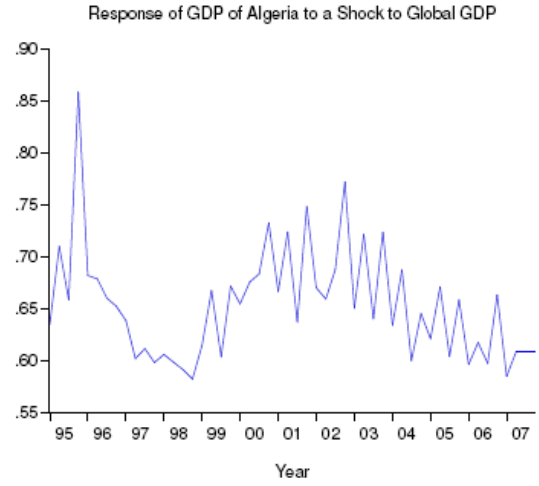
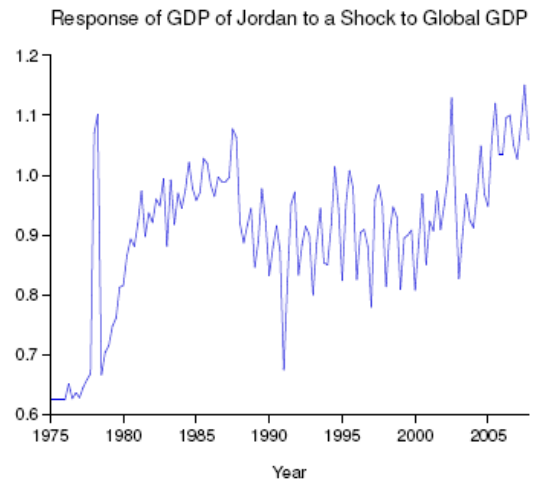


