Economic Stability in the GCC Countries

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Key Points

Evidence confirms that there is a positive correlation between the economic growth rate and its volatility/risk in the Gulf Cooperation Council (GCC) region. In other words, there is a trade-off between the benefits of oil and gas activity and the volatility resulting from unpredictable commodity price swings in such resource dependent economies.

Our analysis uses a financial portfolio framework approach (and more specifically an efficient frontier analysis), treating economic sectors as individual investments. We calculate a relative risk measure termed the 'beta coefficient' and assemble a portfolio of sectors with varying weights to find the efficient frontier. If the beta of the portfolio representing the economy is above global average, the economy will generally grow faster than the global average but with greater volatility – the upturns will be higher and the downturns deeper. We aim to shed light on diversification policy from this novel, if not yet widely accepted, perspective.

The GCC economies exhibit 'high beta,' particularly Qatar. Saudi Arabia sits in the middle of the group, but above the global average, while Oman has the lowest coefficient of the group.

Saudi Arabia's National Transformation Plan to 2020 and economic Vision 2030 envisage an economy that is still invested in oil and gas activity at 45 percent of total output. While diversification policies in these plans promote economic growth, it still leaves the economy exposed to the volatility of energy markets. In comparison, the optimal mix of economic sectors could increase the growth rate by more than 1 percent annually and nearly halve the expected volatility (to less than 60 percent of growth rate).

Saudi Arabia's historical economic policies were effective in achieving some diversification. However, their benefits could be increased by policies that balance productive efficiency with diversification of economic activity.

The difference between policy-optimized portfolio and non-constrained optimization can be used to estimate the size of the fiscal stabilization fund needed to protect the economy from stop/go risks to diversification objectives.

Executive Summary

Economic diversification has been a priority for economic planners in GCC states for several decades. Despite noteworthy developments in per capita income and economic growth, such achievements have hinged on the region's huge endowment in oil and gas. In turn, this reliance has exposed the economies of the GCC to fluctuations in oil prices and brought into question the long-term fiscal sustainability of its economic development. Our research confirms that diversifying both the sources of economic growth and government revenue streams can contribute to reducing these instabilities while doing least harm to the rates of economic growth.

While individual strategies may differ, diversification goals are common to all GCC countries: to increase the variety of exports, goods and services of domestic production. Recently, the World Bank (2014) explored the concept of 'high-beta' in its Diversified Development report. The beta coefficient is a well-known corporate finance concept that is used as a risk measure. In the macroeconomic context, it refers to the instability of gross domestic product (GDP) associated with a lack of economic diversification – measured as its standard deviation over a specific time period.

Investigating diversification practices, progress and policies is not new. However, recent research has found evidence of a parabolic relationship between growth and its instability in developed, oil importing economies – such as the U.S. and Europe – and puts forward suggestions for managing diversification and economic growth. In this paper, we test this relationship in the GCC region, given the region's heavy reliance on a single sector for its economic well-being, and ask what it says about policymakers' economic diversification goals.

Modeling the economy and its sectors within a portfolio framework in this way is a direct application of Markowitz's (1959) work on portfolio optimization. If there is a growth instability (GI) frontier, this paper draws insights relating to the macroeconomies of the GCC region from a portfolio model application drawn from financial economics. We treat individual sectors in the economy as assets in a portfolio and applied the Markowitz theorem; that the return on a portfolio is a weighted average of the returns on the individual assets in the portfolio, with the weights being equal to each asset's partial share of the portfolio.

The data confirms the existence of a GI frontier in the GCC region as well as at the country level, suggesting a portfolio framework application can be used to analyze diversification targets of the GCC's macroeconomies. Diversification driven policies applied since the early 1980s appear to have had an impact on this analytical frontier through either a cost-minimizing or a value-maximizing framework. Yet there are opportunities for improvement, including a focus on productivity efficiency, and more investments in the tradable sectors of the economy coupled with incentivizing private sector development and employment.

Allowing the resulting model to determine the structure of the Saudi economy that maximizes growth for a given level of volatility leads to a mix with only 5 percent 'mining and quarrying' (the internationally recognized classification that include oil and gas extraction activities). The largest sectors would be manufacturing (45 percent) and services (27 percent), with agriculture accounting for 12 percent. Obviously it would be difficult to reduce the share of oil and gas so dramatically without considerable economic and social upheaval.

The 'optimum' diversification of the economy represents a valid long-term goal. In the short term, the policy targets and objectives outlined in the

National Transformation Plan (NTP 2020) and the economic Vision 2030 represent a more pragmatic interim step in the transition. Our analysis suggests that the Kingdom may be able to achieve growth rates of 4.4 percent (but with a 6 percent instability) given the current economic health and resources at its disposal. This is considerably better than the current mix (expected to deliver 4.1 percent growth with 8 percent instability). Although the difference is 0.3 percent, on an aggregate scale this translates into a SAR 5.5 billion improvement. Additionally, the 2 percent difference in instability places SAR 56 billion at risk. The optimal scenario mentioned earlier suggests that Saudi Arabia could achieve an economic growth rate above 5 percent while limiting risks to growth (3 percent instability) by directing investments into and promoting services and manufacturing.

Given that a constraint-free optimum diversification of the economy is not feasible in the short or medium term, the question is how to provide an appropriate estimate of the size of the required fiscal stabilization fund that will keep the economy protected from being derailed on its path toward efficient diversification.

Growth Instability Frontier – A Review of the Evidence

The GCC economies punch above their economic weight within the global marketplace due to their substantial oil and gas production. They share similar cultures, macroeconomic structures and natural resource wealth. All also share the challenge of diversifying their economic activity to smooth out shocks in oil prices or demand.

Recently, the World Bank's Diversified Development (2014) report used the concept of 'high betas' to describe growth rates of economies in Eurasia. This concept of a 'beta coefficient' is borrowed from corporate finance, where it describes the performance of a stock compared with the market. A high beta stock is one that would outperform the market on an upswing and underperform the market on downswing. In a macroeconomic context, it refers to the economic performance of a specific country versus the global benchmark. We explain this further in Appendix I and show the beta calculation relating to the GCC economies. According to the World Bank report, economies with high betas should focus more on becoming resilient to economic volatility through diversification, rather than taking specific action to try to minimize it. Additionally, they proposed a focus on education and health care, which would complement such policies to achieve efficiency in production.

The World Bank's contention, and KAPSARC's suggestion, is that the use of a portfolio construct to describe the macroeconomy reveals the potential for non-intuitive policies that might have remained unnoticed through using more traditional tools. Examining the relative weights of different sectors and then adding a stabilization fund may provide a path on the way to a diversified economy that does not require such a sovereign investment reserve.

With its status as the largest oil exporter, the Kingdom of Saudi Arabia is arguably the most influential player in the region, which warrants particular focus on its economy. However, the regional analysis allows us to benchmark the Saudi Arabian economy. A crucial starting point in our research was to investigate whether or not a convex relationship between growth and its instability exists in the GCC.

Before optimizing the portfolio model, we used country-wide growth rates and standard deviation to plot the relationship across time. This primary step allows us to formulate expectations on the GI frontier before executing the model. Figure 1 shows a scatterplot that outlines the relationship between economic growth and its instability for the GCC region.

It appears to take on a convex shape. However, the Kuwaiti data shows high instability for two out of the three decade spliced data. We have followed the approach of Chandra (2002) among others in dropping data that may adversely impact the results of the model, especially when the model depends on averages in the sample. Brace (1991) provides more detail on those that followed the same practice. Each of the points has the coordinates of an 11-year average rate of economic growth and its instability for an economy. With 33 years of data, this means that each country has three points, with six countries in the GCC, this totals 18 points. The efficient frontier can be visualized as surrounding the outermost points of the scatterplot.

In Figure 2, the efficient frontier location may fall into one of four quadrants in the risk return space. The dashed line represents the set of attainable portfolios for a given set of conditions such as production ability, natural resources and other country-relevant characteristics. The solid line is the efficient frontier where only the optimal set of portfolio exists. The lower right quadrant shows a frontier that is characterized by high levels of instability and

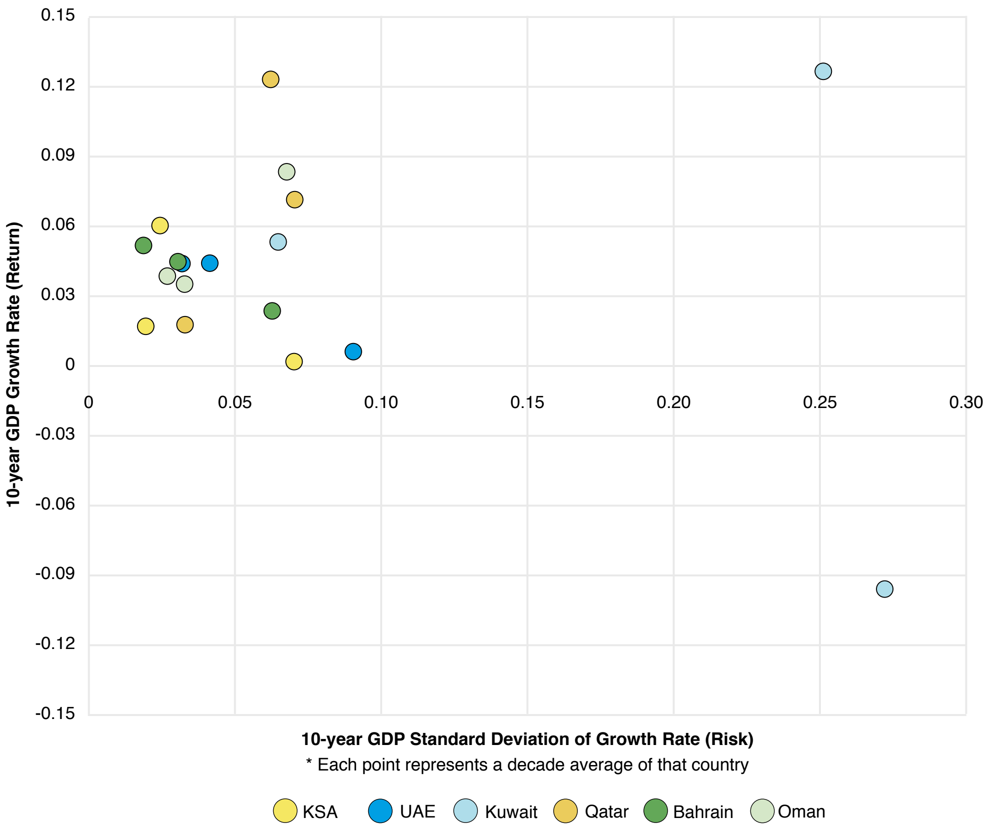

Figure 1. Scatterplot of the GCC panel.

Source: KAPSARC, Sama Data.

