Volatility, Diversification and Development in the Gulf Cooperation Council Countries[1]

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Introduction

Confronting the economic and security challenges posed by an unstable regional environment, the governments of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates agreed in 1981 to form the Gulf Cooperation Council (GCC). Initially a common trade bloc, the GCC launched a common market on January 1, 2008, and plans to establish a common currency, the *Khaleeji*.

The economic history of these six countries has been powerfully shaped by the discovery of oil fields, which started in Bahrain in the early 1930s, Saudi Arabia and Kuwait in the late 1930s, and Qatar, Oman, and the United Arab Emirates in the 1940s and 1950s. While initially the oil fields were exploited by British companies, by the early 1970's all six countries had gained independence and were in full control of the fields and means of production, as well as being active members (except for Bahrain and Oman) of the Organization of the Petroleum Exporting Countries (OPEC). Oil had by then become the dominant sector in these economies.

The steep rises in oil prices caused by the 1973 Arab oil embargo and the 1979 Iranian revolution, and the dramatic six-year-long decline in prices caused by the oil glut that followed, led to increased concern for the insurmountable volatility brought about by the economies' heavy reliance on oil. These developments were to a large extent the motivation for one of the central objectives of the 1981 Unified Economic Agreement between the Countries of the Gulf Cooperation Council, which seeks to "coordinate industrial activities, formulate policies and mechanisms which will lead to industrial development and the diversification of their products on an integrated basis." (Article 12).

In this chapter, we seek to study whether and to what extent the objectives of industrial development and diversification envisioned in the formation of the GCC have materialised.[2] Concretely, we study the patterns of economic diversification and volatility in all six countries, decomposing volatility in three main components.

The first component relates to the volatility of sectoral shocks. In general, the more diversified countries are, and the smaller the intrinsic variability of each sector, the lower is the level of volatility. Sectoral shocks can be global (affecting all countries in the world in the

[2] For theories linking risk, diversification, and development, see Acemoglu and Zilibotti (1997), Greenwood and Jovanovic (1990), Kraay and Ventura (2007), Obstfeld (1990) and St. Paul (1992). For theories of sectoral transformation, see Caselli and Coleman (2000) and the references therein.

same direction) or country-specific (having different effects in different countries, as, we will argue, is the case with oil shocks).

The second component relates to aggregate country-specific shocks. This component captures aggregate shocks that affect all sectors in the economy, reflecting, for example, policy, institutional, or political changes, as well as technological shocks that are common to all sectors.

The third component relates to the covariance between country-specific and sector-specific shocks; in particular, changes in fiscal or monetary policy instruments in some countries might be a response to shocks experienced by different sectors. This component would be negative, and hence reduce aggregate volatility, for example, if macro-economic policies are countercyclical, that is, they are aimed at neutralizing or mitigating the effect of economic cycles. In the context of GCC countries, this would entail reducing government spending or tightening credit during downturns or periods of relatively low demand for oil and gas. As we show in the paper, in most GCC countries this component is instead positive and large, contributing to aggregate volatility. We argue that this is largely due to the lack of actively countercyclical monetary policy (due to the choice of a fixed exchange-rate regime) and a generally pro-cyclical government spending pattern.

We put the results into context by comparing the countries' patterns of volatility with those observed in other countries at the same level of development, as well as with those observed in other resource-rich economies.

The paper is organized as follows. Section 2 describes the evolution of growth rates, volatility, and the shares of different sectors in the six GCC economies from 1970 to 2006. Section 3 studies the sources of economic volatility and compares the performance of GCC countries vis-à-vis countries at the same level of development or rich in natural resources. Section 4 offers concluding remarks.

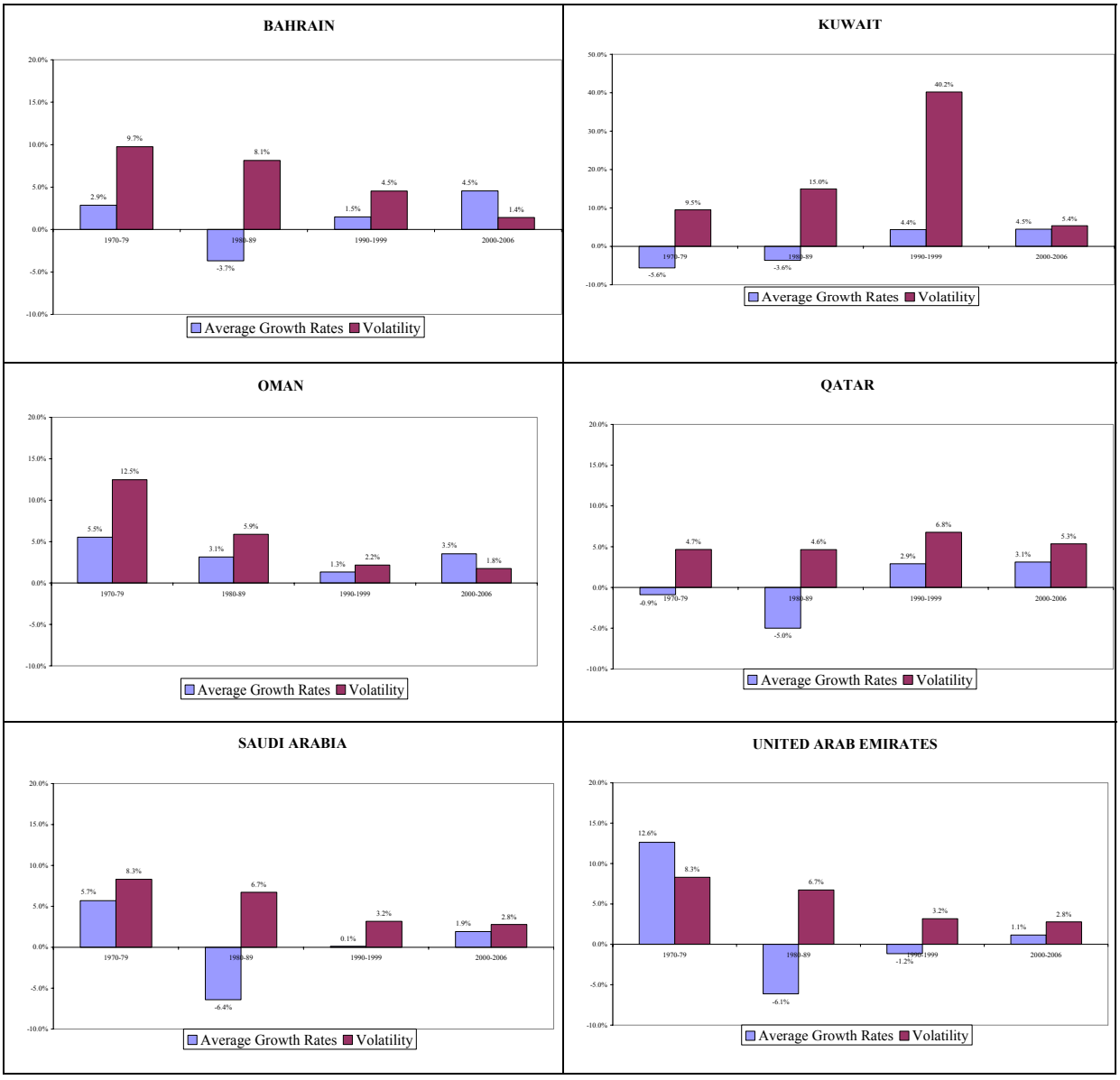
Economic Growth, Volatility and Diversification

The economic performance of GCC countries has been anything but uniform, as illustrated in Figure 1.[3] The Figure depicts the average yearly growth rate of per capita GDP (left bars) and the level of volatility, measured as the standard deviation of annual growth rates (right

[3] All subplots share the same scale, except for Kuwait's, since the high volatility of the 90s, caused mainly by the war, is exceedingly large.

bars), by decade, from 1970 through 2006, for all countries in the GCC.[4] Measured as such, volatility captures deviations, both up and down, from the average growth rate of the decade. These deviations are what we refer as "shocks". The 1970s witnessed large growth rates in the United Arab Emirates (12%), Saudi Arabia (5.7%), Oman (5.5%), and Bahrain (3%), together with negative growth rates in Kuwait and Qatar. The common denominator for the period was the extremely high volatility faced by all six countries. The 1980s opened a grim chapter of negative growth rates for all countries (except Oman), with losses ranging from 3.6% per year in Kuwait to 6.5% per year in Saudi Arabia, and continually high levels of volatility.

Figure 1. Average Yearly Growth Rates and Volatility, by Country: 1970-2006.



[4] The raw data come from the United Nations (UN) Statistical data base from 1970 through 2006.

In the 1990s, despite the difficult start, most countries posted net gains, with the exception of the United Arab Emirates. Kuwait, in particular, experienced an average growth rate over the decade of 4.4%, after two decades of negative growth. Volatility during the decade was still high in all countries, with Kuwait's being dramatically high by any metric. The early 2000s paint a totally different picture: positive growth in all countries together with unprecedented stability.