Figure 9: Response of GDP of Iran to US GDP and Oil Price Shocks

Figure 10: Response of GDP of Israel to US GDP and Oil Price Shocks



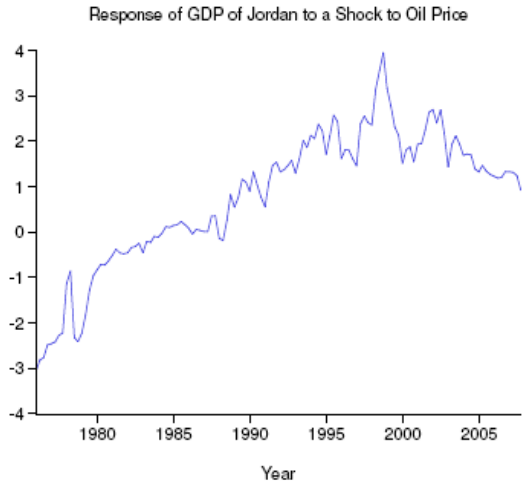


Figure 11: Response of GDP of Tunisia to US GDP and Oil Price Shocks

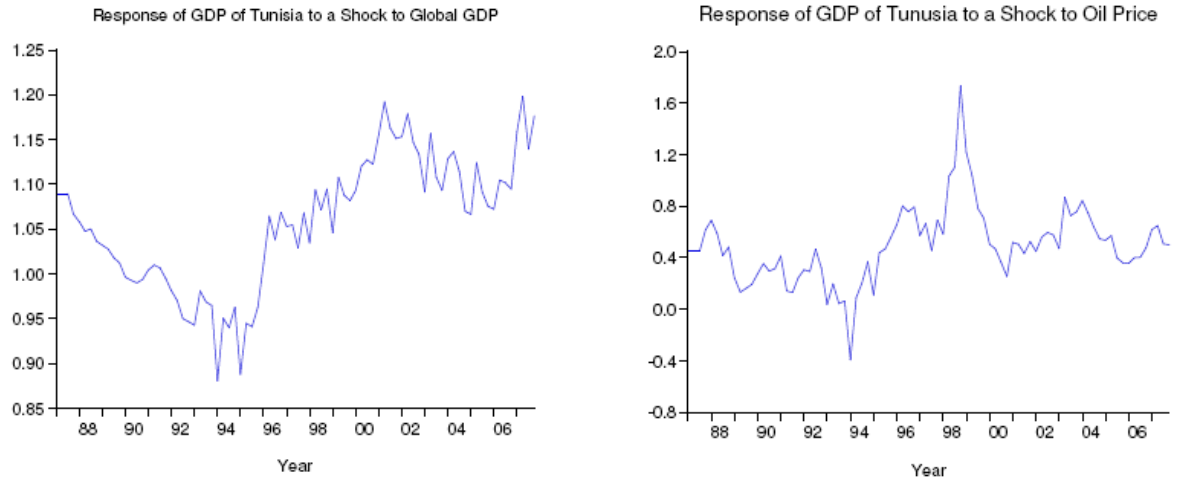


Figure 12: Response of GDP of Turkey to US GDP and Oil Price Shocks

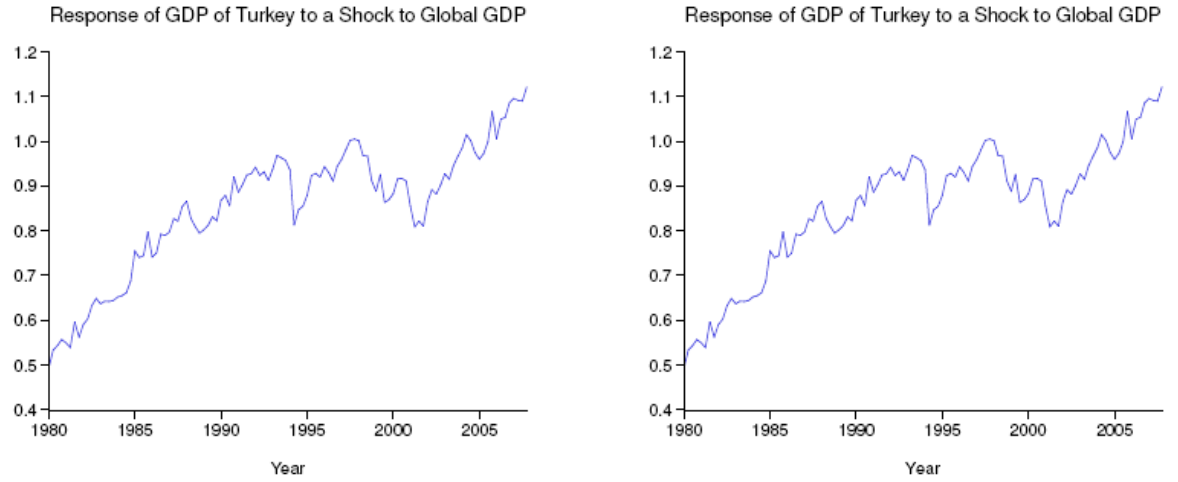


Table 1: Main Economic Indicators in the GCC in 2006

Country	GDP (current US$ Bill)	GDP Share in the GCC GDP (percent)	GDP Annual Growth (percent)	GDP Per Capita (current US$)	Petroleum Production/ GDP (2005 values)	Inflation	Government Expenditure (% of GDP)	Government Deficit (% of GDP)	Population (Mill)
Bahrain	15.83	2.18	7.03	21421.12	23.2	2.01	14.23	3.73	0.74
Kuwait	101.65	14	9.97	39103.49	47.6	3.08	13.88	23.28	2.6
Oman	35.73	4.92	6.27	14031.49	42	3.2	17.89	-	2.55
Qatar	52.72	7.26	9.4	64192.64	62.2	11.83	15.68	9.86	0.82
Saudi Arabia	356.63	49.13	5.31	15061.14		2.21	23.29	-	23.68
UAE	163.3	22.5	8.91	38436.4	32.6	12.23	10.11	-	4.25
GCC	725.85	100	7.16	27343.42	44.34	5.76	15.85	-	34.63

Source: WDI.

Table 2: Descriptive Statistics of Responses and ANOVA Test Statistics for Equality of the Mean and Variance for AGCC countries

Country	Response to Global GDP		Response to Oil Price	
	Mean	Standard Deviation	Mean	Standard Deviation
Bahrain	2	0.73	1.37	2.65
Kuwait	1.39	1.05	1.91	4.67
Oman	0.99	0.12	0.18	0.11
Qatar	1.05	0.2	0.07	0.3
Saudi Arabia	2.19	0.7	-1.76	4.32
UAE	1.33	0.33	0.88	0.84
	Test for Equality Across Countries			
	128.85	458.29	40.61	394.4
	(0.00)	(0.00)	(0.00)	(0.00)

Notes: ANOVA test results. P values presented in parentheses.