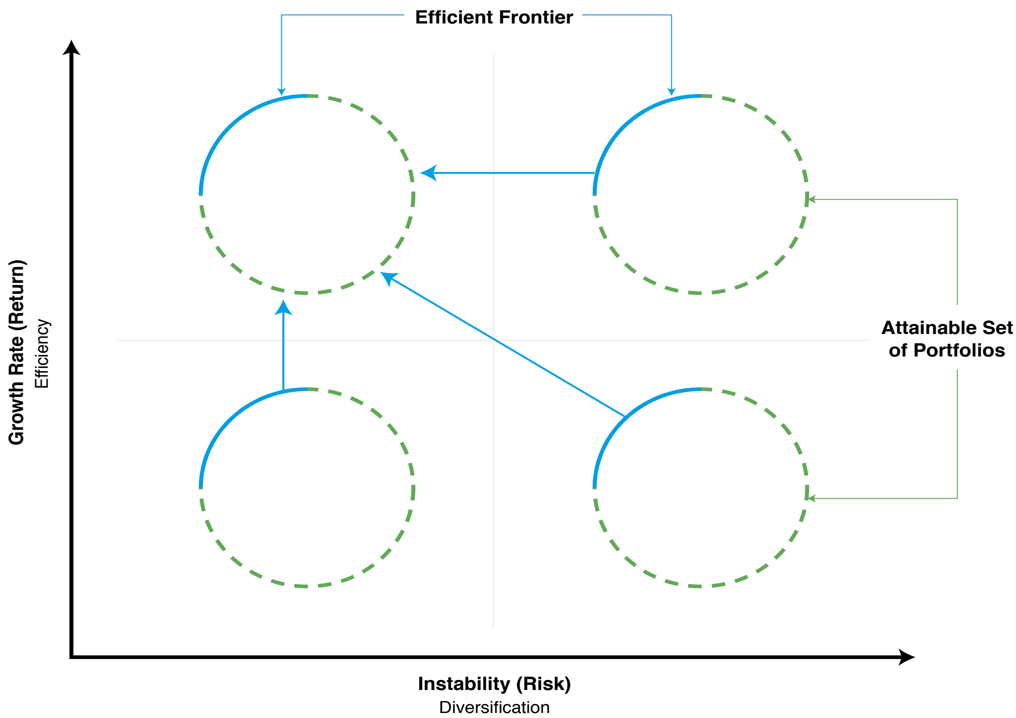

Figure 2. Behavior of the efficient frontier and diversification.

Source: KAPSARC, Sama Data.

low levels of return. From that point, depending on economic development policies, it may move to any of the other quadrants. Movement to the upper right quadrant shows value maximization, but with a high instability factor. For example, Qatar would fall into that quadrant due to its dependence on natural gas. Despite adding to its GDP, its lack of diversification causes the economy to be more sensitive to shocks in the natural gas market. The lower left quadrant represents economies that have diversified their economic activity, but at the cost of inefficiencies. In other words, they are not taking advantage of economies of scale, or streamlining production. While productivity may increase, their efficiencies do not. Movement to the upper left quadrant represents the optimal set of policies which focus on minimizing instability in economic growth through diversification, but also make use of efficient productivity to maximize value. In order to measure the progress of diversification and efficiency, the efficient frontier of an economy must be observed across time.

By definition, the preferences of a risk averse social planner are represented by an upward and leftward shift of the graph toward the northwestern quadrant. Building on this observation, we would expect policy decisions to reflect such preferences, which would be achieved through diversification of economic activity. In other words, the grouping of the data would be representative of higher rates of economic growth for lower instability coefficients. We can then use the growth instability scatterplot to detect the movement of the frontier across time and investigate the statistical significance of the shifts, if any. Figure 3 allows for a direct comparison between time periods, thereby providing visual tracking of the frontier in the

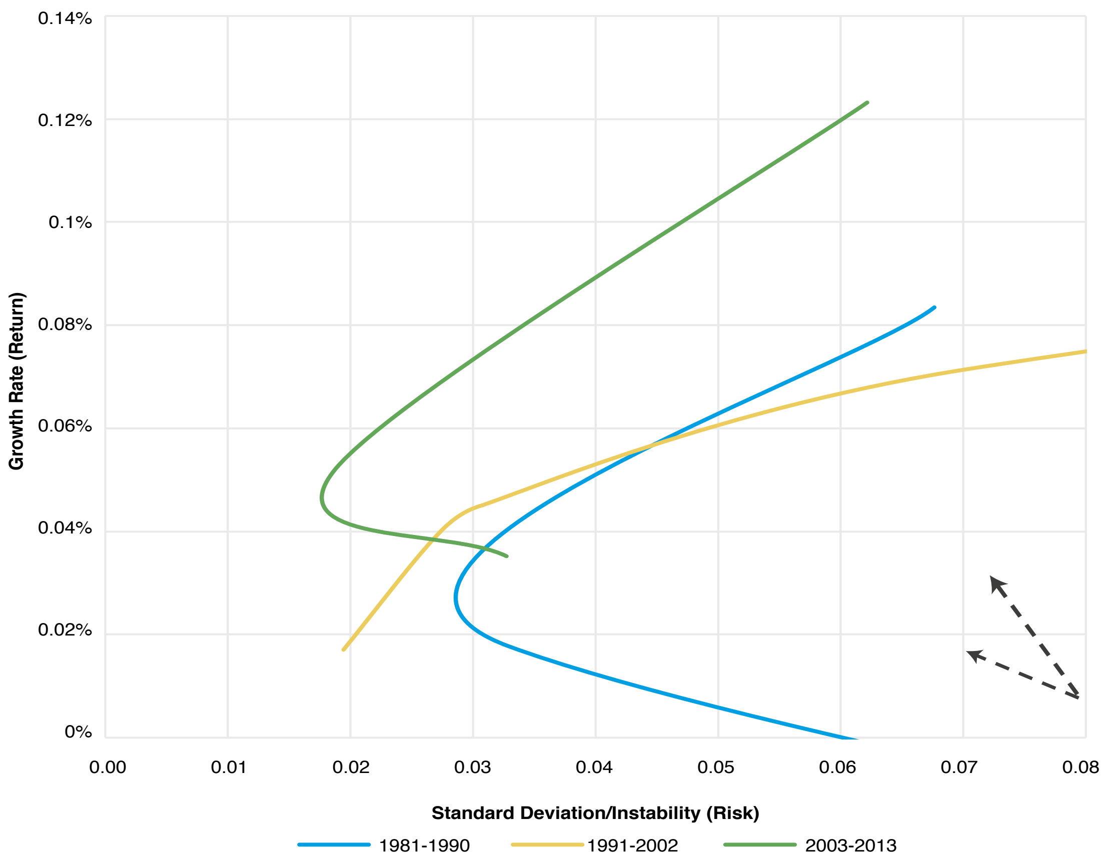

Figure 3. Three-sample efficient frontier for the GCC.

Source: KAPSARC, Sama Data.

risk-return space. To better visualize the frontiers only the outermost points were plotted and it is demonstrated that there is a shift of the frontiers across time, with the most recent set of data being closer to the northwestern quadrant. This quantifiable evidence of the diversification policies impacts the examined economies. Statistical tests indicate that such shifts are significant at the 5 percent level.

Based on our knowledge of the GCC economies and supporting empirical evidence, we note that oil production and sales constitute a large part of the countries' export revenue and GDP. Accordingly, diversification policies were aimed at the reduction of oil activities in the countries' economies. In the sectoral context, this means a reduction in share of oil activities as a percentage of GDP and an increase in the weights of non-oil sectors. Figure 4 illustrates the temporal weights of mining and quarrying as a percent of GDP for the GCC economies over the period 1993 – 2013, demonstrating a negative sloping trend that is statistically significant (Descriptive statistics of the data can be found in Appendix III).

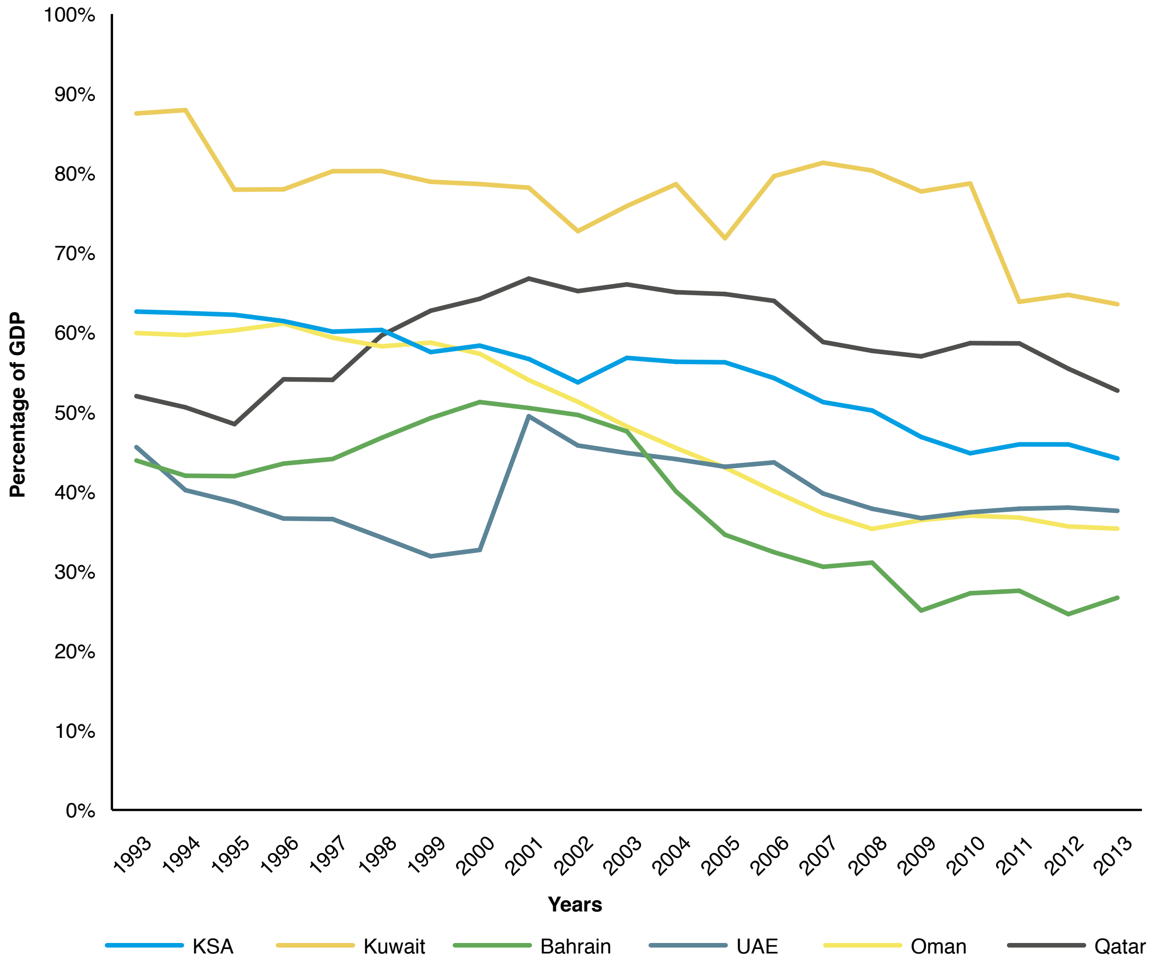

Figure 4. Mining and quarrying share of GDP across time.

Source: KAPSARC, Sama Data.

Reviewing all the evidence establishes two crucial points:

> First, the existence of a convex relationship between economic growth rates and growth instability, thus enabling the use of a portfolio framework for diversification analysis and subsequent policy implications.

> Second, the impact of diversification policies may be observed across time. This is especially true for the Kingdom of Saudi Arabia, since one of the three primary objectives of its first economic development plan (1970–1975) was to diversify economic activity away from the oil sector. This has become a recurring theme in all the five-year economic plans that followed.

However, despite diversification efforts and policies, oil-related activities still constitute 48 percent of GDP for Saudi Arabia (SAMA, 2015). Given that economic growth in the GCC countries is heavily dependent on oil production, it is highly sensitive to the volatilities exhibited in energy markets. In turn, we expect that GCC countries will exhibit a high-beta coefficient in relation to the global environment (detailed calculation of the GCC betas can be found in Appendix II). The results confirm this hypothesis, except for Oman. Saudi Arabia's estimated beta is 1.43, which means that its economic growth instability is 143 percent of the global economy. The highest of the GCC group is Qatar with 234 percent, followed by UAE and Kuwait with 203 percent and 188 percent, respectively. Comparatively, Saudi Arabia is in the middle of the group in terms of instability. Oman exhibits a negative correlation to the global economy, but at a coefficient that is less than one in absolute value terms.

Table 1. Beta calculation and expected rates of economic growth.

	Beta	E(rr)
Saudi Arabia	1.43	3.9%
UAE	2.03	4.4%
Kuwait	1.88	4.3%
Qatar	2.34	4.7%
Bahrain	0.96	3.5%
Oman	-0.80	2.0%
Global GDP growth average 3.55% (1981 - 2013)		

Source: Author's calculation and World Bank Database.