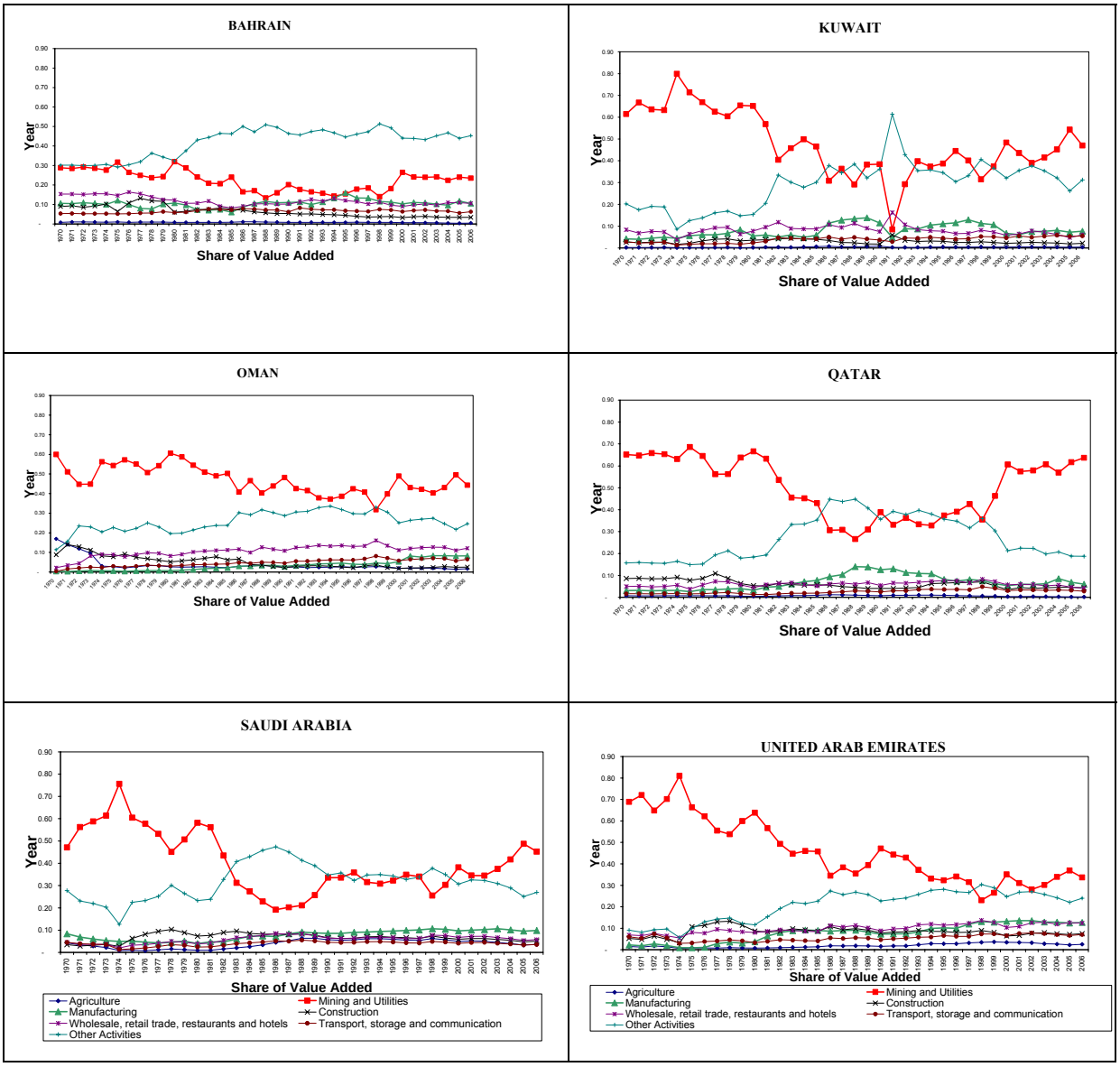
The lower volatility of the later period does not seem simply the result of positive contagion from the so called "Great Moderation," or the long period of low volatility enjoyed by most developed countries before the onset of the current financial crisis. More fundamental changes seem to have taken place in GCC countries, as illustrated in Figure 2. The Figure shows the shares of different sectors in total GDP from 1970 through 2006 for all six GCC countries.

As Figure 2 shows, the most prominent sector in all subplots is Mining and Utilities, reflecting the preponderance of oil in GCC economies.[5] The prevalence of oil, however, has been decreasing. Most notably, the United Arab Emirates have seen a steady decline in Mining as a share of GDP, from above 70% in the 70s to around 30% in the 2000s, despite the sharp increase in oil prices in recent years. "Other activities", comprising financial intermediation, real estate, public administration, education, health, and other services, have gained ground during this period to reach above 20% of the Emirates' GDP by the end of the period. Other GCC countries have undergone a similar, though less steep structural transformation. The earliest diversifier is Bahrain, where services grouped under "Other activities" reached roughly 50% of the economy already in the 1980s. Manufacturing, which was virtually inexistent at the beginning of the 1970s has also increased significantly as a share of GDP in all countries, accounting for about 10% or more of GCC economies.

In spite of the progress over the past decades, however, GCC economies continue to be highly volatile. In the next section, we study the sources of volatility and, in particular, we measure the extent to which sectoral concentration accounts for the observed outcome volatility.

Figure 2. Sectoral Shares of GDP, by Country: 1970-2006.

[5] Mining and quarrying is mostly oil, while utilities include electricity, gas and water supply. Unfortunately, the source (United Nations Statistics) does not disaggregate the data further.



Sources of Volatility and the Role of Sectoral Diversification: A Comparative Analysis

Volatility Components

In this section we study the sources of economic volatility in GCC countries. Following Koren and Tenreyro (2007), the analysis identifies three main components of the volatility of aggregate GDP growth.[6] The first component relates to the volatility of sectoral shocks: an economy that specializes in sectors that exhibit high intrinsic volatility will tend to experience higher aggregate volatility. Two different elements play a role: One is the degree of sectoral concentration (how concentrated or diversified the economy is in terms of the

[6] For alternative or complementary empirical studies see Forni and Reichlin (1996), Brooks and del Negro (2004), del Negro (2003), Kose, Otrok and Whiteman (2002), Imbs and Wagziarg (2000), Imbs (2008), Lehman and Modest (1985), Ramey and Ramey (1995), Stockman (1992).

number and relative sizes of the sectors) and the other is the volatility of the different sectors. In GCC economies, traditionally, the two elements have played in the same direction: The economies have been highly concentrated in one, very volatile sector.

The second component relates to aggregate country-specific shocks that are common to all sectors in the economy. This component aims at capturing the volatility due to macroeconomic policy or political instability. In our study, it will also capture the volatility induced by the the 1991 Gulf war. It may also capture other aggregate shocks, such as technological developments that affect all sectors in the economy.

The third component of volatility relates to the covariance between country-specific and sector-specific shock. Concretely, changes in fiscal or monetary policy in some countries might be deliberate responses to shocks experienced by particular sectors. This component will be negative, for example, if macro-economic policies are countercyclical, that is, they are aimed at mitigating or neutralizing the effect of economic cycles; in the context of GCC economy, a countercyclical policy would imply reducing government spending or tightening credit during periods of relatively weak demand for oil. We show later that this component tends to be positive in most countries, largely reflecting the lack of actively countercyclical policies.

This breakdown of volatility is important because it allows us to asses the extent to which volatility in GCC countries is due to high exposure to the oil sector as opposed to country-specific shocks, more likely to be caused by domestic macroeconomic policy; in other words, aggregate volatility might result from possibly inadequate domestic policies.

Formally, as in Koren and Tenreyro (2007), the variance of GDP growth, Var(y), can be decomposed as (See Technical Appendix):

$$\text{Var(y)=Sectoral Variance + Country Variance + Sector-Country Covariance,}$$

where the sectoral-variance component can be further decomposed into the variance due to global shocks, that is, shocks that affect all countries in the world in the same fashion, and the variance due to idiosyncratic (or country-specific) sectoral shocks, which affect different countries in different ways.

$$\text{Sectoral Variance=Global Sectoral Variance + Idiosyncratic Sectoral Variance.}$$

In the case of GCC countries, we expect both the idiosyncratic sectoral variance (mostly generated by the oil sector) and the country-specific variance (mostly due to policy and political instability, including the 1991 Gulf war to account for a large part of the economies' volatility.

In words, the method used for the volatility decomposition can be summarized as follows. We first compute for each country (c), sector (s) and year (t), a measure of "shock", denoted y_{cst}. This is calculated as the deviation of the growth rate of a given sector in a given country from the average growth rate over the period. We measure sector-specific shocks (λ_{st}) as the average of y_{cst} over all countries for a given sector.[7] Put differently, a sector-specific shock is the average shock affecting a given sector in all countries. Country-specific shocks are then identified as the average shock in a given country, after subtracting the sector-specific shock.[8] In other words, a country-specific shock is the average shock affecting all sectors in a given country. The residual is the country and sector specific shock, ε_{js}.[9] Once the three different shocks (λ_{st}, μ_{jt}, ε_{jst}) are identified, we compute variances and covariances as detailed in the Appendix.

To carry out the sectoral decomposition, we use data on GDP in constant 2000 US dollars from the United Nations (UN) Statistical data base from 1970 through 2006. The countries in the analysis are listed in Appendix A. Before proceeding, it should be said upfront that one limitation in studying the productive structure of GCC economies is the paucity of organized information on the subject, especially for the early period. The UN data base is the only source available with comparable data across GCC countries. We are hence unavoidably exposed to inaccuracies due to measurement error by the source. The estimation procedure yields a decomposition of volatility into different sources for each country and year. Figures 3 through 8 plot the decomposition for the six GCC countries in 1975, 1985, 1995 and 2005. Figure 3 shows the volatility decomposition for Bahrain, which is surprisingly stable over the thirty-year period we analyze. The most important source of volatility in Bahrain is the aggregate country-specific variance, the component that is common to all sectors in the economy. This accounts for more than 60 percent of overall volatility. The second biggest component is the idiosyncratic sectoral variance, which accounts for almost 30 percent of

[7] In formula, this is $\lambda_{st}=(1/C)\sum^{C}_{i=1} y_{cst}$, where C denotes the number of countries

[8] In formula, this is $\mu_{jt}=(1/S)\sum^{S}_{i=1} y_{cst}-\lambda_{st,}$ where S is the number of sectors.

[9] In formula $\varepsilon_{jst}= y_{cst,}- \lambda_{st} - \mu_{jt}$

volatility. The covariance term and the global sectoral variance component account for the remainder 10 percent.

Figure 4 shows the volatility decomposition in Kuwait. As the plot shows, in the 1970s the idiosyncratic sectoral variance---mostly dominated by shocks to the oil sector, was the biggest source of volatility, accounting for more than 50 percent of overall volatility. Country-specific volatility in the decade accounted for about 45 percent of aggregate volatility, while the other two components were jointly below 5 percent. The picture changes in the 1980s and particularly the 1990s, when the idiosyncratic sectoral variance becomes less important, explaining about 35 and 30 percent of overall volatility, respectively. Country-specific volatility became the dominant source of volatility reaching 70 percent in the 1990s. This pattern only slightly reverted in the 2000s, with the idiosyncratic-sectoral-volatility component accounting for 40 percent and the country-volatility component accounting for 57 percent of overall volatility. As the picture shows, global shocks play a relatively small role in the Kuwaiti economy.

The volatility decomposition for Oman, depicted in Figure 5 shows a similar pattern. In the 1970s, the idiosyncratic component accounted for about 45 percent of the variance, while the country-specific component accounted for about 57 percent. The role of idiosyncratic sectoral shocks decreased over the 1980s and 1990s, reaching just a third of the overall volatility in the 1990s. The 2000s saw a reversal, with the idiosyncratic component climbing back to 42 percent of the variance. The time-series evolution of the country-specific component is the mirror image of the idiosyncratic component, increasing over the 1980s and 1990s and decreasing in the 2000s. The covariance of sectoral and aggregate shocks was actually negative in Oman (the only GCC country for which this was the case), contributing to lower volatility (not shown in the pie chart); its magnitude, however, was relatively small. Finally, the global volatility component played virtually no role in the economy.

Qatar's volatility decomposition is portrayed in Figure 6. As was the case in Kuwait and Oman, the idiosyncratic component in Qatar was high in the 1970s, reaching 55 percent of overall volatility. It fell to 35 percent in the 1980s and 1990s and then increased again in the 2000s to about half of the overall volatility. The opposite trend is followed by the country-specific component. Unlike in the other economies, the covariance between macroeconomic and sector-specific shocks accounts for a non-negligible share of the overall volatility, in the order of 10 percent throughout most of the period, suggesting that more could be done in terms of enacting countercyclical fiscal or monetary policies in the economy. Finally, global

sectoral shocks account for roughly 3 percent of volatility, with no significant changes over time.

Figure 3. Sources of Volatility in Bahrain, by Decade.