Table 3: Descriptive Statistics of Responses and ANOVA Test Statistics for Equality of the Mean and Variance for MENA Countries

Country	Response to Global GDP		Response to Oil Price	
	Mean	Standard Deviation	Mean	Standard Deviation
Algeria	0.64	0.03	-0.47	0.52
Iran	1.62	0.92	7.79	9.51
Israel	0.82	0.23	2.51	1.99
Jordan	0.81	0.17	-0.62	2.17
Tunisia	1.08	0.05	0.47	1.19
Turkey	0.07	0.21	0.07	1.09
	Test for Equality Across Countries			
	171.6	242.5	125.9	230.3
	(0.00)	(0.00)	(0.00)	(0.00)

Notes: ANOVA test results. P values presented in parentheses.

Table 4: Determinants of the Cross-Country Differences to Global Shocks

Country	Exchange Rate	Inflation Target	Central Bank Transparency(Recent)	Institutional Quality
Bahrain	fix	non IT	3	2
Kuwait	fix	non IT	2	3
Oman	fix	non IT	1.5	2
Qatar	fix	non IT	3	1
Saudi Arabia	fix	non IT	1	1
UAE	fix	non IT	2	3
Algeria	float	non IT	-	5
Iran	interm	non IT	-	2
Israel	interm	IT	8.5	7
Jordan	fix	non IT	1	3
Tunisia	interm	non IT	-	2
Turkey	float	IT	8.5	7

Table 5: Panel Data Regression of the Determinants of Sensitivity to Global Shocks

Variable	Global GDP	Oil Price
fix	1.971	-3.986
	(28.07)**	(13.70)**
IT	1.431	-13.819
	(6.47)**	(15.10)**
Transparency	-0.309	0.691
	(14.53)**	(7.85)**
Quality	0.030	1.571
	(1.34)	(16.68)**
R-Square	0.80	2020
Number of Obs.	2020	0.19

Appendix

A. Overview of the Kalman Filter Algorithm

The Kalman filter is an algorithm for sequentially updating a linear projection for a dynamic system which is expressed in state-space representation.

A more complete exposition of the Kalman filter algorithm can be found in Hamilton (1994), chapter 13.

A.1 The State-Space Representation of a Dynamic System

The Kalman filter addresses the general problem of trying to estimate the state ζ of a discrete time-controlled process that is governed by the linear stochastic difference equation.

- State equation

$$\zeta_{t+1} = A\,\zeta_t + B\,\gamma_t + \omega_{t+1}$$

where ζ_t is rx1 state vector and γ_t is the optimal control input with an observation z.

- Observation equation

$$z_t = H\,\zeta_t + Cs_t + v_{t+1}$$

where z_t is (nx1) vector of variables observed at time t and s_t (kx1) vector of exogenous or predetermined variables.

F, A', and H' are matrices of parameters of dimension (r x r), (n x k), and (n x r), respectively. The (r x 1) vector ω_t and the (n x 1) vector v_t are vector white noise. v_t and w_t are assumed to be independent of each other and with normal probability distributions

$P(v) \sim N(0, Q)$

$P(\omega) \sim N(0, R)$

A.2 Forecast Equation of the Kalman Filter

When the system can be expressed in state space representation as in A.1, the Kalman filter delivers the following forecast equation after many calculations and manipulations:

$$\hat{\zeta}_{t+1/t+1} = A\,\hat{\zeta}_{t/t} + B\,\gamma_t + K_t(z_t - (A\,\hat{\zeta}_{t/t} + B\,\gamma_t))$$

$$K_t \equiv (Ap_{t-1}A' + Q)\,H'(HP_{t-1}\,H' + R)^{-1}$$

where $\hat{\zeta}_{t+1/t+1} = E(\hat{\zeta}_{t+1} / \Omega_t + 1)$ and $P_t = E[(\zeta_t - \hat{\zeta}_{t/t})(\zeta_t - \hat{\zeta}_{t/t})']$.

B. Data

The data used in this study can be presented as the macroeconomic variables and structural variables. The AGCC (Bahrain, Kuwait, Qatar, Oman, Saudi Arabia and the United Arab Emirates), and other MENA countries (Algeria, Iran, Israel, Jordan, Tunisia and Turkey) are investigated. The data is quarterly from the International Financial Statistics (IFS) of the IMF. All available data is used.

B.1 Macroeconomic Variables

The GDP, CPI inflation, exchange rate, interest rate and monetary aggregates are used in the VAR analysis. The global variables are global GDP from the IFS. The oil price is the crude oil price of the West Texas Intermediate from the FRED database of the Federal Reserve Bank of St Louis.