A Portfolio Framework Application – Results

In order to properly investigate economic diversification in the Kingdom, a benchmark was needed to evaluate the efficiency of resource allocation in the Saudi economy. By grouping the GCC economies and their output, we were able to obtain a theoretical benchmark for economic efficiency. In turn, each country is then evaluated against the overall frontier and then the measured deviation from the frontier would indicate how efficient/inefficient that economy was.

The benchmark potential growth and instability were 4.3 percent and 2.1 percent, respectively. Given the current economic mix of each country, the distance from that hypothetical frontier was measured and plotted in efficiency and instability space (refer to Figure 2). As illustrated by Figure 5, we find that Saudi Arabia, Bahrain and Oman are in the risk-minimizing quadrant. Alternatively, they are less efficient than UAE, Kuwait and Qatar. While the latter group is more efficient, they exhibit larger instability. Statistically, Saudi Arabia is the least efficient in the region, with an efficiency gap of 3.5 percent. Although the Kingdom is lagging in economic efficiency, the average difference between it and the most efficient economy (UAE) is less than 1.25 percent.

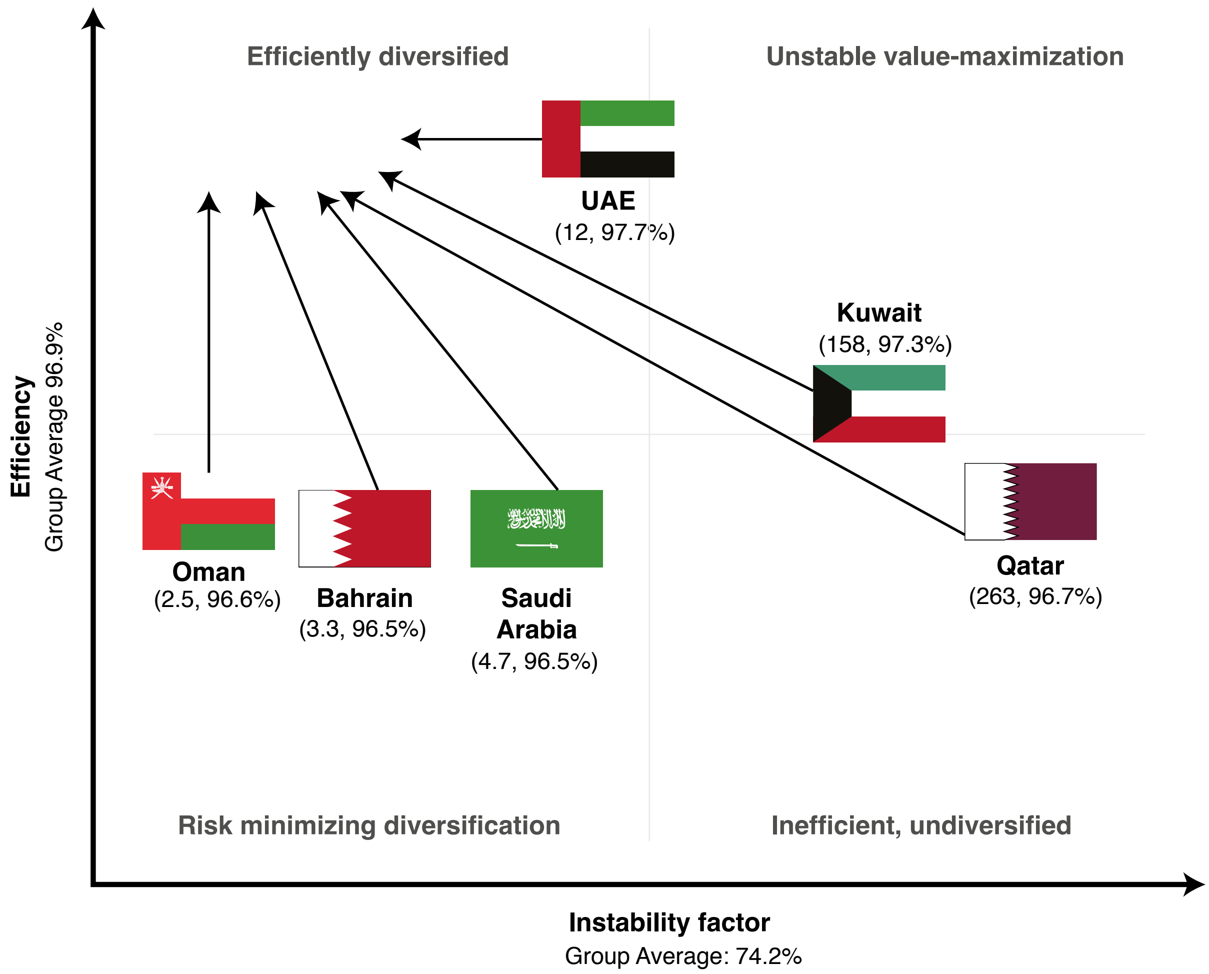

Figure 5. Economic diversification (stability) and efficiency.

Source: KAPSARC, Sama Data.

It may be the case that openness to foreign investment and business attractiveness together represent the primary driver of efficiency in economic diversification. Additionally, investments in tradable goods and private sectors could also contribute to higher levels of efficiency. While this cross-sectional comparison is useful for the region, a country level analysis is more relevant for domestic policy generation.

We will focus in on Saudi Arabia shortly but, for the other five GCC economies (model results can be found in Appendix IV), the sectoral composition that would lead to minimizing the instability of economic growth in each country is presented in Figure 6. These country-level compositions would lead to growth rates of:

- 3.5 percent for UAE.
- 2.8 percent for Kuwait.
- 6.5 percent for Qatar.
- 4.2 percent for each of Bahrain and Oman.

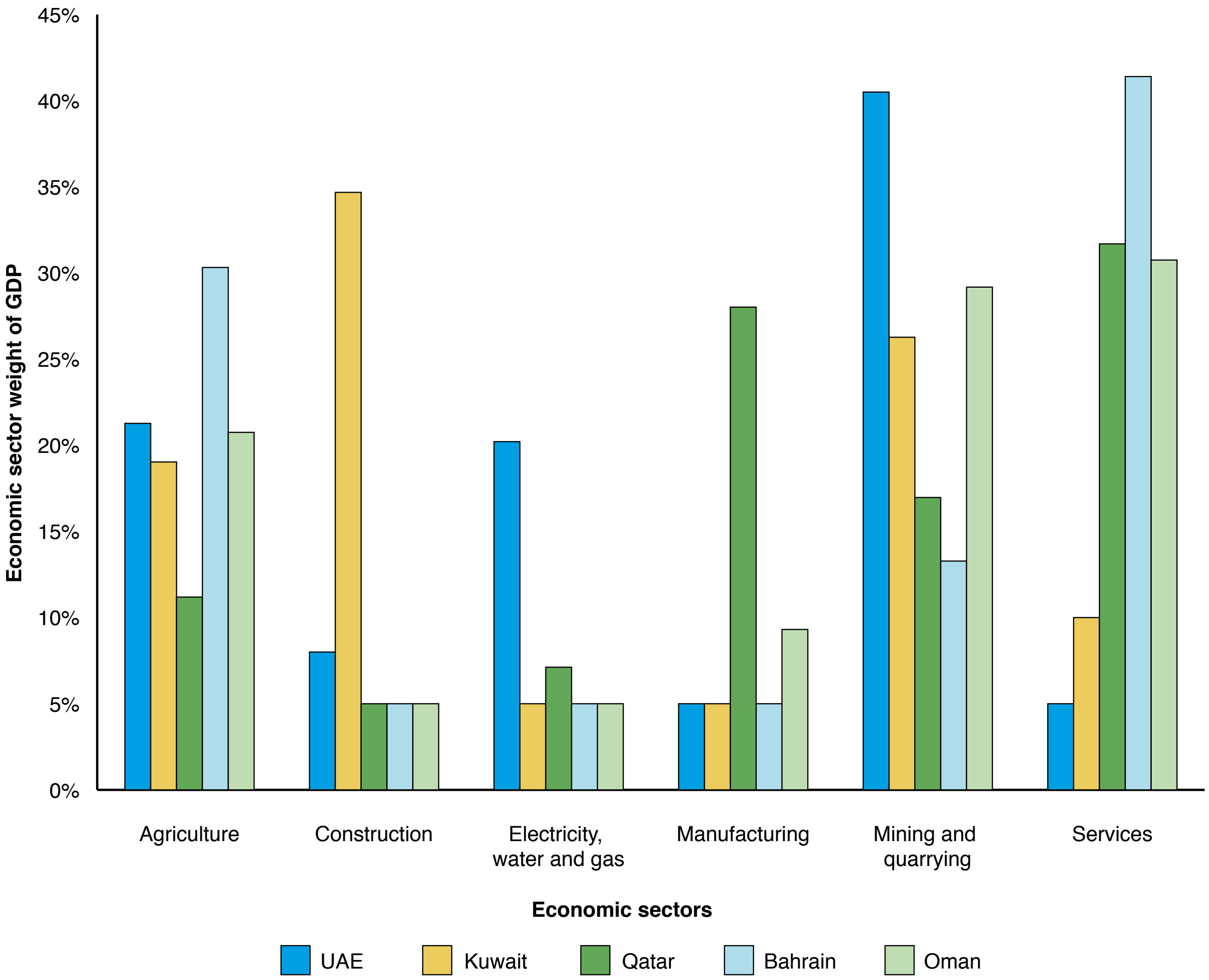

Figure 6. GCC recommended economic instability minimizing mix.

Source: KAPSARC, Sama Data.

This economic weight is not only restricted for government expenditures, but is a direct indication of efficiency in that specific sector. More generally, it refers to policies that would reduce instability of growth; alongside expenditures, it refers to enhancement of productivity and reduction of inefficient practices.

For Saudi Arabia, Figure 7 describes the economic activity composition in the Kingdom that would maximize economic diversification while minimizing the instability factor of economic growth, in line with 2030 economic vision objectives. Notably, the diversification plan focuses on reducing its dependence on the oil sector (mining and quarrying), developing manufacturing and tradable goods, and increasing industrial activity within its borders.