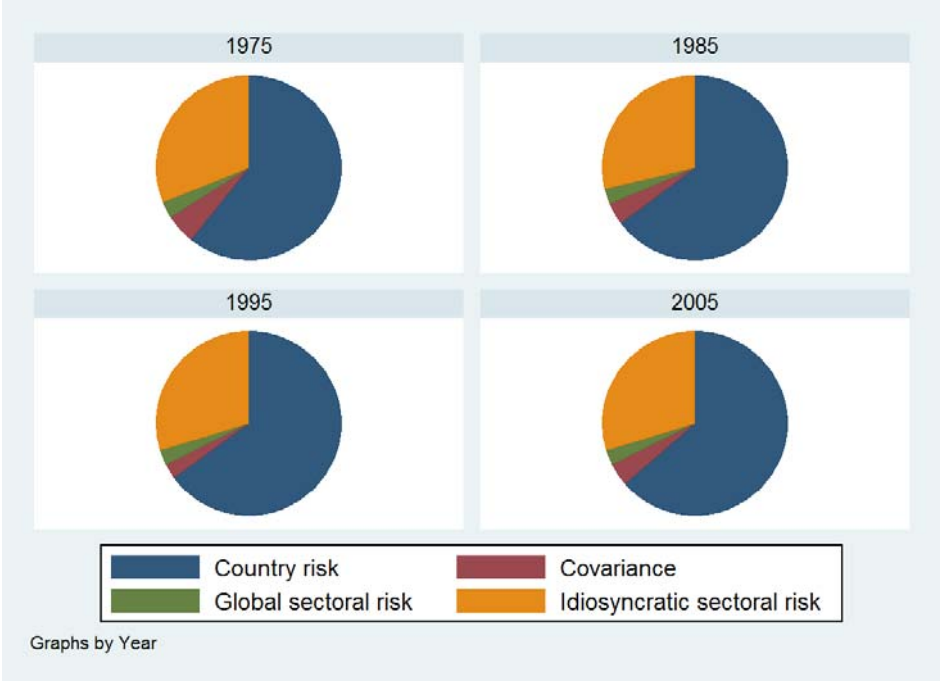


Figure 4. Sources of Volatility in Kuwait, by Decade.

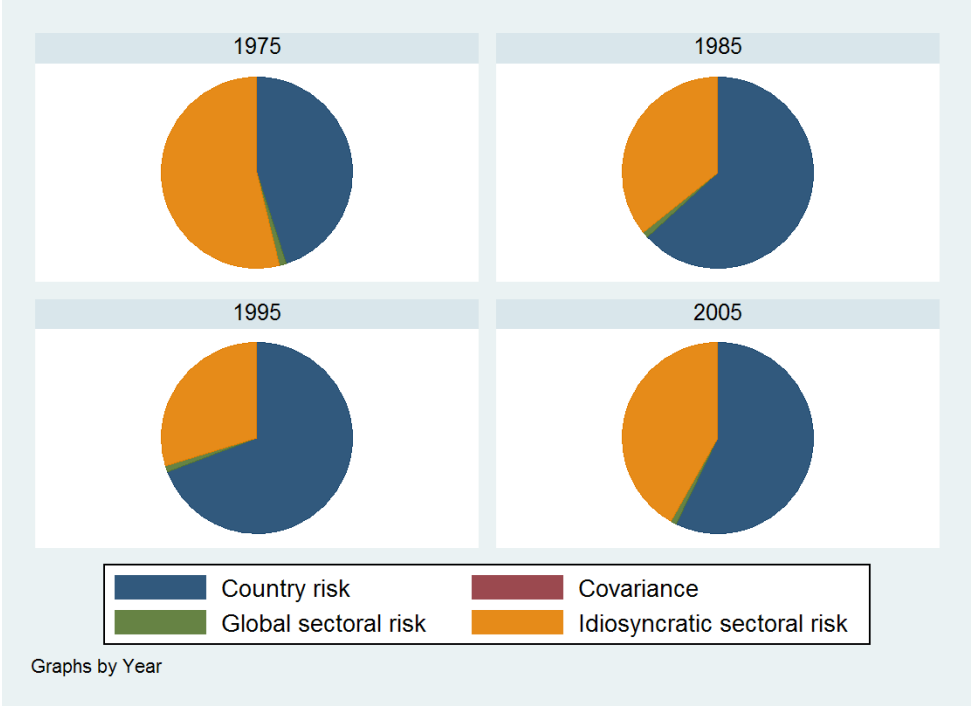


Figure 5. Sources of Volatility in Oman, by Decade.

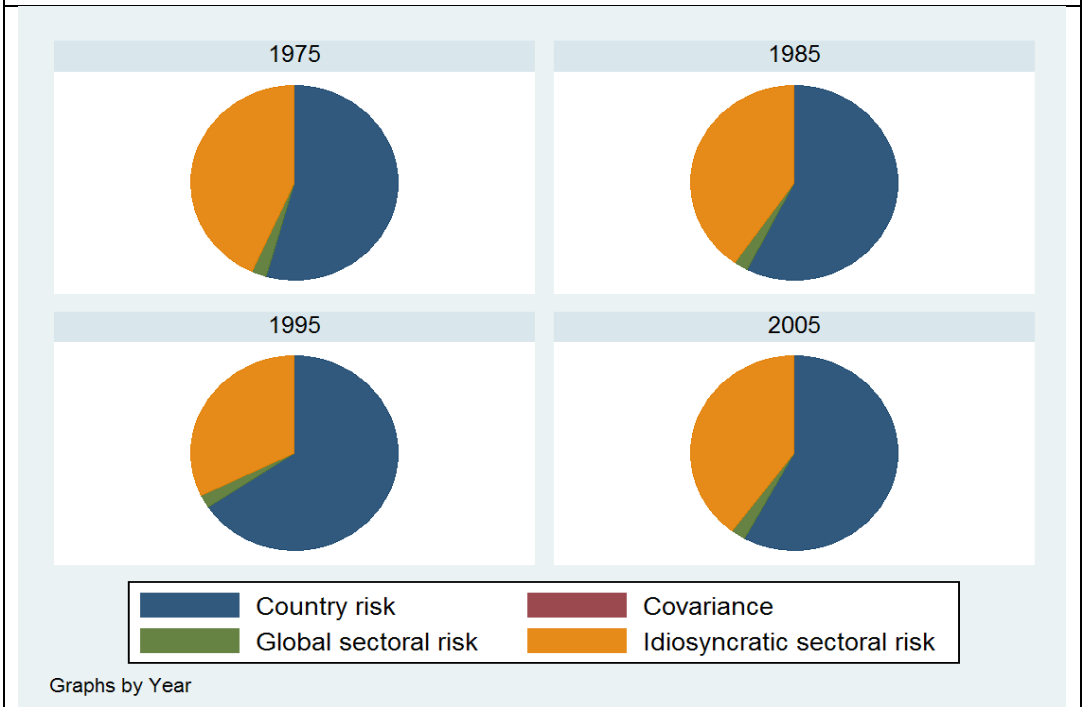
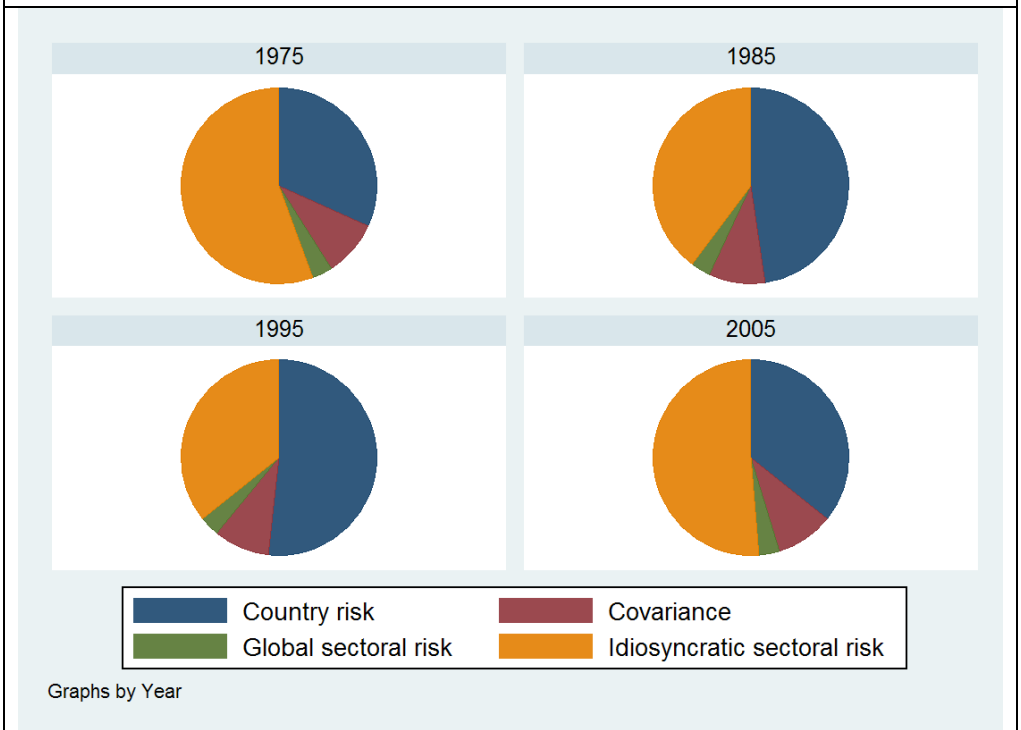


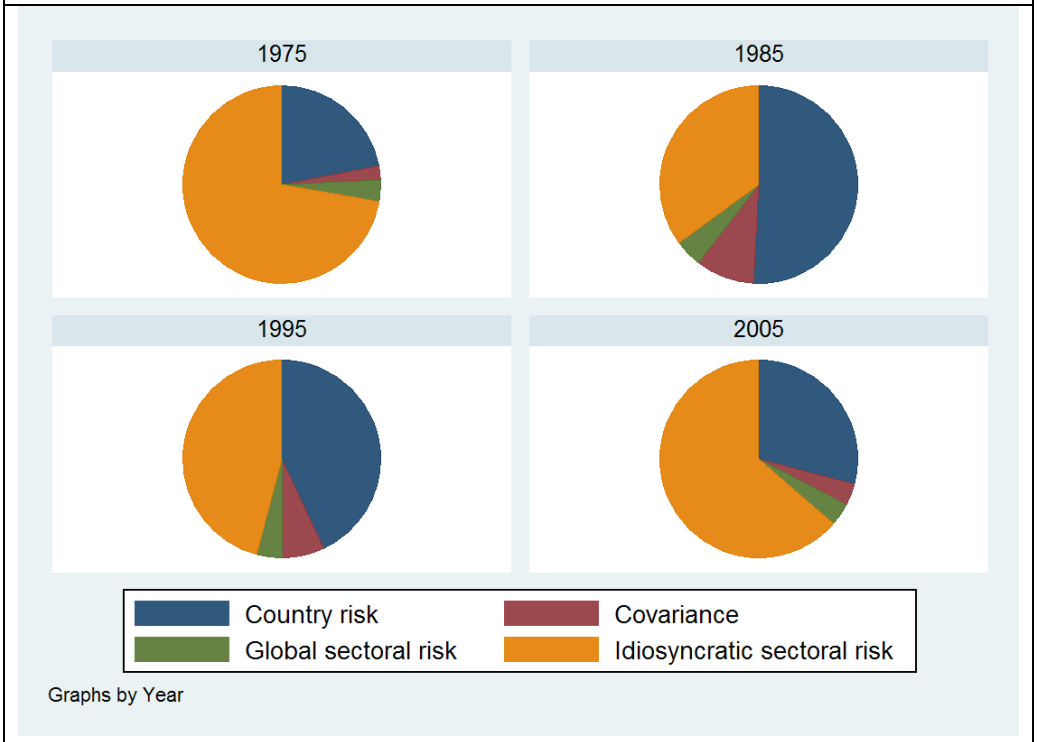
Figure 6. Sources of Volatility in Qatar, by Decade.