B.2 Structural Variables

The exchange rate regime, inflation targeting, the transparency score of the central bank and institutional quality are used to present the structure of the economy. The exchange rate regime is determined using the classification of Edwards and Levy-Yeyati (2003). Time-varying central bank transparency score of each country is from Dincer and Eichengreen (2009). We use the Polity IV institutional quality measure as employed by Acemoglu and Johnson (2005).

C. Pearson Correlation Coefficient Analysis

To validate the robustness of our results, we implement the Pearson correlation coefficient method which is extensively used in the international macroeconomics literature. The coefficient determines the relationship between cyclical components of US GDP and GDP of each MENA country at each time period. Thus, this method also allows us to examine the time variation in the responses of countries to global shocks.

C.1 Analysis of AGCC countries

Figure 13: Pearson Correlation Coefficient for all AGCC Countries.

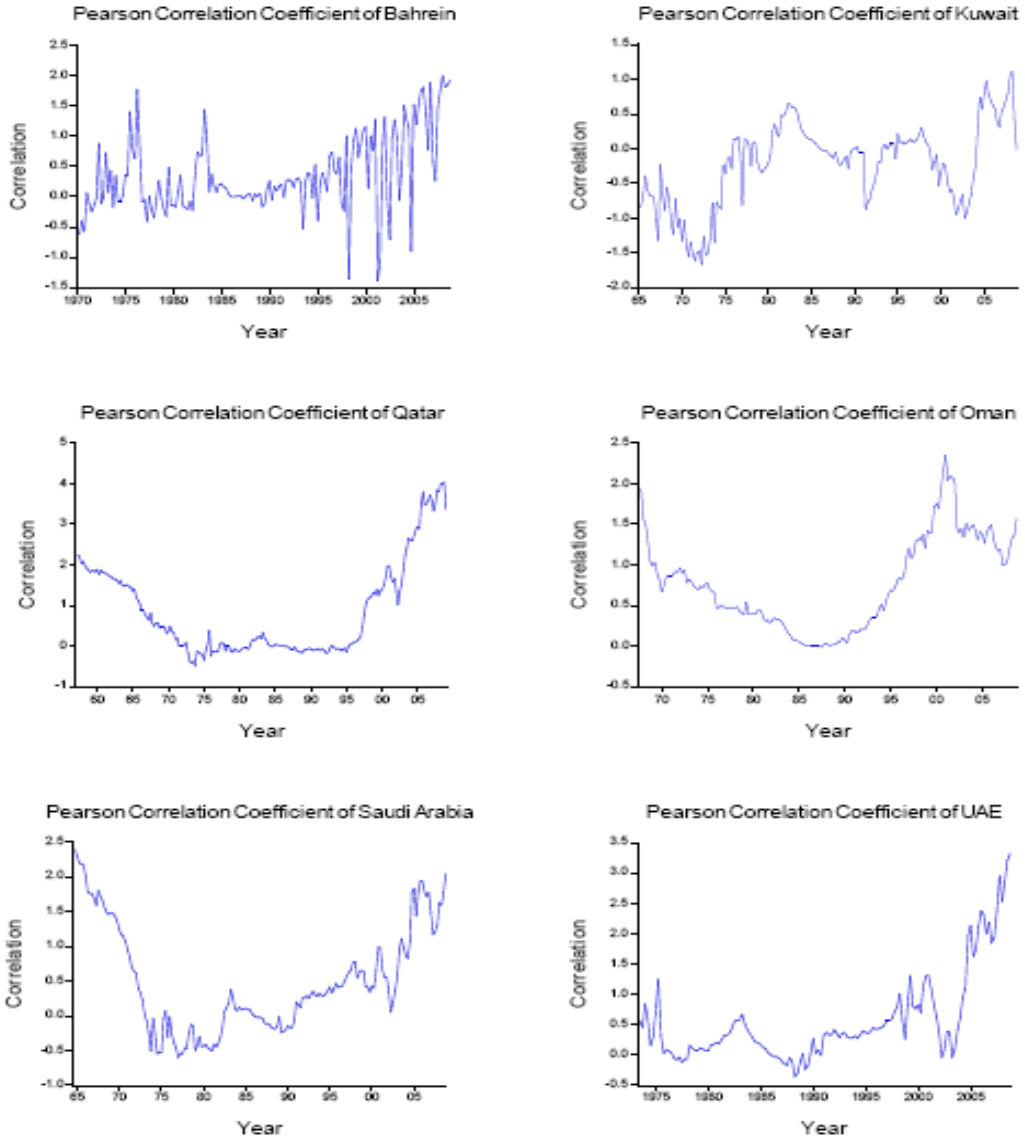


Figure 13 depicts the Pearson correlation coefficients of cyclical components of US GDP and AGCC countries. The coefficient varies a lot in Bahrain and Kuwait. The other countries have similar Pearson correlation coefficients.