In order to achieve a sustainable economic growth of 4.56 percent – with an instability of 7.02 percent – our data indicates that Saudi Arabia should direct policies toward development of its manufacturing

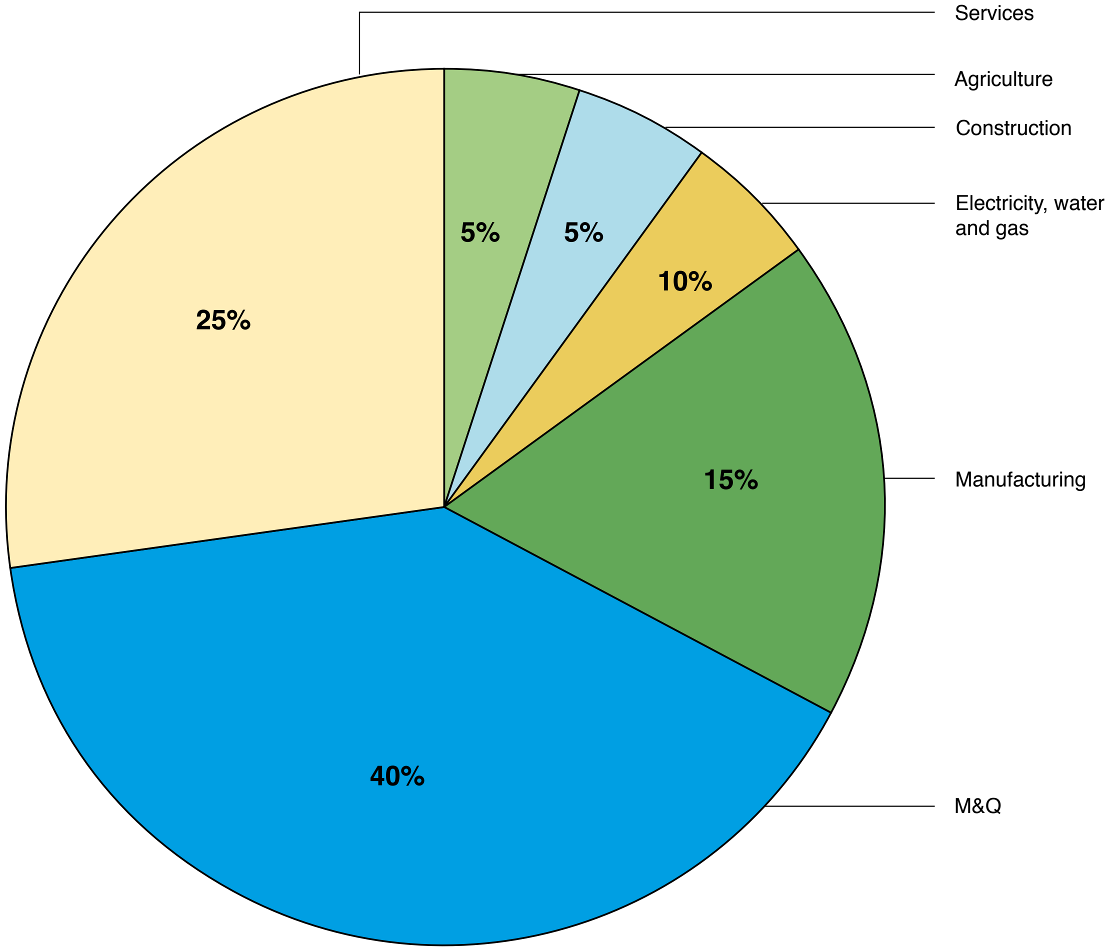

Figure 7. Saudi Arabia instability minimizing growth rate.

Source: KAPSARC, Sama Data.

and tradable good sectors. As shown in Figure 8, this calls for a substantial shift of government expenditures from the current economic mix. Most notably, less reliance on the mining and quarrying sector – which primarily comprises oil GDP – and reallocation of expenditure toward manufacturing instead.

If we relax the constraints on the economic mix, then the portfolio model presents us with significant changes (See Table A4.4 in Appendix IV). It demonstrated that the optimal mix would have close to 80 percent of the economic activity from manufacturing and services, with the latter being around 30 percent. Mining and quarrying would constitute about 2.5 percent from the economy. In turn, the expected growth rate is closer to 5.7 percent with 3.11 percent instability risk. However, this mix is only theoretical as it does not consider policy requirements, reconciliation between economic and finance theory, or long-term commitments in the economy. Yet, we can think of these results as the steady state target mix.

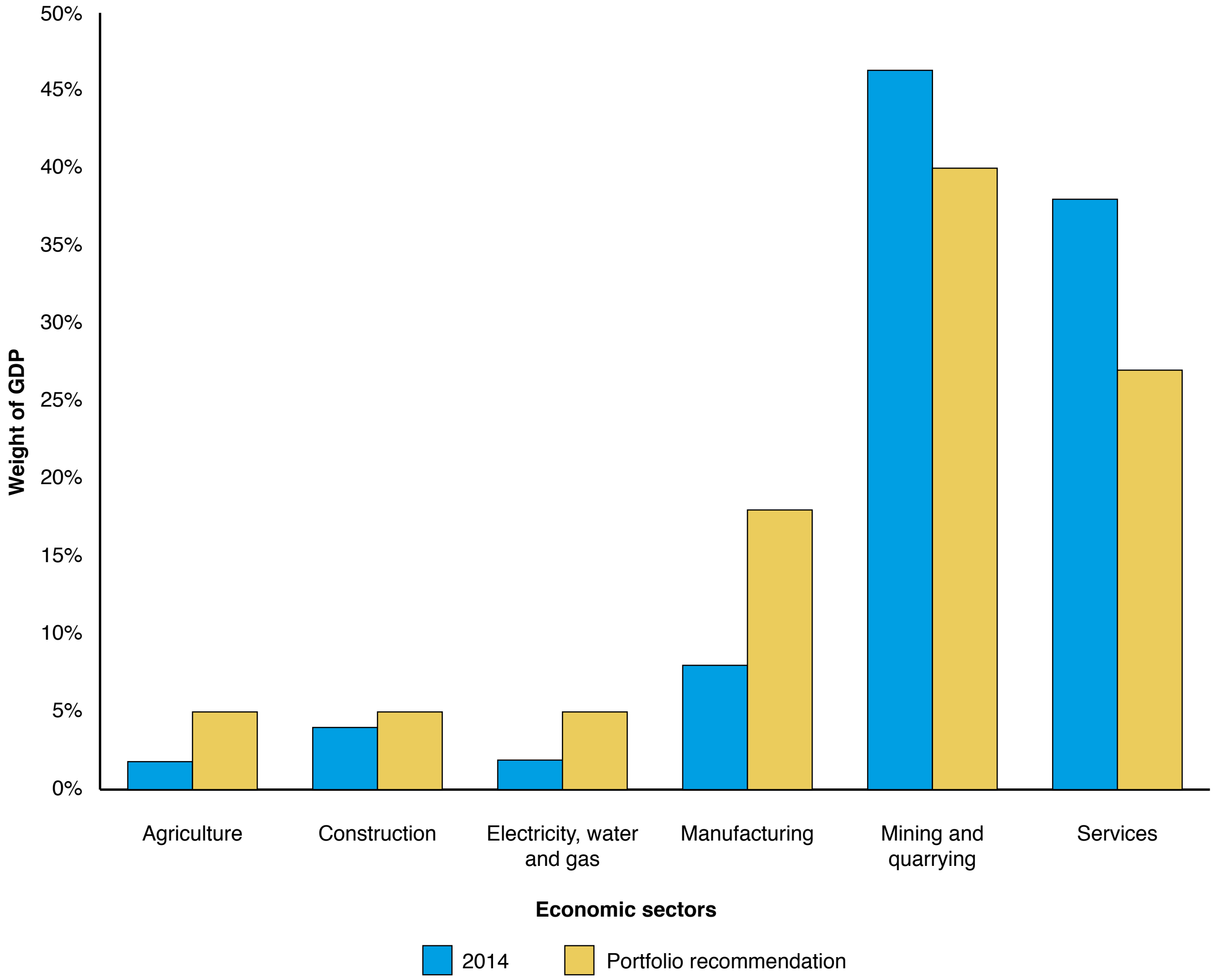

Figure 8. Economic mix comparison for Saudi Arabia.

Source: KAPSARC, Sama Data.

Conclusion and Policy Implications

To adopt a portfolio framework approach in analyzing diversification strategies and economic development is a relatively novel approach. Nonetheless, we found it provided insights that are different from those achieved using classical vantage points. Naturally, the policy implications of such an approach are circumscribed by long-term development plans. Given the nature of the macroeconomic environment, neither the recommended changes in expenditures and policies, nor their benefits, can be realized in the short term.

Diversification efforts made under historical economic policies were effective; however, to increase their benefits, policies must seek a balance between diversification of economic activity and productive efficiency. With the exception of Oman, all of the GCC economies exhibit a high beta status, with Qatar being the highest and Saudi Arabia in the middle of the group. In turn, Saudi Arabia's economic growth follows the global economy, but at a slightly larger magnitude of impact both in upturns and downturns.

For Saudi Arabia, an economic growth rate of 5.59 percent would minimize the instability of economic development, so long as the bulk of investments and resources are directed toward services and manufacturing sectors. Policies should focus on creating additional incentives in the tradable sectors of the economy, reduction of incentives in the public sectors and the promotion of private sector activities. In terms of government expenditure, fiscal policy should promote investments in human capital via education, business climate appeal and attracting foreign capital inflows.

The portfolio framework can also be utilized to support long-term strategic plans in transforming the economy. By targeting an overall economic growth rate, we are able to identify specific targets for each sector, which provides a roadmap for policymakers in terms of what is the value added of each sector and how to achieve it.

One of the possible uses of the portfolio framework directly relates to economic performance. Simply, the weights of the optimal economic mix may be utilized alongside the constrained weights to estimate the size of a fiscal stability fund. The growth-rate differential may be thought of as the initial size of the stability fund, while the instability differential can be a proxy for the drawing/deposit requirements. Preliminary results demonstrate that for Saudi Arabia on a five-year horizon, the average balance of the stability fund should be between SAR 591 billion and SAR 740 billion. Future research in this topic will attempt to formalize the approach and test its validity by comparing its results with those of other methodologies or models.

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Appendix I: Empirical Evidence

Conroy's seminal work (1972, 1974 and 1975) introduced the application of a portfolio framework to the macroeconomic environment. It is not uncommon to find studies taking similar approaches to developed economies such as the U.S., Italy and other eurozone countries. A number of empirical papers followed Conroy's approach with increasing sophistication and complexity of model components, such as estimation of the variance-covariance matrix of growth rates (Brown and Pheasant, 1985; Board and Sutcliffe, 1991; Schoening and Sweeney, 1991; Hunt and Sheesley, 1994).

Wagner and Deller (1998) constructed a set of metrics for economic diversification in the U.S. that were based on diversity of economic activity as well as sectoral interdependencies. More recent research has examined the implications of economic diversification for growth and stability, or lack thereof. Chandra (2002) tested the existence of the regional growth instability frontier in the U.S. using state level data across three decades. The results confirm the existence of a convex relationship between growth and instability, yielding favorable implications for economic growth rates based on diversification of economic activity. Additionally, in the long run, economic instability is found to be negatively correlated with various metrics of economic diversification, providing further support for the portfolio construct in the economic field.

Chandra (2003) expanded his research and investigated the regional economy size and the growth instability frontier in Europe. The findings show that the portfolio approach is more suitable for large economies where the convex relationship between growth and its instability will hold; while in small economies it is hard to obtain such a characteristic in the relationship between economic growth rate and its instability. Bigerna (2013) found evidence of the existence of the growth instability frontier in Italy at the regional level. Applying portfolio optimization analysis, the results show that more diversification reduces risk or instability of growth.

Somewhat later, Callen et al., (2014) examined diversification policies in the GCC region. Mainly, they indicate that despite a policy framework aimed at alleviating the 'natural resource curse' concerns such as low inflation, favorable business environments, investments in human capital and development of industries to employ high-skilled labor, it is difficult to diversify away from oil activities. Going forward, our research suggests that GCC economies should focus more on realigning incentives in the non-oil tradable sectors.

This research attempts to fill the gap in literature by investigating the existence of the relationship between economic growth rate and its instability in the GCC economies. Alongside the conventional methodology, the paper presents an alternative approach to constructing the portfolio based on portfolio theory and consequential analysis.

Most of the previous studies have assumed the absence of a risk free asset, as this made the assumptions in the model easier to manage. Yet it is possible to expand the regional portfolio construct as part of a larger economy. In other words, the findings show that the larger the economy – or the more aggregated the regional economy – the greater the suitability of a portfolio application for analyzing it.

In that sense, we could assume that the global economy consists of the entire population of assets (smaller economies), and thus we were able to apply modern financial theory and its implications to the various countries and regions. To the extent of our knowledge, the global instability frontier and the application of other modern portfolio theories have not been applied in literature to GCC economies. We expected to find a convex relationship between growth and its instability in the GCC economies: that is, as instability (risk) increases, growth of a particular economy will increase, but at a declining rate. In the countries studied here, the policy implications and shape of the frontier may differ due to the different extents to which they rely on oil production as a main source of export revenue.