The pattern of decrease in idiosyncratic sectoral volatility from the 1970s to the 1980s and 1990s and the reversal in the 2000s is intensified in Saudi Arabia. The idiosyncratic

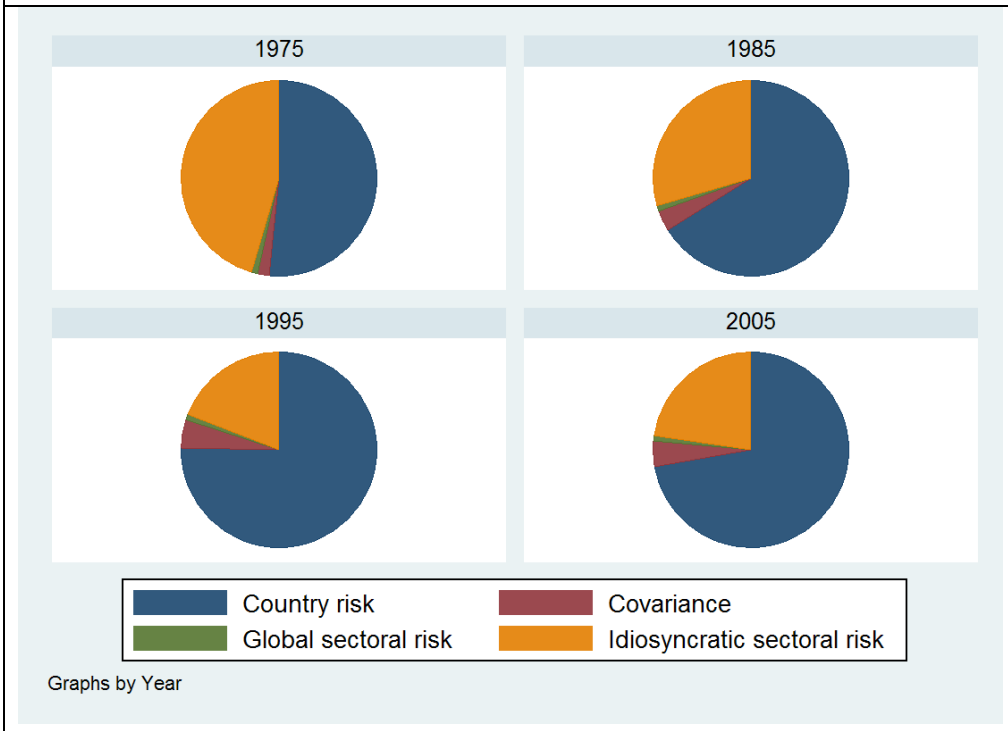
component accounted for 72 percent of overall volatility in the 1970s; 35 and 45 percent in the 1980s and 1990s, respectively; and 63 percent in the 2000s. Country volatility, in turn, moved from 20 percent in the 1970s peaking at 50 percent in the 1990s, falling to 29 percent in the 2000s. The covariance between aggregate and sectoral shocks was high in the 1980s and 1990s, at just below 10 percent of overall volatility, and smaller in the 1970s and 2000s.

Figure 7. Sources of Volatility in Saudi Arabia, by Decade.



The volatility decomposition for the United Arab Emirates is shown in Figure 8. Differently from the other GCC economies, the idiosyncratic component fell steadily over time in the Emirates, going from 45 percent in the 1970s to about 20 percent in the 2000s. The country-specific component increased accordingly from 50 percent to 70 percent during the period. The covariance term as well as the global-sectoral-volatility component accounted for a small share of overall volatility during the period.

Figure 8. Sources of Volatility in United Arab Emirates, by Decade.



The general message from these pictures is that the idiosyncratic component of volatility, which is to a large extent unavoidable in a resource-rich economy, is of the same order of magnitude as the country-specific component, which is to a large extent a reflection of aggregate domestic policy. Equally important, the covariance between aggregate shocks and sectoral shocks is positive in most countries. This suggests that there is scope for improvement in terms of domestic policies. Specifically, more aggressively countercyclical monetary and fiscal policy should help attenuate the fluctuations in output caused by the inherently volatile nature of the oil sector. With regards to monetary policy, however, most GCC countries have maintained a fairly passive stance. In particular, most currencies of GCC countries have been formally pegged to the SDR (special drawing rights), except for the Omani rial, which has been pegged to the dollar since the 1970s and the Kuwaiti dinar, which has been pegged to an undisclosed basket of currencies. De facto, however, most countries have been pegged to the US dollar for the last three decades, with the peg becoming official in the early 2000s. Pegging the exchange rate under free movement of capital implies that GCC countries have relinquished monetary policy autonomy and the scope for actively counteracting shocks is hence limited. (Only Kuwait and Oman have used direct

instruments---ceilings on certain types of credit---in order to use monetary policy more actively.)

With regards to fiscal spending, GCC countries have failed to undertake countercyclical policies (Fasano and Wang, 2002), though the extent of pro-cyclicality in spending is hard to gauge, partly because of the lack of clear and comparable fiscal concepts, methods, and data across GCC countries. Fasano and Wang (2002) argue that most GCC countries have followed highly procyclical spending policies (that is, increasing government spending in times of oil booms and decreasing it in downturns.)

Volatility Patterns in Perspective: Comparative Analysis of Volatility Patterns vis-à-vis Other Countries

In this section, we study the evolution of the different components of volatility over time for the six GCC countries. We compare their performance with that of countries at the same level of development, measured by the level of GDP per capita in the year analysed. We also compare their performance with countries that are also rich in oil, which we call our control group.

To build the control group, we sorted countries by the share of petroleum, petroleum products and gas in their exports in 2000. We selected the top 25 countries. Out of these 25, we formed a control group according to the following two criteria: (1) the country is not in the Gulf region, (2) the country exports more than $4 billion worth of oil or gas. This resulted in the following countries:

Control Group: Natural-resource-rich exporters not in the Gulf

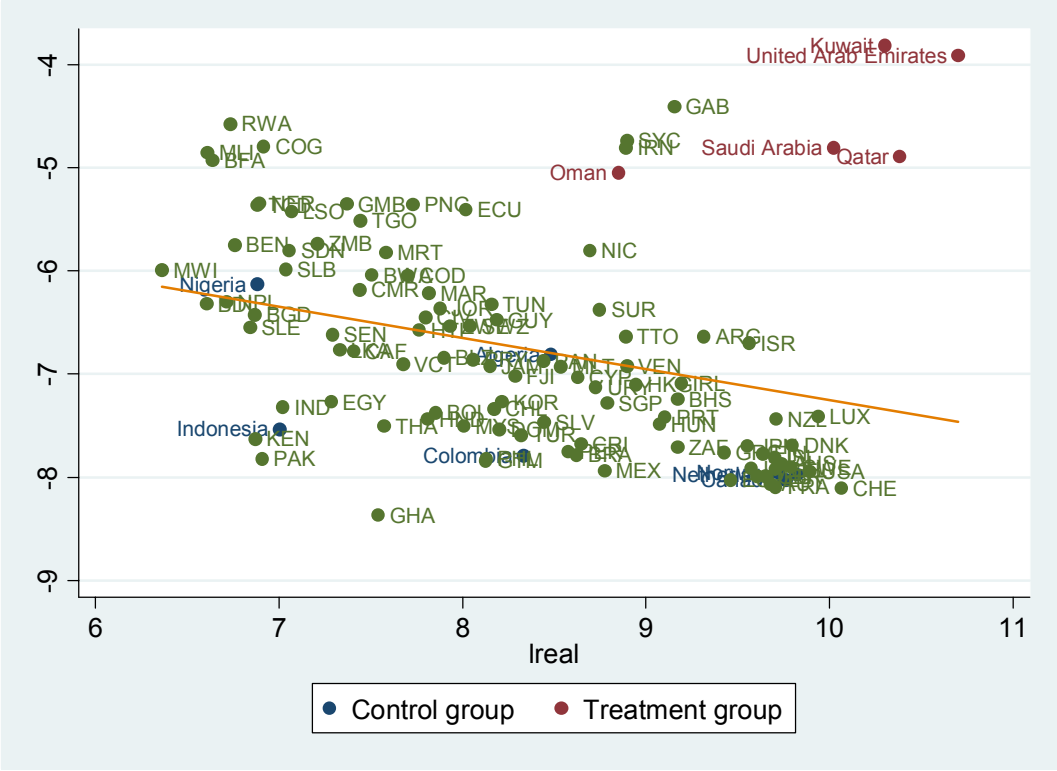
1. Algeria
2. Canada
3. Colombia
4. Indonesia
5. Nigeria
6. Netherlands
7. Norway

In what follows, we graphically show the performance of each component of volatility in 1975, 1985, 1995, and 2005, plotted against the level of real GDP per capita in the corresponding country and year. Data on real PPP-adjusted GDP per capita come from the World Bank's World Development Indicators.[10] We highlight in the plots both the "treatment group," that is, the group of six GCC countries, and the "control group," listed above. The list of countries and the conventional alphabetic code abbreviations are displayed in Appendix A.

Sectoral Volatility

Figure 9 shows the plot of the (natural logarithm of) the Sectoral Volatility Component (the aggregate of both global and idiosyncratic volatility) against the (log of) level of development in 1975. The fitted line is the result of a linear regression.[11]

Figure 9: Sectoral Volatility (Global and Idiosyncratic) Component and Development, 1975. All Countries.



As the plot shows, sectoral volatility tends to fall quite markedly with the level of development. Strikingly, all six GCC countries stand out as the biggest outliers in the plot, meaning that their levels of sectoral volatility are significantly above those in countries at

[10] Data for Bahrain in 1975 and for Oman in 2005 are not available from this source.
[11] We aggregate both sources of sectoral risk for ease of exposition.

similar levels of development. Interestingly, they also stand out in 1975 when compared to other resource-rich countries. The latter systematically fall on or below the predicted regression line for the whole sample, showing that natural resource endowments do not necessarily imply high volatility.[12]

Figure 10 shows the relation between the (log of) Sectoral Volatility and the (log of) level of development in 1985. As before, the relationship is strongly negative and hence we should expect relatively richer countries to display lower levels of sectoral volatility. GCC countries are, as before, remarkable outliers in the regression. Compared with the levels a decade earlier, however, some progress can already be appreciated: While still outliers, the GCC countries are relatively closer to the prediction line, with Saudi Arabia particularly close to it. The figure clearly shows where resource-rich countries stand in the sectoral-volatility-development line. GCC countries are overwhelmingly more volatile than other resource-rich economies outside the Persian Gulf, with Kuwait and the United Arab Emirates at the high end of the group.