C.2 Analysis of Other MENA Countries

Figure14: Pearson Correlation Coefficient for the Remaining MENA Countries.

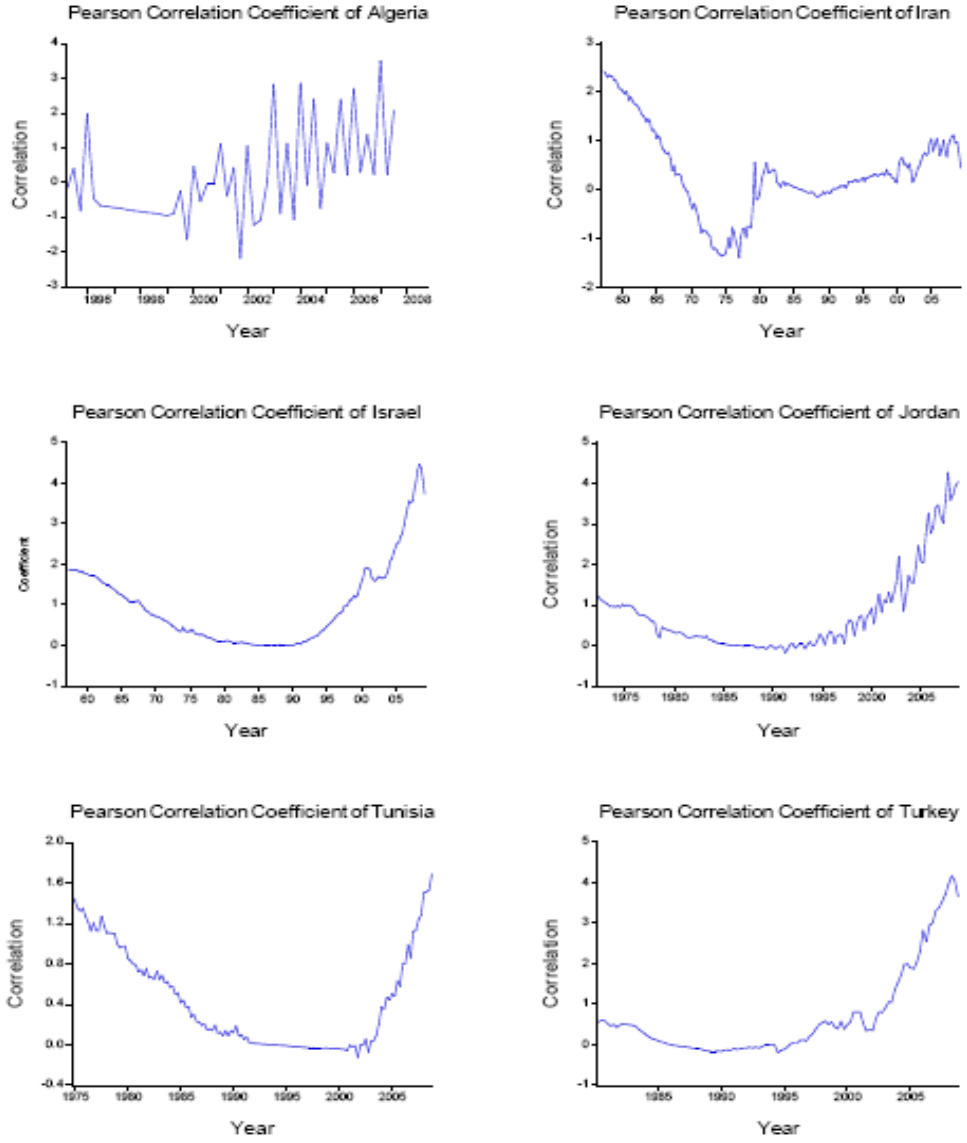


Figure 14 depicts Pearson correlation coefficients of cyclical components of US GDP and remaining MENA countries. Except for Algeria and Iran the remaining MENA countries have similar Pearson correlation coefficients. In all countries, the coefficient significantly varies over time.