Appendix II: Theoretical Underpinnings

Traditionally, economic literature employs an aggregate economic growth model that is centered on business cycle approaches. Various studies estimate a linear and causal relationship between growth and instability (Grier and Tullock, 1989; Ramey and Ramey, 1995). Taking a business cycle model approach (Black, 1987), these studies tweak control factors of hypothesized placement to affect growth when testing for causality. Ramey and Ramey (1995) found a negative relationship between growth and instability, while Grier and Tullock (1989) demonstrated a positive one. However, recent studies that have shown a parabolic shape to the relationship between growth and its instability suggest that we may depart from the traditional linear approach and explore other possibilities. Further support is given to the efficient frontier approach, given that it is well exhibited in larger or more aggregated regions.

Conventional methods promote the use of stochastic frontier analysis (SFA) or the data envelopment approach (DEA) for investigating the convex parabolic shape between growth and its instability. We have preferred the first as it provides flexibility in analyzing panel datasets by allowing control of state and time effects. The SFA model can be estimated using the following equation:

$$S_{it} = \alpha_i + \delta_i + \beta_1 G_{it} + \beta_2 G_{it}^2 + u_{it} \tag{7}$$

Where S_{it} is the standard deviation of the growth rate for region i over period, t, α_i is the fixed state effect, δ_i is the time fixed effect, G_{it} the rate of growth for state i over period t, u_{it} is the error term, and β_1, β_2 are parameters to be estimated. Equation 8 shows the random effects specifications of the SFA model, where state and time effects are randomly modeled.

$$S_{it} = \alpha + \beta_1 G_{it} + \beta_2 G_{it}^2 + u_{it} \tag{8}$$

The null hypothesis is that the parameters are equal to zero. Rejection of the null would indicate a curvature in the function, with the signs of the coefficients indicating the shape. In our case, which is a convex frontier, the first coefficient should be negative, and the second should be positive. Kumbhakar et al. (2015) note that the SFA models are appropriate where the data's residuals exhibit statistically significant negative skewness. Otherwise, the frontier model would boil down to a restricted ordinary least squares (OLS) model, though the model's specifications would not affect the signs of the coefficients. In other words, it is possible to have a convex frontier without satisfying the negative skewness condition.

A common starting point in heterodox analysis of growth instability is the Markowitz (1959) framework. Heterodox approaches to economics refer to nontraditional approaches in analyzing economic factors. In this case, we have departed from the conventional approach that is based on business cycle methods and yields an aggregate, one-to-one, causal analysis.

Let us consider a portfolio consisting of ***n*** number of risk assets. In the original Markowitz framework, no asset had zero variance. In other words, there was no inclusion of a risk free asset or investment, a development that was introduced into modern portfolio theory after Markowitz's seminal paper in 1959. The total expected return on the portfolio $E(r_p)$ is equal to the sum of the weighted expected returns of the individual assets.

$$E(r_p) = \mu = \sum_{i=1}^{n} s_i r_i \tag{1}$$

$$Var\left(r_p\right) = \sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n}\sigma_{i,j}s_i s_j \quad (2)$$

$$\sum_{i=1}^{n} s_i = 1 \quad (3)$$

Where $s_i \geq 0$ is the asset's weighted share in the portfolio, r_i is the return for assets $i = 1, 2, \ldots, n$. The variance of the portfolio – represented by the second equation – is the summation of the assets' covariance, multiplied by their relative shares. Constraining the shares to be positive implicitly implies that only long positions are allowed within this setup. If we are to include short positions on the assets then we allow for negative percentages, which represent a sale of these assets.

Taking the square root of the variance yields the standard deviation of the portfolio (σ), which is interpreted as the overall risk for that specific portfolio, characterized by a given set of shares. As the percentages of the shares vary due to preferences, behavioral tendencies or investment rationality, the mean and variance of the portfolio will change accordingly and a unique portfolio emerges.

Repeating the process and plotting the risk return coordinates within the space of σ and μ will display all the possible portfolios within the given parameters. Maximizing (minimizing) the return (risk), will plot all attainable portfolios that are on the efficient frontier. As shown in Figure A2.1, the attainable set of portfolios will exhibit a circular shape in the space of σ and μ. Point A represents the current portfolio, given a certain budget and shares.

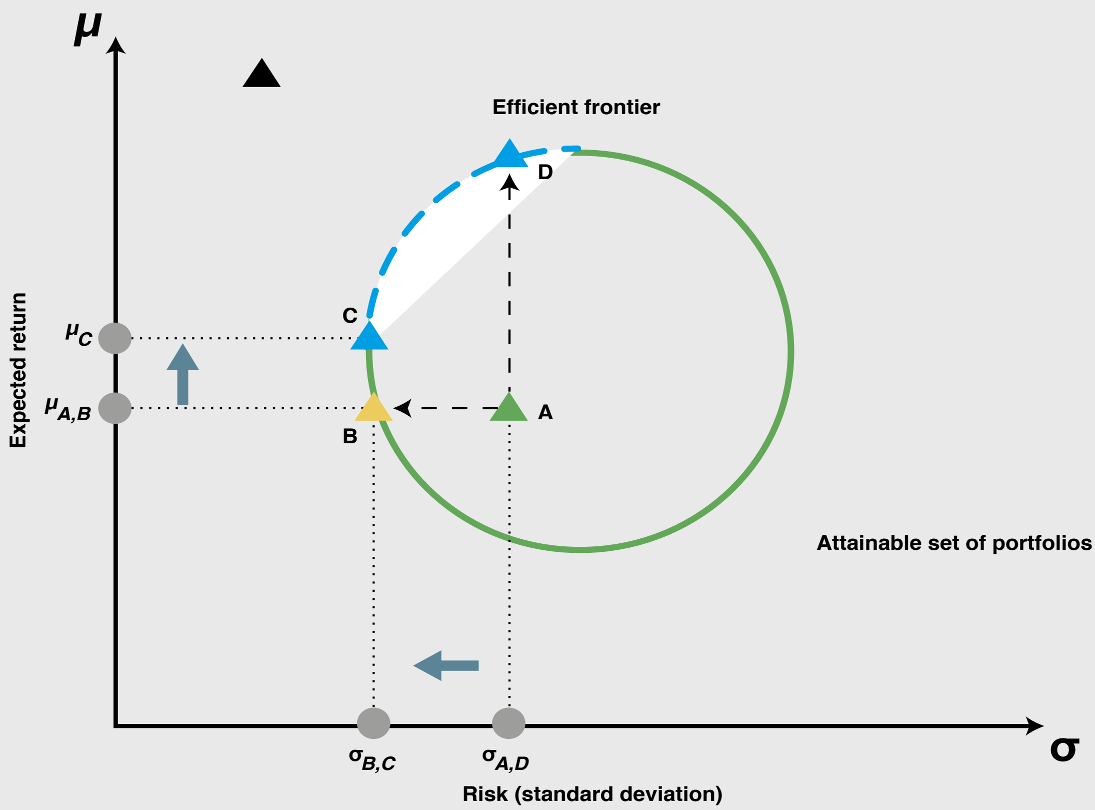

Figure A2.1. Efficient frontier space.

Source: KAPSARC, Sama Data.

Although *A* is within the attainable set boundary, it is not efficient. An investor can obtain the same return for a lower level of risk by moving to portfolio *B*. Since this presents the same value but for a lower risk, and in turn a lower budget, it is a cost minimizing portfolio. Yet portfolio *C* provides a higher return for the same level of risk as in portfolio *B*. In turn, this is a value maximizing portfolio as it has the same risk and budget, but for a higher return or value. Any portfolio that is on the dashed line is labeled as an efficient portfolio that either can be cost minimizing or value maximizing. Thus, the only difference between the efficient portfolios is directly related to the risk preference of the investor or, implicitly, the available budget for investment.

Assuming the investor is risk neutral, then a higher value can be obtained for the same level of risk by moving from point *A* to point *D*. A risk averse investor would move either from point *D*, *A* or *B* to point *C*. Point *E* represents an unobtainable portfolio set, since it is outside all attainable portfolios, given the parameters of the portfolio's components and its shares. Since diversification reduces the risk exposure of the portfolio, increased diversification would cause the set of attainable set of portfolios to shift to the left. Lack of diversification would cause the overall risk of the portfolio to approach the risk level of the asset with the highest share, i.e., a single asset portfolio would have the same risk as the asset held. The inclusion of a risk free asset would be interpreted as the 'floor' return with zero variance. In turn, it would be exhibited as a tangent line intersecting the efficient frontier at a point of the optimal portfolio.

In Figure A2.2, the efficient frontier *A* moves to the left (right) if there is more (less) diversification to efficient frontier *B (C)*;

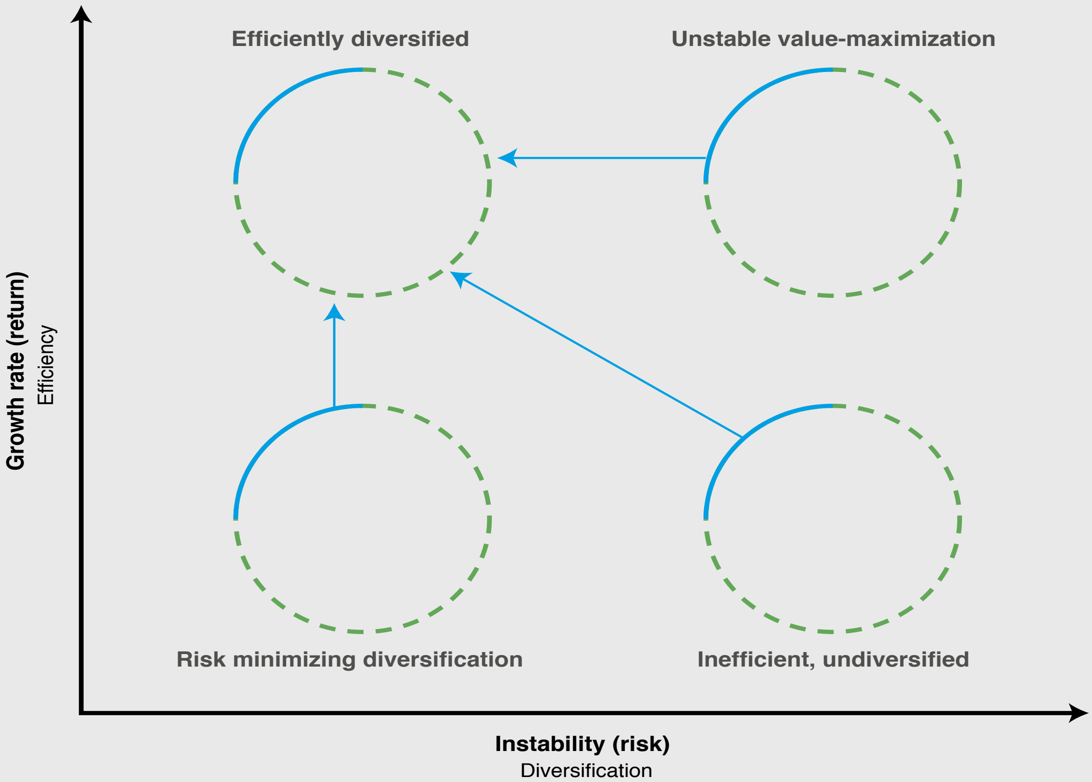

Figure A2.2. Behavior of the efficient frontier and diversification.

Source: KAPSARC, Sama Data.

Similarly, we can model the economy's output as a portfolio consisting of various economic sectors, but with some minor adjustments and constraints. Following Chandra (2002), consider the gross regional product (GRP), with $\boldsymbol{n}$-sectors of economic activity:

$$GRP = \sum_{i=1}^{n} GP_i \tag{4}$$

The expression in equation 4 simply states that the GRP is equal to the summation of the gross product of the $\mathbf{i}^{th}$ sector in the region. Chandra (2002) provides proof of convexity. The change and growth of GRP can be expressed as:

$$\Delta GRP = \sum_{i=1}^{n} \Delta GP_i \tag{5}$$

$$G = \frac{\Delta GRP}{GRP} = \sum_{i=1}^{n} \frac{\Delta GP_i}{GRP} = \sum_{i=1}^{n} s_i g_i \tag{6}$$

Therefore, the growth rate of the GRP is the weighted sum of the rates of growth of the individual sectors. While this expression closely resembles the expected return of the portfolio – and subsequent implications for diversification – we must consider the different theoretical drivers.