Figure 11 and 12 show the relation between (logged) sectoral volatility and (logged) GDP per capita in 1995 and 2005, respectively. The overall relation continues to be significantly negative. The most salient change from previous decades is the decline in sectoral volatility of GCC countries. While still above the prediction line, the countries appear to be much closer to countries at their same level of development.[13]

In comparison with other resource-rich countries, significant progress can be appreciated as well, as now two out of the seven control-group countries are above the fitted line. While still above the levels typical of other countries rich in natural resources, the convergence is evident.

[12] Note that the prediction line in these and the following graphs, are obtained from a regression that uses the whole sample.

[13] Oman is not displayed in the Figures of 2005, since data on real GDP per capita is not available from WDI for that year.

Figure 10: Sectoral Volatility (Global and Idiosyncratic) Component and Development, 1985. All Countries.

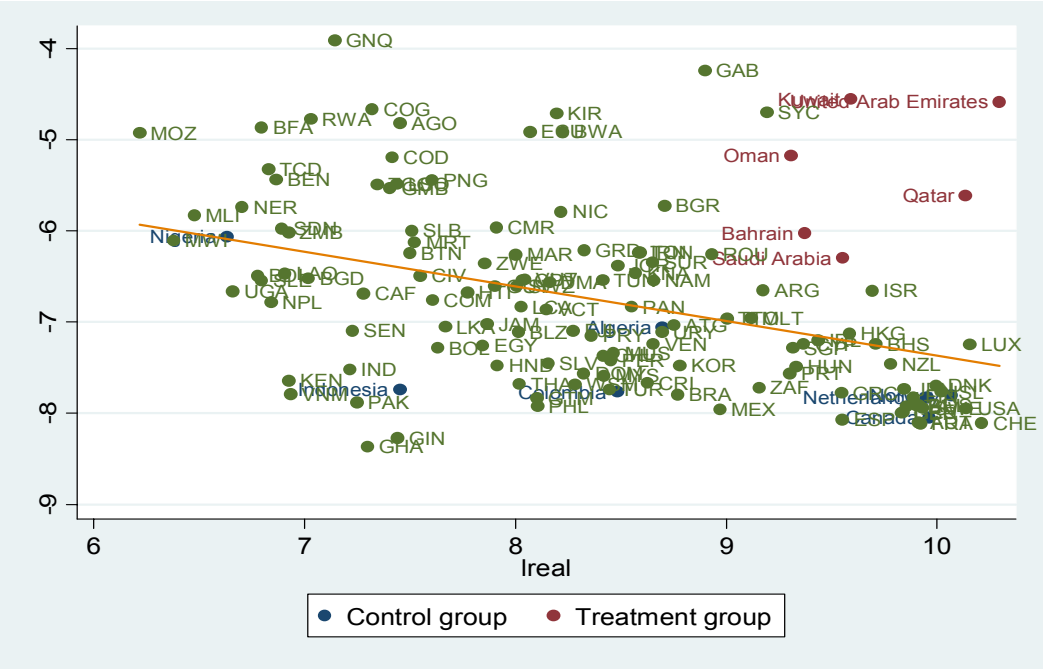


Figure 11: Sectoral Volatility (Global and Idiosyncratic) Component and Development, 1995. All Countries.

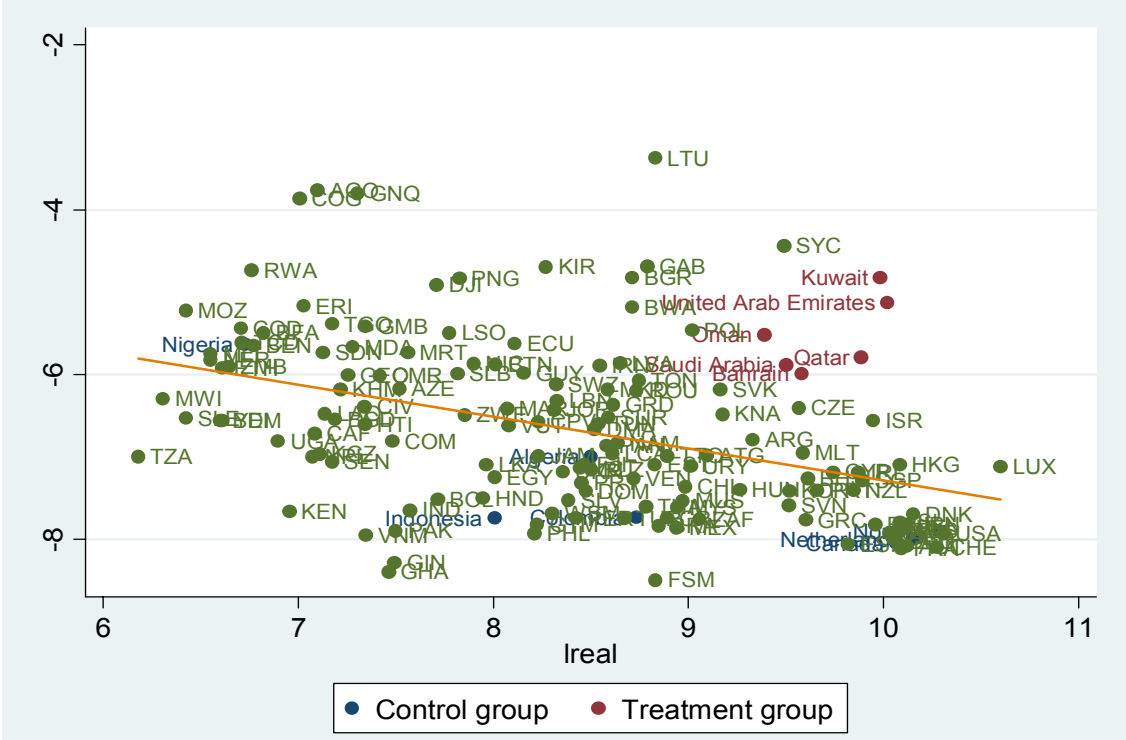
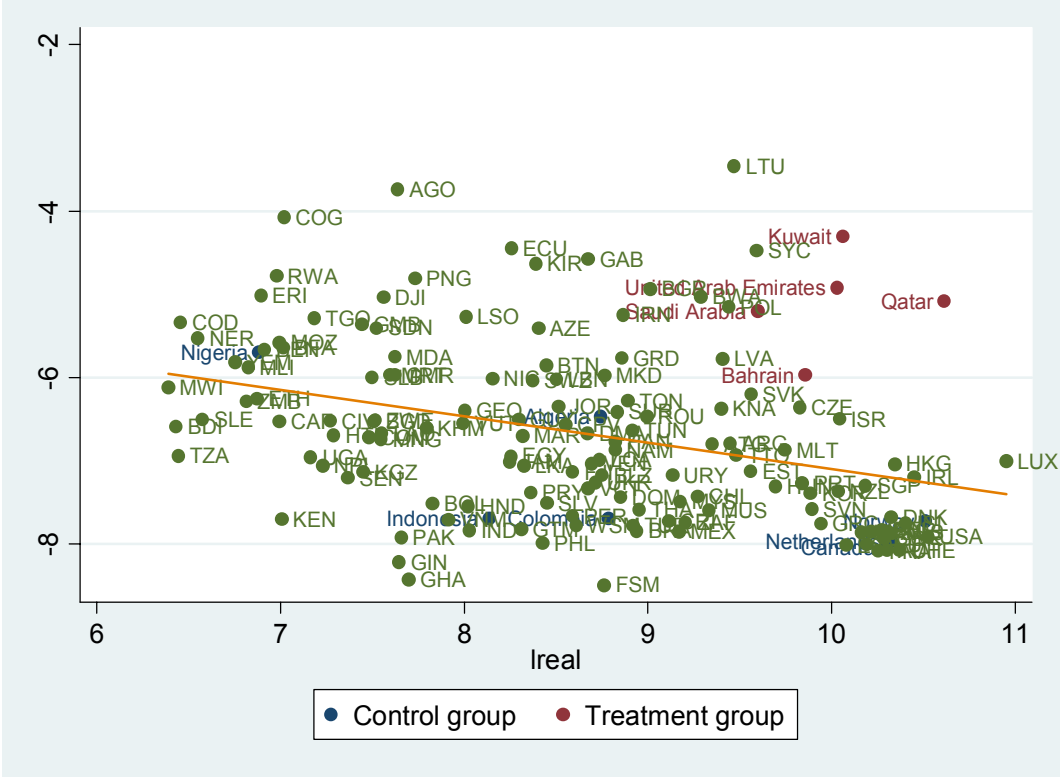


Figure 12: Sectoral Volatility (Global and Idiosyncratic) Component and Development, 2005. All Countries.



Covariance of Sector-Specific and Country-Specific Shocks

Figure 13 shows the covariance of sector-specific and country-specific shocks in 1975 for all countries, plotted against the (log of) real GDP per capita in that year. The scatter plot, together with the regression line, shows that there is no systematic relation between the two. All GCC countries, however, with the exception of Oman, appear to have above-average covariance. This suggests, as argued earlier, that there is no systematic countercyclical response of policies to shocks. More concretely, monetary and fiscal policies have failed at being sufficiently countercyclical (that is, they have not been expansionary in recessionary times---or times in which oil prices are low); this lack of counter-cyclicality can explain why most countries feature negative values for the covariance. When compared to other resource-rich economies, GCC countries also perform rather poorly, again, with the exception of Oman, which shows a negative covariance. The picture proves resilient to the passage of time. In 1985, there is a change in rankings, with the United Arab Emirates becoming the country with the highest covariance in the group and in the world. This is shown in Figure 14, which shows the plot of the covariance against the (logged) level of development in 1985.

Oman is systematically the country with the lowest (most negative) covariance among the resource-rich control group.

Figure 13: Covariance of Sectoral and Country-Specific Volatility and Development, 1975. All Countries.

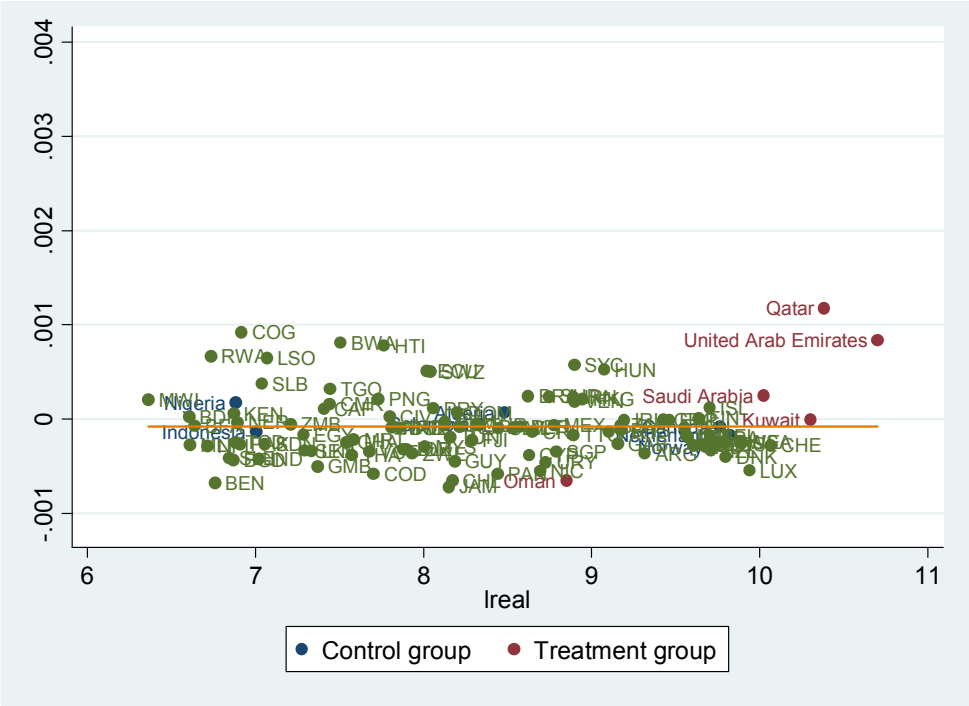


Figure 14: Covariance of Sectoral and Country-Specific Volatility and Development, 1985. All Countries.

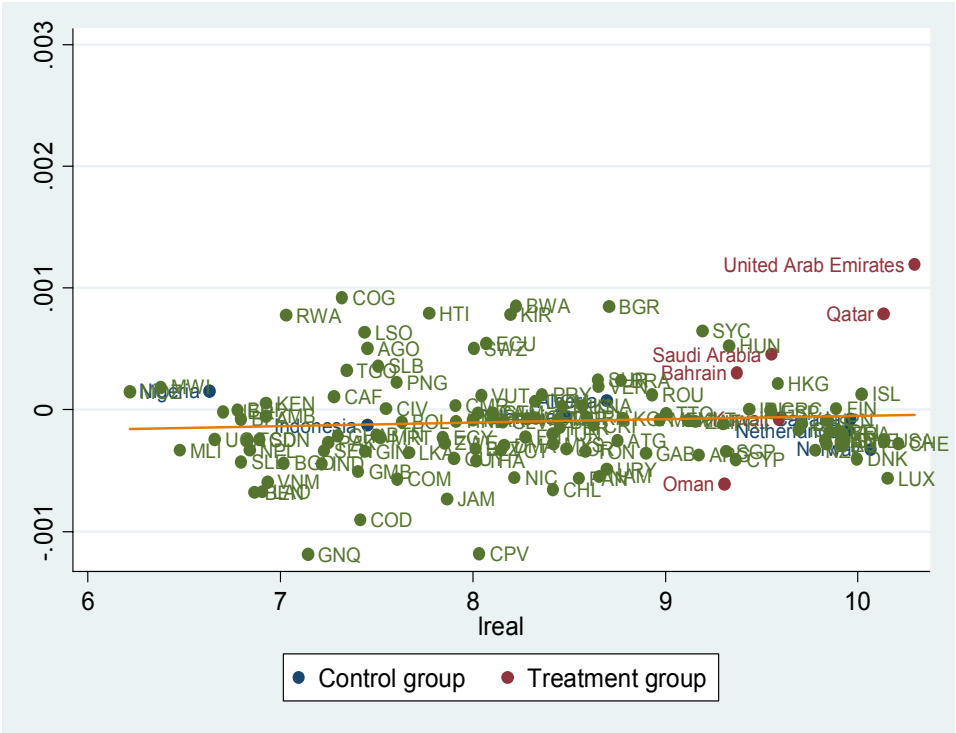
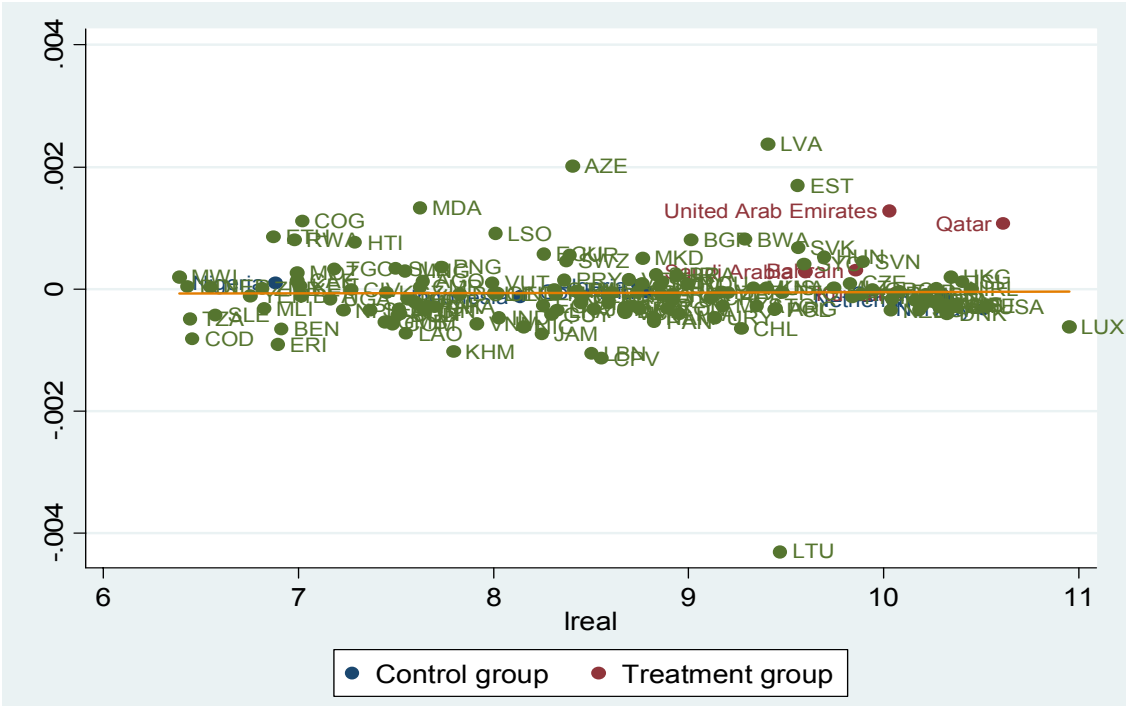


Figure 15: Covariance of Sectoral and Country-Specific Volatility and Development, 1995. All Countries.

Figure 16: Covariance of Sectoral and Country-Specific Volatility and Development, 2005. All Countries.



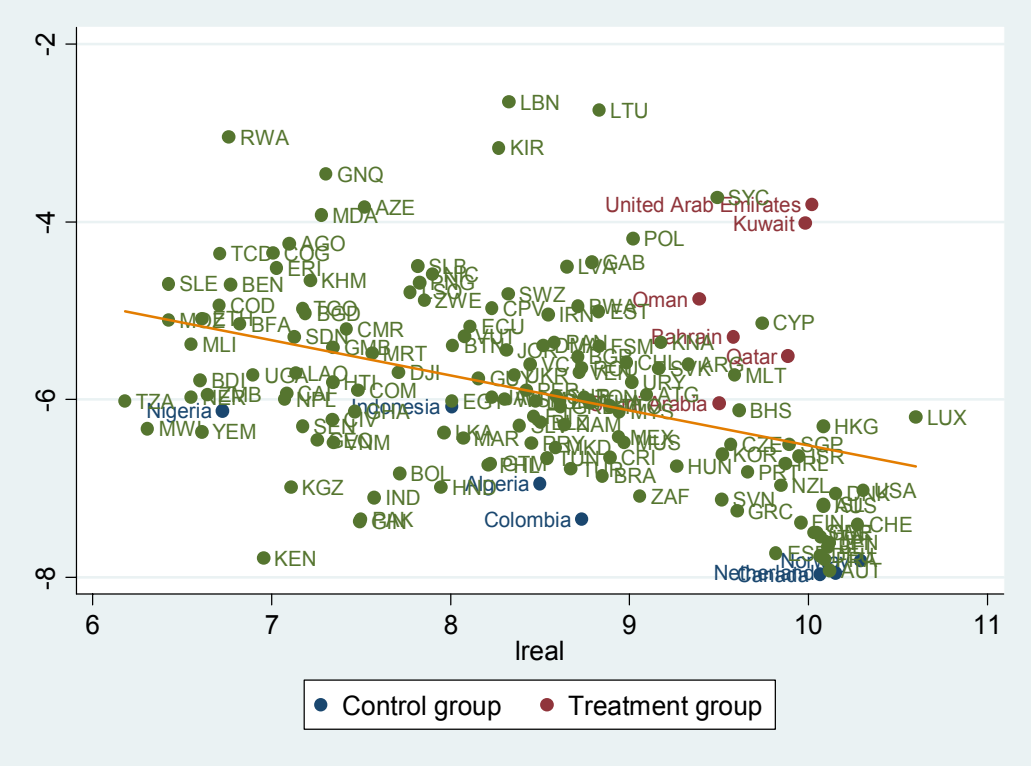
Figures 15 and 16 show the covariance component of volatility in 1995 and 2005, plotted as before against the level of development. The conclusion from these pictures is that no significant progress has been made in terms of lowering the level of the covariance over time, whether in absolute terms or relative to other countries at the same level of development or endowed with natural resources.

As argued before, this is perhaps one of the determinants of volatility that policy makers could more effectively influence, through more aggressive counterbalancing policies.

Country-Specific Volatility

The last component of volatility, country-specific volatility, is studied in Figure 17. (As explained in the technical Appendix, by construction, the country-specific volatility component is invariant over time.) The Figure shows the (log of) country-specific volatility against the (logged) real GDP per capita in 1995. (The picture does not change substantially when volatility is plotted against GDP per capita in other years).

Figure 17: Country-Specific-Volatility Component (1970-2006) and Development (1995).
All Countries.



As before, the **regression line** shows the fitted values from a regression of (log) country volatility on real GDP per capita. The relation is significantly negative, that is, countries at lower level of development tend to experience higher country-specific volatility. The figure also shows that GCC countries tend to be outliers when compared to the reference groups, showing higher country volatility than countries at the same level of development or countries that are also rich in natural resources.

Saudi Arabia is the best performer, being just above the level predicted for countries at the same level of development. The United Arab Emirates and Kuwait are the countries that show the highest level of country volatility.

Concluding Remarks

In part due to their strong dependence on oil, GCC economies are intrinsically more volatile than other economies at the same level of development. Startling progress has been achieved, however, since the 1970s, with volatility falling in most GCC countries by a factor of 4 or more by 2005. The fall in volatility is mostly due to two factors. The first is the rise of the service economy (comprising, among others, financial intermediation, tourism, and real estate), which is inherently less volatile than the oil sector and has led to higher levels of sectoral diversification. The second is the general decline in volatility in world markets since the 1980s, a period that economists have called the "Great Moderation." The current Great Credit Crisis, however, has interrupted this trend.