There are a variety of issues concerning the conceptual framework and theory behind the application of portfolio optimization to the economy. First, the economic sector weights, or shares, do not change from one period to the next. In comparison, asset weights can be overhauled and changed within a short amount of time. This is because sectoral shares are constrained by size, which makes it extremely difficult for an economy to carry out a reallocation of its economic sectors in the short term.

However, constraining the sectoral weights should not affect the prediction of the frontier or its implications for diversification. Simply expressed, this means that the weights are fixed, with some marginal changes allowed in the short run, but major changes are more likely to take place in the long run. In turn, if changes are recommended from the framework, they will be part of an economic plan that will gradually shift sources to that specific economic sector.

Chandra (2002) notes that there are two issues of concern in applying portfolio optimization methodology to economic analysis:

First, the composition of the economy may cause high covariance between the sectoral growth rates due to the input-output structure. In simple terms, reallocating resources between sectors in economies that demonstrate closely related growth processes means that those economies will benefit less from diversification. This is related to the empirical findings of Chandra (2003), in which a positively correlated relationship between economy size and diversification was found. Variety in economic activity allows for a higher probability in differing growth processes, which increases the benefits realized from diversification.

Second, unlike assets in a portfolio, the sectoral weights can impact the growth of the economy, or other sectors, due to economies of scales. A high weight in an input such as silicon chips may have a propagation affect that could cause unstable growth in outputs such as the computing producing sector. This should not alter the presence of the convex frontier, but could have an impact on the curvature of the parabola, due to spillover effects and returns to scale (Chandra, 2002).

Building on the Markowitz (1959) model of mean-variance portfolio optimization – previously mentioned in equations 1 through 3 – we can investigate the growth-instability frontier on a sectoral level. The sectoral level data had fewer observations than aggregated GDP, making them a poor candidate for the empirical model.

To calculate the minimum variance portfolio weights – the optimal weights that maximize growth rate while minimizing its instability – a required rate of return is needed. We make use of the capital asset pricing model (CAPM) to obtain a required rate of return for each country.

$$E(rr_i) = R_f + \beta_i\left(G_{global}\text{-}R_f\right) \tag{9}$$

The CAPM provides us with a benchmark for the expected return on equity by relating the risk free rate, the market premium and the coefficient of risk for each region $\boldsymbol{I}$, where $\boldsymbol{R}$ is the risk free rate, $\boldsymbol{G}$ is the global GDP growth rate, and beta is the riskiness of the region in relation to the global. In other words, beta would be the instability factor for the region $\boldsymbol{i}$. Based on the above, two parameters need to be estimated. First, the risk coefficient for each country, $\boldsymbol{\beta}$, and the risk free rate $\boldsymbol{R_f}$; in addition, we must estimate the market premium.

Commonly referred as the beta, the market premium is the covariance between the market returns and the specific asset, divided by the market's variance. The same result could be obtained by regressing the asset's returns on the market returns, where the coefficient of the market returns will be the beta. In the case we are discussing, the global GDP growth rate is treated as the market returns, and each of the GCC economies' growth rates will be regressed on it to obtain the coefficient of risk compared with the global one. By definition, a beta coefficient that is equal to one would mean that the specific economy is as risky as the global economy, i.e., no idiosyncratic risk due to lack of diversification in economic activity. A beta that is less (more) than one would mean that it is less (more) risky than the global economy.

We use the World Bank's reported real global GDP growth from 1981 to 2013 as well as our GDP group data for the GCC countries. As reported in Table A2.1, the betas of Qatar and UAE show a steeper correlation to the global market. In other words, the instability of Qatar's GDP growth rate is 2.3 times the instability of the global growth rate. Saudi Arabia's growth instability is considered to be more in the middle of the group, while Oman's stability is negatively correlated to the global growth rate.

Table A2.1. Risk coefficient (beta).

	Beta	Prob > T	R-square
Saudi Arabia	1.426551	0.035	0.1358
UAE	2.029859	0.013	0.1822
Kuwait	1.880859	0.561	0.011
Qatar	2.342394	0.014	18.11
Bahrain	0.961233	0.098	0.086
Oman	-0.79598	0.252	0.042

Source: KAPSARC, Sama Data.

Appendix III: Descriptive Statistics of the Data

We examined two data samples. The first was GDP data for each of the six GCC countries. To ensure consistency in the methodology of GDP calculation, we used the GDP reported by the World Bank, which includes the levels of GDP in local currency and GDP deflators. The length of the GDP data time series varies from country to country. For Saudi Arabia, Oman and Kuwait, real GDP data is available from 1961; while for Bahrain, Qatar and UAE it is available from 1975. The sample was truncated to ensure a balanced panel starting from 1980 to 2013. The second dataset is gross value added to GDP by sector, which is primarily collected from appropriate domestic institutions such as statistical agencies, ministries and central banks (secondary sources such as the CEIC database were used to compile the required data; see CEIC) starting from 1990 until 2013 using constant prices in local currencies.

The decision to use two samples for the analysis relates to the availability of the data, the restrictions of econometric methods and suitability of the model. The first model used annual GDP data from 1981–2013 and applies an SFA approach to the analysis. The second model uses a mean variance optimization approach, as outlined in modern portfolio theory. In addition, the risk profile for each country was calculated under the theme of a portfolio construct.

A. GDP group

The first (GDP) sample is transformed into panel data, consisting of GDP levels time series starting from 1980 to 2013, across six countries, for a total number of 204 observations. Table 1 provides the descriptive statistics for the sample.

Table A3.1. Descriptive statistics for GDP group.

Real GDP	Mean (LCU)	Mean (USD)	Std. (LCU)	Min (LCU)	Max (LCU)
Saudi Arabia	1,503,473.00	406,970.40	538,816.40	922,108.20	2,791,259.00
Growth	***2.64%***		***4.98%***	***-11.00%***	***9.50%***
UAE	820,443.30	223,271.82	340,892.50	414,727.20	1,477,594.00
Growth	***3.14%***		***6.11%***	***-16.20%***	***16.80%***
Kuwait	27,389.71	47,007.53	12,146.51	6,886.92	49,862.60
Growth	***2.80%***		***23.02%***	***-75.10%***	***84.10%***
Qatar	171,192.30	45,506.15	157,081.90	56,072.23	580,362.10
Growth	***7.08%***		***7.07%***	***-3.60%***	***25.70%***
Bahrain	6,318.59	94,302.75	2,967.60	2,881.51	12,369.50
Growth	***4.01%***		***4.22%***	***-7.90%***	***12.10%***
Oman	17,165.93	16,803.52	6,703.99	5,327.12	30,061.20
Growth	***5.25%***		***4.98%***	***-3.50%***	***15.70%***

Note: GDP is in millions (2013 = 100)

Source: KAPSARC, Sama Data.

Given that the GCC economies follow an exchange rate regime fixed to the U.S. dollar (USD), the mean GDP levels were transformed using the vehicle currency as a scalar for comparability. Exchange rates for each country were averaged across the sample period and then used to transform the average real GDP level. Please note that the inclusion of the USD exchange rate serves to unify the baseline of comparison between the countries and it is not included in the portfolio construction or frontier analysis.

Saudi Arabia takes the lead with an average GDP of $407 billion, nearly twice that of the second ranking economy; UAE, Kuwait and Qatar show an average of nearly one-eighth the GDP of Saudi, while Oman's GDP averages $16.8 billion. Despite these vast differences, a more insightful comparison and one that is relative to our model is the relationship between the growth rates and their standard deviations.

On average, Qatar's real GDP growth is the highest in the group at about 7.08 percent across the sample period. This is followed by Oman, Bahrain, UAE, Kuwait and Saudi with 5.25 percent, 4.01 percent, 3.14 percent, 2.80 percent and 2.64 percent, respectively. In comparison, Kuwait has the highest instability – standard deviation of growth – in the group at 23.02 percent across the sample period.

B. Sectoral group

Table A3.2 shows the summary statistics of the sectoral groups. The economic sectors from each country were investigated for definition and component structure, and then disaggregated and recompiled under six different categories.

Table A3.2. Sectoral group descriptive statistics (balanced panel).

Real Growth/Country	Saudi	UAE	Kuwait	Qatar	Bahrain	Oman	GCC
Agriculture	1.47%	1.79%	3.03%	2.80%	1.70%	2.14%	**2.16%**
sd	0.0122	0.0942	0.1324	0.1494	0.0541	0.0328	***0.0792***
Construction	5.18%	3.39%	3.04%	16.13%	7.60%	10.23%	**7.59%**
sd	0.0383	0.1610	0.0646	0.2141	0.1693	0.1592	***0.1344***
Electricity, water and gas	8.33%	6.10%	6.79%	8.63%	9.61%	5.49%	**7.49%**
sd	0.0923	0.1170	0.2611	0.2640	0.1226	0.0567	***0.1523***
Manufacturing	5.92%	6.73%	4.17%	8.97%	4.98%	9.25%	**6.67%**
sd	0.0348	0.0848	0.1099	0.0781	0.0804	0.0970	***0.0808***
Mining & quarrying	1.32%	2.84%	1.96%	10.80%	2.01%	1.37%	**3.38%**
sd	0.0716	0.0821	0.0870	0.0985	0.1279	0.0403	***0.0846***
Services	5.50%	2.40%	4.07%	10.97%	5.87%	5.59%	**5.74%**
sd	0.0239	0.1621	0.0747	0.1094	0.0463	0.0422	***0.0764***
N	18						
Sample Start	1996						
Sample End	2013						

Source: KAPSARC, Sama Data.

The first column from the right shows the averages if the GCC were treated as a single economy with each of the countries as its regions. While it is beneficial to observe the overall GCC sectoral growth, a country by country analysis can shed additional insights. Starting with Saudi Arabia, we see that the electricity, water and gas sector takes a commanding lead in growth by roughly 8 percent. The construction, manufacturing and services sectors average 5.7 percent, with agriculture lagging behind with a 1.47 percent rate of growth. Surprisingly, the average rate of growth for mining and quarrying (M&Q) – which is mainly composed of oil and gas production – is at 1.32 percent across the sample period; yet it exhibits a high instability with 7.2 percent.

Interestingly, with the exclusion of Qatar, the M&Q and agriculture growth rates are the lowest among the sectors. While this is understandable for the later of these, it is counterintuitive for the M&Q sector. One explanation could be that we are capturing a policy shift in diversifying economic activity in the later years, by which its rapid short-run growth in non-oil activities outweighs the oil sector's long-run growth. A second reason could be exogenous shocks experienced in the oil markets, in which the oil sector acted as a buffer to other sectors and absorbed the heaviest of blows.