Our comparative analysis of the sources of volatility suggests that despite the progress achieved, there is still scope for improvement. First, other resource-rich economies facing the same challenges (and shocks) as GCC countries tend to systematically display lower levels of volatility.

Second, and perhaps more relevant, the high levels of country-specific volatility and the positive covariance between sectoral shocks and country-specific shocks suggest that macroeconomic policy could be improved to further mitigate volatility. Concretely, it seems that more aggressively countercyclical fiscal and monetary policies could be put in place in GCC economies to lower the macroeconomic impact of oil-shocks. With regards to monetary policy, most GCC countries have maintained a fairly passive stance. In particular, most currencies of GCC countries have been de facto pegged to the US dollar for the last three decades, with the peg becoming official in the early 2000s. (Officially, most were pegged to

the SDR, except for the Omani rial, which has been pegged to the dollar since the 1970s and the Kuwaiti dinar, which has been pegged to an undisclosed basket of currencies, but de facto, the currencies have mostly followed the dollar). Pegging the exchange rate in a context of free movement of capital implies that GCC countries have relinquished monetary policy autonomy. The scope for actively counteracting shocks through credit policy is hence limited. (Only Kuwait and Oman have used direct instruments---ceilings on certain types of credit---in order to use monetary policy more actively.)

With regards to fiscal spending, GCC countries have failed to undertake countercyclical policies (i.e., cutting government spending during booms and increasing spending in downturns); on the contrary, fiscal policy in most GCC countries has been highly pro-cyclical (Fasano and Wang, 2002), contributing to higher volatility.

In sum, the overall balance for GCC countries over the past four decades is positive: Significant progress has been made in terms of increasing stability in the region. There is, however, scope for further gains, as the experience from other resource-rich economies shows. More countercyclical policies appear to be a promising route. Last, but not least, the current global financial crisis has also underscored financial sector vulnerabilities that need to be addressed (on this GCC countries are by no means unique); diversification alone is not enough, as it does not shield countries from aggregate shocks; Dubai is perhaps the best example in point. Its efforts to diversify and develop other sectors (real estate, tourism, finance) have led to significant improvements in performance and living standards, along with lower dependence on oil. But it opened the door to other sources of shocks (e.g., financial and real estate bubbles) that led to sharp disruptions in the economy when the global credit crunch caused substantial falls in real estate and stock markets. We leave for future work the new challenges underscored by the global crisis.

Appendix A: List of Countries

Country Name	Code	Country Name	Code
Afghanistan	AFG	Colombia	COL
Albania	ALB	Comoros	COM
Algeria	DZA	Congo	COD
Andorra	AND	Costa Rica	CRI
Angola	AGO	Cote d'Ivoire	CIV
Antigua and Barbuda	ATG	Cuba	CUB
Argentina	ARG	Cyprus	CYP
Armenia	ARM	Czech Republic	CZE
Aruba	ABW	Democratic People's Rep. of Korea	PRK
Australia	AUS	Democratic Republic of the Congo	COG
Austria	AUT	Denmark	DNK
Azerbaijan	AZE	Djibouti	DJI
Bahamas	BHS	Dominica	DMA
Bahrain	BHR	Dominican Republic	DOM
Bangladesh	BGD	Ecuador	ECU
Barbados	BRB	Egypt	EGY
Belarus	BLR	El Salvador	SLV
Belgium	BEL	Equatorial Guinea	GNQ
Belize	BLZ	Eritrea	ERI
Benin	BEN	Estonia	EST
Bermuda	BMU	Ethiopia	ETH
Bhutan	BTN	Fiji	FJI
Bolivia	BOL	Finland	FIN
Bosnia and Herzegovina	BIH	France	FRA
Botswana	BWA	French Polynesia	PYF
Brazil	BRA	Gabon	GAB
Brunei Darussalam	BRN	Gambia	GMB
Bulgaria	BGR	Georgia	GEO
Burkina Faso	BFA	Germany	DEU
Burundi	BDI	Ghana	GHA
Cambodia	KHM	Greece	GRC
Cameroon	CMR	Greenland	GRL
Canada	CAN	Grenada	GRD
Cape Verde	CPV	Guatemala	GTM
Cayman Islands	CYM	Guinea	GIN
Central African Republic	CAF	Guinea-Bissau	GNB
Chad	TCD	Guyana	GUY
Chile	CHL	Haiti	HTI
China	CHN	Honduras	HND

Appendix A: List of Countries Continued

Country Name	Code	Country Name	Code
Hong Kong SAR of China	HKG	Monaco	MCO
Hungary	HUN	Mongolia	MNG
Iceland	ISL	Montenegro	MNE
India	IND	Morocco	MAR
Indonesia	IDN	Mozambique	MOZ
Iran (Islamic Republic of)	IRN	Myanmar	MMR
Iraq	IRQ	Namibia	NAM
Ireland	IRL	Nepal	NPL
Israel	ISR	Netherlands	NLD
Italy	ITA	Netherlands Antilles	ANT
Jamaica	JAM	New Caledonia	NCL
Japan	JPN	New Zealand	NZL
Jordan	JOR	Nicaragua	NIC
Kazakhstan	KAZ	Niger	NER
Kenya	KEN	Nigeria	NGA
Kiribati	KIR	Norway	NOR
Kuwait	KWT	Oman	OMN
Kyrgyzstan	KGZ	Pakistan	PAK
Lao People's Democratic Republic	LAO	Palau	PLW
Latvia	LVA	Panama	PAN
Lebanon	LBN	Papua New Guinea	PNG
Lesotho	LSO	Paraguay	PRY
Liberia	LBR	Peru	PER
Libyan Arab Jamahiriya	LBY	Philippines	PHL
Liechtenstein	LIE	Poland	POL
Lithuania	LTU	Portugal	PRT
Luxembourg	LUX	Puerto Rico	PRI
Macao SAR of China	MAC	Qatar	QAT
Madagascar	MDG	Republic of Korea	KOR
Malawi	MWI	Republic of Moldova	MDA
Malaysia	MYS	Romania	ROU
Maldives	MDV	Russian Federation	RUS
Mali	MLI	Rwanda	RWA
Malta	MLT	Saint Kitts and Nevis	KNA
Marshall Islands	MHL	Saint Lucia	LCA
Mauritania	MRT	Saint Vincent and the Grenadines	VCT
Mauritius	MUS	Samoa	WSM
Mexico	MEX	San Marino	SMR
Micronesia (Federated States of)	FSM	Sao Tome and Principe	STP

Appendix A: List of Countries Continued

Country Name	Code	Country Name	Code
Saudi Arabia	SAU		
Senegal	SEN	Timor-Leste	TLS
Serbia	SRB	Togo	TGO
Seychelles	SYC	Tonga	TON
Sierra Leone	SLE	Trinidad and Tobago	TTO
Singapore	SGP	Tunisia	TUN
Slovakia	SVK	Turkey	TUR
Slovenia	SVN	Turkmenistan	TKM
Solomon Islands	SLB	Uganda	UGA
Somalia	SOM	Ukraine	UKR
South Africa	ZAF	United Arab Emirates	ARE
Spain	ESP	United Kingdom	GBR
Sri Lanka	LKA	United Republic of Tanzania: Mainland	TZA
Sudan	SDN	United States	USA
Suriname	SUR	Uruguay	URY
Swaziland	SWZ	Uzbekistan	UZB
Sweden	SWE	Vanuatu	VUT
Switzerland	CHE	Venezuela	VEN
Syrian Arab Republic	SYR	Vietnam	VNM
TFYR of Macedonia	MKD	Yemen	YEM
Tajikistan	TJK	Zambia	ZMB
Thailand	THA	Zimbabwe	ZWE

Appendix B: Technical Supplement

Two main ideas underlie the discussion over the determinants of the volatility of GDP growth. The first emphasizes the role of the sectoral composition of the economy as the main determinant of volatility: a high degree of specialization or specialization in high-volatility sectors translates into high aggregate volatility. The second idea points to domestic macroeconomic volatility, possibly related to policy mismanagement or political instability, among other country-specific factors.

The emphasis on sectoral composition motivates us to first break down the value added of a country into the sum of the value added of different sectors, each of which has a potentially different level of intrinsic volatility. Innovations in the growth rate of GDP in country j, (j=1,...,J) denoted by q_j, can then be expressed, as the weighted sum of the innovations in the growth rates of value-added in every sector, y_{js}, with s=1,...,S:

$$q_j = \Sigma\, a_{js}\, y_{js},$$

where the weights, a_{js}, denote the share of output in sector s of country j. The object of our study is the variance of q_j, Var(q_j), and its components.

To separate the role of domestic aggregate volatility[14] from that of the sectoral composition of the economy, we can further breakdown innovations to a sector's growth rate, y_{js}, into three disturbances:

$$y_{js} = \lambda_s + \mu_j + \varepsilon_{js}. \qquad (1)$$

The first disturbance (λ_s) is specific to a sector, but common to all countries. This includes, for example, a shock to the price of a major input in production, such as steel, which may affect the productivity of sectors that are steel-intensive. More generally, technology- and price-shocks that affect a sector or group of sectors across countries in the same way will fall in this category.

The second disturbance (μ_j) is specific to a country, but common to all sectors within a country. So, for example, a monetary tightening in country j might deteriorate the productivity of all sectors in country j, because all need some amount of liquidity to produce.

[14] The terms risk and volatility are used interchangeably.

The third disturbance (ε_{js}) captures the shocks that are specific to a sector and country. In the previous example, if some sectors are more sensitive to the liquidity squeeze and have a deeper fall in productivity, the difference with respect to the average will be reflected in ε_{js}. Similarly, if some global shocks have different impact on sectoral productivity in different countries, the differential impact will be captured by ε_{js}. Finally, any disturbance specific to both a country and sector will be reflected in ε_{js}. Oil shocks, which affect countries in different ways, depending on whether they are net exporters or importers, will tend to fall in this category. This is why, as the analysis will show, this term will be particularly high in GCC economies.

Of course all three disturbances can potentially be correlated with each other. For example, λ_s and μ_j will tend to be correlated if in some countries macroeconomic policies are more responsive to global sectoral shocks, or, alternatively, if a country is highly influential in a particular sector, in which case an aggregate shock in that country may affect that sector in other countries. Moreover, as pointed out above, certain sectors may be more responsive to country-specific shocks (implying that ε_{js} and μ_j could be correlated) or sectoral productivity in certain countries may be affected differently by global sectoral shocks (implying that ε_{js} and λ_s could be correlated).

Expression (1) provides a convenient way of partitioning the data. Written as such, it is simply an accounting identity, since ε_{js} picks up everything not accounted for by the sector- or country-specific shocks, and since we do not place any restriction on the way the three disturbances covary.

In what follows, we explain how to decompose the variance of q_j into the corresponding variances and covariances of these different disturbances.