The following figures (A3.1 to A3.5) illustrate the movement of real GDP growth across time,

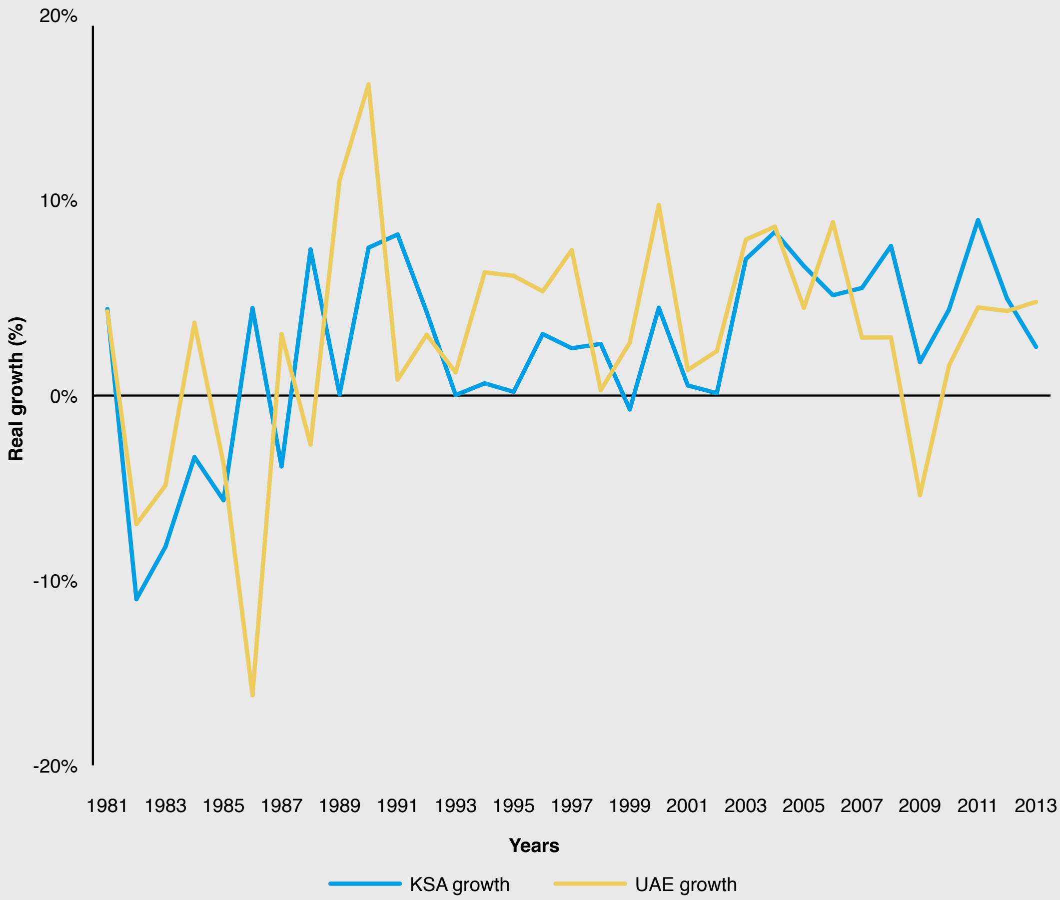

Figure A3.1. Saudi and UAE economic growth.

Source: KAPSARC, Sama Data.

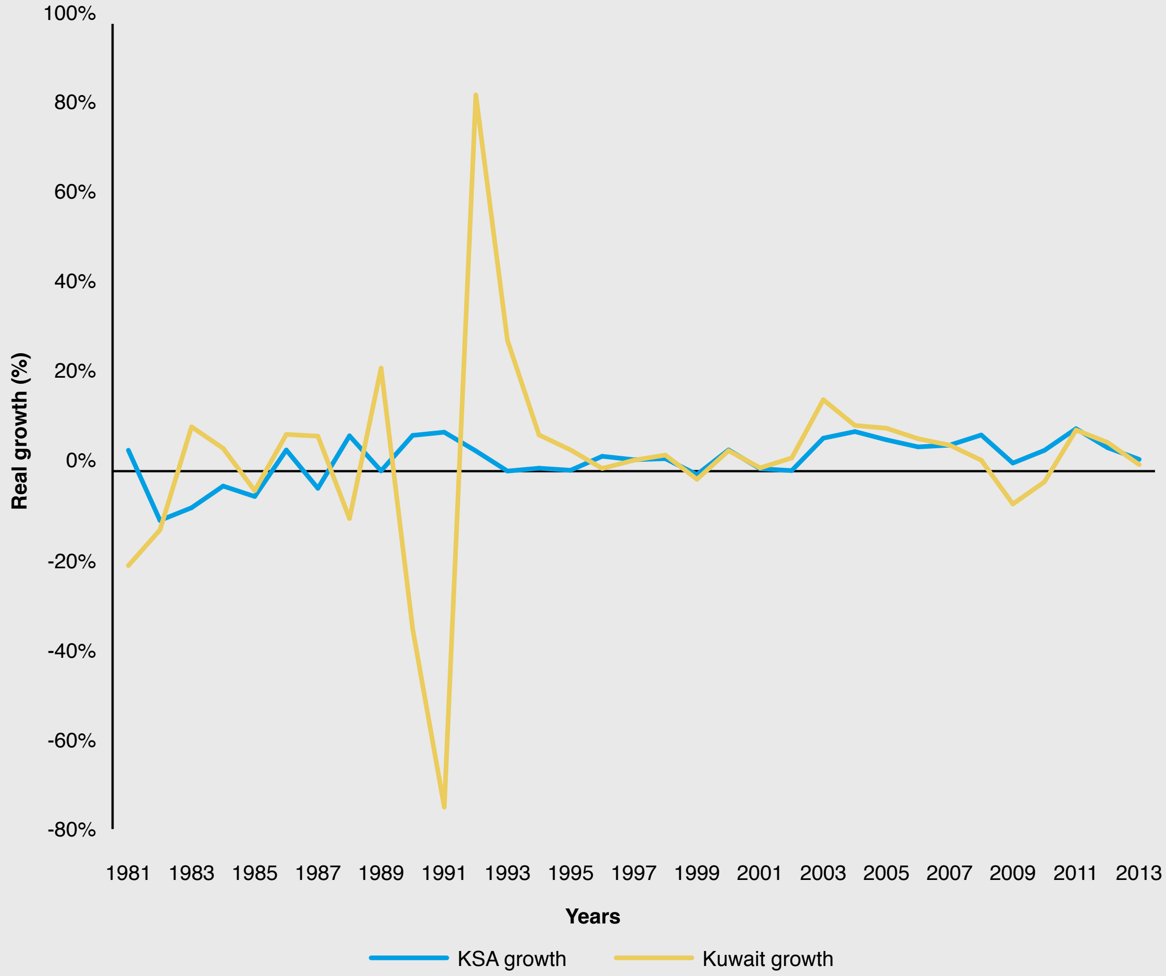

Figure A3.2. Saudi and Kuwait economic growth.

Source: KAPSARC, Sama Data.

compared with Saudi Arabia. Referring to Figure A3.2, we observe the impact on the Kuwaiti economy of the Second Gulf War, commonly referred to as Desert Storm; a period in which the Iraqi forces invaded Kuwait. The war started August 2, 1990 and ended February 28, 1991, lasting six months. This caused the GDP growth rate to plummet by 35 percent in 1990 and 75 percent in 1991; it then jumped to 84 percent in 1992.

A common factor between the growth rates of the GCC economies is a decline in the wake and

Figure A3.3. Saudi and Qatar economic growth.

Source: KAPSARC, Sama Data.

aftermath of the financial crisis in 2008. Between 2008 and 2009, real growth rates of GDP declined by 6.3 percent, 8.5 percent, 9.8 percent, 5 percent, 3.6 percent and 1.95 percent for Saudi, UAE, Kuwait, Qatar, Bahrain and Oman, respectively (figures A3.1 to A3.5). Saudi Arabia's GDP growth proved to be more versatile, as it quickly recovered in 2010. Between Saudi Arabia and Bahrain, Figure A3.4, we note a higher correlation in the growth rates in the earlier periods. No other economy exhibits the same type of relationship in movement and magnitude.

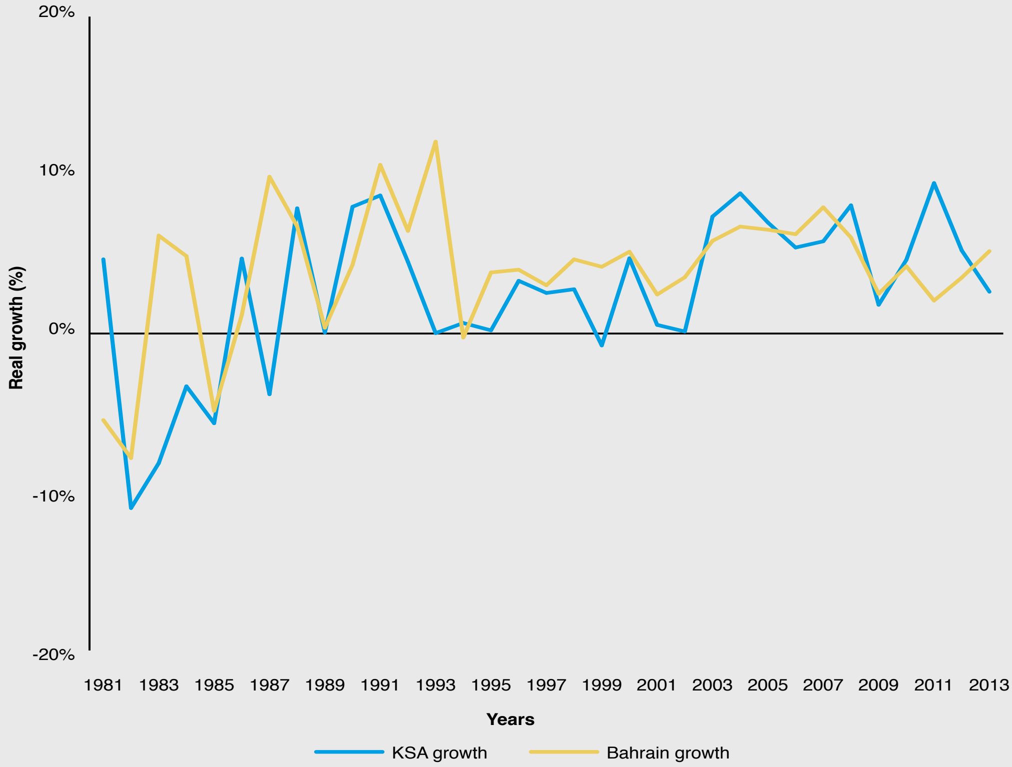

Figure A3.4. Saudi and Bahrain economic growth

Source: KAPSARC, Sama Data.

Figure A3.5. Saudi and Oman economic growth.

Source: KAPSARC, Sama Data.

Appendix IV: Model Results

In order to assess whether or not the shift in the two and three sample frontier is statistically significant, we must compare the economic growth rates as being statistically different, over an interval of a standard deviation. We tested the statistical significance between the two sample frontiers (Table A4.1), and found that the difference in growth rates is statistically significant at the level of 10 percent. The test is based on a t test for differences in mean. While statistically significant at the 90 percent level, the probability is close to the 95 percent level. A longer time series might allow for additional room for significance, bringing the confidence level to 95 percent or even higher. The table only reports the significant results in the three frontier comparison. The tests on the second frontier relative to the first and third were inconclusive.

The three sample frontier tests confirm that the recent decade is more diversified – higher growth rates at lower instability intervals – than the prior decades, at the 5 percent significance level. In other words, based on the direction shift of the graph, the newer frontier opens additional opportunities for value maximizing and cost minimizing points to be obtained due to economic activity diversification.

A. GCC GDP group

Based on Table A4.2, we find empirical evidence of a parabolic efficient frontier for the GCC region. As expected, the signs on the coefficients conform to a convex relationship between growth rate and its instability. In optimizing this portfolio, we find that the instability minimizing growth rate of the GCC

Table A4.1. Testing mean difference.

				95 percent CI	
Group	**Mean**	**SE**	**SD**	**Lower**	**Upper**
1981 – 1997 (1)	0.032333	0.010248	0.04348	0.010711	0.053955
1998 – 2013 (2)	0.053605	0.008266	0.035068	0.036166	0.071044
Combined	0.042969	0.006733	0.040397	0.029301	0.056637
H0: diff = 0	Prob.	0.1158		**Reject**	
Ha: 1998 - 2013 > 1981 - 1997	Prob.	0.0579		**Fail to reject**	
				95 percent CI	
Group	**Mean**	**SE**	**SD**	**Lower**	**Upper**
1981 – 1990 (1)	0.00614	0.02370	0.05805	-0.05479	0.06706
2003 – 2013 (3)	0.06133	0.01288	0.03154	0.02823	0.09443
Combined	-0.05519	0.027767	0.06801	-0.12657	0.016179
H0: diff = 0	Prob.	-1.9879		**Reject**	
Ha: 2003 – 2013 > 1981 – 1990	Prob.	0.0518		**Fail to reject**	

Source: KAPSARC, Sama Data.