It is convenient to rewrite innovations to growth of GDP in matrix notation. Denoting by $\mathbf{y}_j$ the vector of sectoral innovations y_{js} and by $\mathbf{a}_j$ the vector of sectoral shares a_{js}, our object of interest, $Var(q_j)$, can be written as:

$$Var(q_j) = \mathbf{a'}_j \, E(\mathbf{y}_j \, \mathbf{y'}_j) \, \mathbf{a}_j \qquad (2)$$

Thus, in order to decompose $Var(q_{js})$ we need to decompose the variance-covariance matrix of the innovations to sectoral growth rates, $E(\mathbf{y}_j \, \mathbf{y'}_j)$. Simple matrix algebra shows that the variance-covariance matrix of country j's sectoral shocks can be written as:

$$E(\mathbf{y}_j \, \mathbf{y'}_j) = \Omega_\lambda + \Omega_{\varepsilon j} + \omega_{\mu j}^2 \mathbf{1}\mathbf{1}' + (\Omega_{\lambda\mu j} \, \mathbf{1}' + \mathbf{1} \, \Omega_{\lambda\mu j}) + \Gamma_j$$

where:

$$\Omega_{\lambda} = E(\boldsymbol{\lambda}\boldsymbol{\lambda}'),$$
$$\Omega_{\varepsilon j} = \text{diag}(\sigma_{j1}^2 ... \sigma_{jS}^2),$$
$$\omega_{\mu j}^2 = E(\mu_j^2),$$
$$\Omega_{\lambda\mu j} = E(\boldsymbol{\lambda}\mu_j),$$

where **1** denotes the S×1 vector of ones, and **λ** and **μ** denote the vectors of sectoral shocks (λ_s) and country shocks (μ_j), respectively. The matrix Ω_{λ} is the variance-covariance of sector-specific global shocks; $\Omega_{\varepsilon j}$ is the matrix collecting the variances of the sector- and country-specific residuals $\varepsilon_{\varepsilon j}$, $\sigma_{js}^2 = E(\varepsilon_{\varepsilon j}^2)$; $\omega_{\mu j}^2$ is the variance of country-specific shocks; $\Omega_{\lambda\mu j}$ is the covariance between country-specific and global sectoral shocks; and finally, the matrix Γ_j collects the remaining components of $E(\mathbf{y}_j \mathbf{y}'_j)$, that is, the covariances between the residuals and the sectoral and country-specific shocks, and the covariance among residuals.
It turns out that the term Γ_j plays a quantitatively negligible role in accounting for aggregate volatility. In anticipation of that result, the exposition that follows ignores this last component. More specifically, we will maintain the working hypothesis that the residual shocks are idiosyncratic (uncorrelated with each other and with the sector- and country-specific shocks), and hence Γ_j is null. This implies that we can write the variance-covariance matrix as:

$$E(\mathbf{y}_j \mathbf{y}'_j) = \Omega_{\lambda} + \Omega_{\varepsilon j} + \omega_{\mu j}^2 \mathbf{1}\mathbf{1}' + (\Omega_{\lambda\mu j} \mathbf{1}' + \mathbf{1} \Omega_{\lambda\mu j}) \quad (3)$$

Plugging (3) into (2), aggregate volatility can be written as:

$$\text{Var}(q_j) = \mathbf{a}'_j E(\mathbf{y}_j \mathbf{y}'_j) \mathbf{a}_j = \mathbf{a}'_j \Omega_{\lambda} \mathbf{a}_j + \mathbf{a}'_j \Omega_{\varepsilon j} \mathbf{a}_j + \omega_{\mu j}^2 + 2 \mathbf{a}'_j \Omega_{\lambda\mu j}. \quad (4)$$

This formulation clearly shows that production in country j is more volatile:
1. If the country specializes in volatile sectors, that is, sectors exposed to large and frequent shocks. This is reflected in the first two terms:

a. The first, $\mathbf{a}'_j \Omega_{\lambda} \mathbf{a}_j$, relates to global sectoral shocks. This term is large when sectors exposed to big and frequent global shocks account for a large share of the country's GDP.

b. The second term, $\mathbf{a'}_j \Omega_{\varepsilon j} \mathbf{a}_j$, relates to idiosyncratic sectoral shocks. This term is large when sectors with high idiosyncratic volatility, σ_{js}^2, account for a large share of GDP.

2. If country risk ($\omega_{\mu j}^2$) is big, that is, the country is more volatile if aggregate domestic shocks are larger and more frequent.

3. If specialization is tilted towards sectors whose shocks are positively correlated with country-specific shocks ($\mathbf{a'}_j \Omega_{\lambda\mu j}$ is big). This term will tend to be small, for example, if policy innovations are negatively correlated with the shocks to sectors that have a large share in country j's GDP.

Thus, the aggregate volatility of the economy can be decomposed as the sum of components with fundamentally different meanings.

In order to quantify the various components of volatility in equation (4), we need to estimate the variance-covariance matrices Ω_λ, $\Omega_{\varepsilon j}$, $\omega_{\mu j}^2$, and $\Omega_{\lambda\mu j}$. Our general strategy is to use data across countries, sectors, and time to back out estimates of the sectoral shocks, λ_s, and the country shocks, μ_j. We then compute the sample variances and covariances of the estimated shocks and treat them as estimates of the corresponding population moments.

Innovations to growth in value-added in country j and sector s, y_{jst}, are computed as the deviation of the growth rate from the average (growth rate) of country j and sector s over time.

We measure global sector-specific shocks as the cross-country average of y_{jst} in each of the sectors. Country-specific shocks are then identified as the within-country average of y_{jst}, using only the portion not explained by sector-specific shocks. The residual is then the difference between y_{jst} and the two shocks. Formally,

$$\lambda^e_{st} \equiv (1/J) \times \sum y_{jst},$$

$$\mu^e_{jt} \equiv (1/S) \times \sum (y_{jst} - \lambda^e_{st})$$

$$\varepsilon^e_{jst} \equiv y_{jst} - \lambda^e_{st} - \mu^e_{jt},$$

where superscript "e" stands for "predicted."

Note that we normalize shocks so that $\sum \mu^e_{jt} = 0$, that is, country shocks are expressed as relative to world shocks.

An equivalent way to formalize this is to frame the analysis as a set of cross-sectional regressions of y_{jst} on country and sector dummies. More specifically, the formulas for λ^e_{st}, μ^e_{jt}, and ε^e_{jst} given above will be the result of running a regression, for each time t, of y_{jst}, on a set of sector-specific and country-specific dummies. (See Koren and Tenreyro, 2007.)

Estimates of the matrices Ω_λ, $\Omega_{\varepsilon j}$, $\omega_{\mu j}^2$, and $\Omega_{\lambda\mu j}$ are then computed using the estimated

shocks. In particular, $\Omega^e_\lambda = (1/T) \times \sum \boldsymbol{\lambda}^e_t \boldsymbol{\lambda}^e_t{}'$ is the estimated variance-covariance of global-sectoral shocks; $\omega^e_{\mu j}{}^2 = (1/T) \times \sum \mu^e_{jt}{}^2$ is the estimated variance of country-j-specific shocks; $\Omega^e_{\lambda\mu j} = (1/T) \times \sum \boldsymbol{\lambda}^e_t \mu^e_{jt}$ is the estimate of the covariance between sectoral shocks and country-j shocks; and $\sigma^e_{js}{}^2 = (1/T) \times \sum \varepsilon^e_{jst}{}^2$, with s=1,..., S are the estimated variances of the sectoral idiosyncratic shocks.

Given the estimates of the variance-covariance matrix of factors, we use data on sectoral GDP shares, a_{jst}, to compute the various measures of risk exposure:

$$GSECT_{jt} = \mathbf{a'}_{jt}\, \Omega^e_\lambda \mathbf{a}_{jt}$$
$$ISECT_{jt} = \mathbf{a'}_{jt}\, \Omega^e_{\varepsilon j} \mathbf{a}_{jt}$$
$$CNT_j = \omega^e_{\mu j}{}^2$$
$$COV_{jt} = 2\, \mathbf{a'}_{jt}\, \Omega^e_{\lambda\mu j}$$

where $GSECT_{jt}$ is the part of the volatility of country j at time t due to global sectoral shocks that are common to all countries (Global Sectoral Risk); $ISECT_{jt}$ is the part of volatility due to sectoral shocks idiosyncratic to country j (Idiosyncratic Sectoral Risk); CNT_j is the part of volatility due to country shocks, which, by construction, does not depend on time (Country-Specific Risk); and COV_{jt} is the covariance of global sectoral shocks with the jth country shock at time t (Covariance of Sector and Country-specific Risk). Total volatility can be hence expressed as the sum of these four components.

References

Acemoglu, Daron and Fabrizio Zilibotti, "Was Prometheus Unbound by Chance? Risk, Diversification, and Growth." *Journal of Political Economy*, 1997, 709–751.

Brooks, Robin and Marco Del Negro, "A Latent Factor Model with Global, Country and Industry Shocks for International Stock Returns," 2004. Working Paper 2002-23. Federal Reserve Bank of Atlanta.

Caselli, Francesco and Coleman, Wilbur John, "The U.S. structural transformation and regional convergence : a reinterpretation," *Journal of political economy*, 109 (3), 584-616.

Fasano, Ugo and Qiang Wang, "Testing relationship between Government Spending and Revenue: Evidence from GCC Countries," IMF Working Papers 02/201, International Monetary Fund, 2002.

Forni, Mario and Lucrezia Reichlin, "Dynamic Common Factors in Large Cross Sec-tions." *Empirical Economics*, XXI (1996), 27–42.

Heston, Alan, Robert Summers, and Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP), 2002.

Imbs, Jean, "Growth and Volatility" (2006) Working paper. HEC Lausanne.

Imbs, Jean and Romain Wacziarg, "Stages of Diversification." *American Economic Review*, XCIII (2003),63–86.

Koren, Miklos and Silvana Tenreyro, "Volatility and Development," *The Quarterly Journal of Economics*, February 2007, Vol. 122, No. 1: 243-287.

Kose, Ayhan, Christopher Otrok, and Charles H. Whiteman, "International Business Cycles: World, Region, and Country-Specific Factors." *American Economic Review*, XCIII (2003), 1216–1239.

Kraay, Aart and Jaume Ventura, "Comparative Advantage and the Cross-Section of Business Cycles." Forthcoming *Journal of European Economic Association*.

Lehmann, Bruce N. and David M. Modest, "The Empirical Foundations of Arbitrage Pricing Theory I: The Empirical Tests." NBERWorkingPaper,1725 (1985).

Obstfeld, Maurice, “Risk Taking, Global Diversification, and Growth.” *American Economic Review*, LXXXIV (1994), 1310–1329.

Ramey, Garey and Valerie Ramey, “Cross-Country Evidence on the Link between Volatility and Growth.” *American Economic Review*, LXXXV (1995), 1138–51.

Saint-Paul, Gilles, “Technological Choice, Financial Markets and Economic Development.” *European Economic Review*, XXXVI (1992).

Stockman, Alan C., “Sectoral and national aggregate disturbances to industrial output in seven European countries.” *Journal of Monetary Economics*, XXI (1988), 387–