Table A4.2. The growth instability frontier for GCC economies 1981 - 2013.

				CI	
	Coefficient	**Std. error**	**Prob.**	**Lower**	**Upper**
Growth*	-0.143	0.081	0.096	-0.315	0.029
Growth squared*	3.050	0.171	0.000	2.685	3.416
Constant	0.037	0.006	0.000	0.025	0.049
Pesaran (2007) cross-sectional dependence test	***CD test***	***P-value***	***Corr***	***Abs (corr)***	
SD (dependent variable)	1.65	0.099	0.246	0.815	
Growth	1.63	0.103	0.243	0.850	
N	18				
R-square	95.69%				
Adjusted R-square	95.11%				
Root MSE	0.01608				
Instability minimizing growth rate	4.238%				
Instability (risk) of optimal growth	2.099%				

Source: KAPSARC, Sama Data.

Note: * Panel Unit Root tests rejected non-stationarity.

region is 4.238 percent and would yield an instability (risk) of 2.099 percent. This is an average of the GCC region and would need to be adjusted by the distance to the frontier to obtain a value for each economy.

Table A4.3 estimates the distance to the frontier for each economy across the three decades, and the average distance across the three decades. For Saudi Arabia, UAE, Kuwait and Oman, we note that between the second and third decade, technical inefficiency has decreased. In other words, they have become more diversified and are closer to the frontier. UAE is the most efficient of the group, while Saudi Arabia, Qatar, Bahrain and Oman are least efficient; yet the difference in inefficiencies is concentrated between +/- 1.50 percent. If we hypothesize that the GCC economic union were to

Table A4.3. Distance from the frontier.

	1981 - 1991	**1992 - 2002**	**2003 - 2013**	**Average**	**Optimal weight**
Saudi	1.17%	4.75%	4.70%	3.54%	21.13%
UAE	0.00%	3.84%	3.10%	2.31%	7.72%
Kuwait	4.25%	2.28%	1.63%	2.72%	0.632%
Qatar	3.64%	1.71%	4.49%	3.28%	0.383%
Bahrain	1.48%	3.95%	5.03%	3.49%	30.75%
Oman	2.27%	4.18%	3.68%	3.37%	39.38%

Source: KAPSARC, Sama Data.

be realized in the future, and further assume the creation of a regional economic plan, then each economy would receive the weights outlined in the last column for optimal efficiency. Based on these shares, the GCC would maximize the growth rate of the region without adding to the instability factor.

B. Sectoral growth rates group

The sectoral growth rates group was analyzed based on a portfolio optimization framework. Specifically, this optimization process looks at the global minimum variance of the portfolio, given the growth rates of the sectors. We have six sectors for each country: agriculture, construction, electricity, water and gas (EWG), manufacturing, mining and quarrying, and services. Based on their growth-instability profile, the economy (portfolio of sectors) of a country is optimized to maximize its growth while minimizing instability.

Table A4.4 exhibits the results of the economy optimization for Saudi Arabia's economic sectors. The Global Minimum Variance (GMV) optimizes the portfolio based on the given expected growth rates. It suggests that Saudi Arabia's economy may continue to grow at 5.67 percent, with an instability of 3.11 percent given that most of its investments are directed toward manufacturing and services.

Recall from our previous discussion on reconciling economic growth theory with portfolio optimization that economic sectors cannot have zero weights. Moreover, investments are devised as part of a long-term strategy, i.e., an economic plan. Therefore, we impose a restriction on the GMV that each sector must at least receive 5 percent of the investment, or weight. In doing so, we satisfy the assumptions as to the mechanism of economic sectors, and achieve an instability minimizing growth of 5.59 percent. Naturally, we are able to specify the minimum weight for the entire set, or a minimum weight for each sector. Exact weight specifications can be solicited from a bottom-up approach of economic requirements, or policy-driven weights. The 5 percent specification was an arbitrary weight chosen to demonstrate how the weights will shift.

Table A4.4. Saudi sectors economy optimization (simulations).

		GMV		**Target growth rate CAPM: 3.9%**	
Simulate 10,000 portfolios	**Expected growth rates**	**Unrestricted**	**Restricted 40% oil**	**Unrestricted**	**Restricted 10%**
Agriculture	4.79%	14.03%	5.00%	43.88%	15.00%
Construction	5.68%	0.00%	5.00%	0.00%	15%
EWG	8.45%	5.97%	10%	0.00%	25%
Manufacturing	5.77%	48.46%	15%	0.00%	15%
M&Q	2.29%	2.51%	40%	40.93%	15%
Services	5.65%	29.03%	25%	15.19%	15%
Instability minimizing growth		5.67%	4.35%	3.90%	5.74%
Instability		3.11%	6.91%	7.37%	4.78%

Source: KAPSARC, Sama Data.

Note: Assume a risk-free rate of 2.7%. See Annex II for additional information on CAPM.

Additionally, by restricting the weights, growth and its instability will differ from the optimal GMV unrestricted, and would lead to a higher instability in virtually all cases.

Assuming that the economic policy dictates a target growth rate for the economy in contrast to a target weight for a sector, then we are able to calculate the optimization weights. Using the CAPM output, Saudi's estimated required rate of return is 3.9 percent. In the weight restriction and unrestricted cases, we find a higher instability factor and more concentration on the M&Q sector. However, this is not the optimal composition of the economy since it nearly doubles the instability factor for a lower return. The following tables reflect the output for the remaining GCC economies (Tables A4.5 to A4.9):

Table A4.5. UAE sectors economy optimization.

		GMV		Target growth rate CAPM: 4.4%	
Simulate 10,000 portfolios	**Expected growth rates**	**Unrestricted**	**Restricted 5% oil**	**Unrestricted**	**Restricted 5%**
Agriculture	3.25%	23.64%	21.27%	14.66%	12.78%
Construction	3.71%	8.89%	8%	2.92%	5%
EWG	4.96%	22.46%	20.21%	28.28%	27.93%
Manufacturing	7.86%	0.00%	5%	36.39%	16.35%
M&Q	2.80%	45%	40.50%	17.75%	32.93%
Services	4.15%	0.00%	5%	0.00%	5%
Instability minimizing growth		3.47%	3.72%	4.40%	4.40%
Instability		3.90%	4.11%	4.38%	4.61%

Source: KAPSARC, Sama Data.

Note: Assume a risk-free rate of 2.7%. See Annex II for additional information on CAPM.

Table A4.6. Kuwait Sectors Economy Optimization.

		GMV		Target growth rate CAPM: 3.9%	
Simulate 10,000 portfolios	**Expected growth rates**	**Unrestricted**	**Restricted 40% oil**	**Unrestricted**	***Restricted 5%**
Agriculture	3.33%	21.15%	19.03%	7.82%	6.67%
Construction	3.06%	38.54%	34.68%	0.00%	5%
EWG	6.77%	0.00%	5%	18.58%	5.00%
Manufacturing	3.61%	0.00%	5%	13.02%	6.33%
M&Q	1.82%	29.19%	26.27%	0.00%	5%
Services	3.81%	11.11%	10%	60.56%	72%
Instability minimizing growth		2.84%	3.08%	4.30%	3.78%
Instability		3.94%	4.46%	7.88%	6.20%

Source: KAPSARC, Sama Data.

Note: Assume a risk-free rate of 2.7%. See Annex II for additional information on CAPM.
*Given the set of parameters and weight restriction, the maximum growth achieved would be 3.78% and not 4.3%.

Table A4.7. Qatar sectors economy optimization.

		GMV		Target growth rate CAPM: 4.7%	
Simulate 10,000 portfolios	**Expected growth rates**	**Unrestricted**	**Restricted 5% oil**	**Unrestricted**	**Restricted 5%**
Agriculture	2.22%	2.22%	11.19%	43.20%	49.19%
Construction	10.54%	10.54%	5.00%	0.00%	5.00%
EWG	8.45%	8.45%	7.12%	0.00%	5.00%
Manufacturing	6.53%	6.52%	28.02%	25.19%	16.57%
M&Q	6.17%	6.17%	16.97%	22.35%	19.22%
Services	7.71%	7.71%	31.69%	9.26%	5.00%
Instability minimizing growth		6.50%	6.70%	4.70%	4.70%
Instability		6.04%	6.20%	7.85%	8.46%

Source: KAPSARC, Sama Data.

Note: Assume a risk-free rate of 2.7%. See Annex II for additional information on CAPM.

Table A4.8. Bahrain sectors economy optimization.

		GMV		Target growth rate CAPM: 3.5%	
Simulate 10,000 portfolios	**Expected growth rates**	**Unrestricted**	**Restricted 5% oil**	**Unrestricted**	**Restricted 5%**
Agriculture	2.67%	36.73%	30.32%	51.43%	57.39%
Construction	6.94%	0.00%	5.00%	0.00%	5.00%
EWG	8.68%	4.55%	5.00%	0.00%	5.00%
Manufacturing	5.02%	0.00%	5.00%	0.00%	5.00%
M&Q	2.62%	14.87%	13.28%	19.82%	20.50%
Services	5.59%	43.85%	41.40%	28.73%	7.11%
Instability minimizing growth		4.22%	4.50%	3.50%	3.50%
Instability		2.17%	2.65%	2.59%	2.89%

Source: KAPSARC, Sama Data.

Note: Assume a risk-free rate of 2.7%. See Annex II for additional information on CAPM.

Table A4.9. Oman sectors economy optimization.

		GMV		Target growth rate CAPM: 3.5%	
Simulate 10,000 portfolios	**Expected Growth Rates**	**Unrestricted**	**Restricted 5% oil**	**Unrestricted**	**Restricted 5%**
Agriculture	3.01%	21.73%	20.75%	9.54%	5.00%
Construction	9.74%	0.00%	5.00%	0.00%	5.00%
EWG	5.96%	4.05%	5.00%	0.00%	5.00%
Manufacturing	7.98%	10.42%	9.31%	0.00%	5.00%
M&Q	2.00%	29.58%	29.18%	90.46%	75.00%
Services	5.72%	34.21%	30.75%	0.00%	5.00%
Instability minimizing growth		4.28%	4.50%	2.00%	2.00%
Instability		2.18%	2.43%	3.11%	3.55%

Source: KAPSARC, Sama Data.

Note: Assume a risk-free rate of 2.7%. See Annex II for additional information on CAPM.

Based on a simulation of 10,000 portfolios, we find that Oman and Bahrain have an attractive growth-instability frontier in the base case scenario. Qatar's economy may have the highest return in the unrestricted GMV specification, but at a significantly higher risk than its peers. For the UAE, the global minimum variance optimization would suggest a 45 percent share of the budget allocated toward M&Q, and roughly one-fifth for each of the agriculture and EWG sectors. Table A4.10 summarizes the GVM unrestricted optimization of growth and instability. Figures A4.1 to A4.6 exhibit the efficient frontier and portfolios. The shape and curvature of the frontier depends on the return risk profile of the portfolios for each country. The steeper the frontier, the higher the value obtained from a small change in its instability.

Table A4.10. GMV unrestricted GCC comparison.

	Saudi Arabia	**UAE**	**Kuwait**	**Qatar**	**Bahrain**	**Oman**
Instability minimizing growth	5.67%	3.47%	2.84%	6.50%	4.22%	4.28%
Instability	3.11%	3.90%	3.94%	6.04%	2.17%	2.18%

Source: KAPSARC, Sama Data.

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About the Project

The project explores alternative methods of measuring economic diversification and investigating its associated impacts on the Saudi Arabian economy and other GCC countries. By utilizing a financial portfolio framework reconciled with economic growth theory, the economy is viewed as a portfolio of economic sectors, each contributing to the overall output growth. Results demonstrated that diversification policies have been effective, as the economy moves towards higher growth with lower instability.

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