

The GCC Countries' Growth beyond Oil: The Special Case of Saudi Arabia.

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The GCC countries in the Gulf region seem to have a high potential for growth. Those countries are currently starting a process to diversify their completely oil-based economies. This paper focuses on the case of Saudi Arabia; through an analysis based on the Reserves-to-Production ratio critical value defined by Banks (2004) it will show why the use of renewable sources of energy is a crucial activity for the Kingdom. Renewable energy should serve the internal market and be implemented to construct the New Economic Cities, which are considered the main Saudi tool for development. This way Saudi Arabia would not over-damage the quantities of oil left in its basins, avoiding physical depreciation and accessing a higher availability of oil revenues. The paper will show how, depending on the oil production policy, the New Economic Cities could be either a blessing or a curse for the Kingdom.

JEL Codes: F4, O21, O31, O32 and O33.

1. Introduction

The oil depletion problem and the peak of oil production are often addressed to be a major problem for oil-importing developed countries. On the other hand, this issue is extremely significant for those countries which have completely oil-based economies, such as the GCC countries, whose main percentage of total revenues comes from oil exports. Although rich of a fundamental natural resource, the Persian Gulf countries did not perform well in terms of growth in the last decades compared to other emerging economies, growing less than countries with a lower endowment of natural resources, hence falling into the category of countries which suffered from the resource curse (Sachs & Warner, 1999, 2001; Wright & Czelusta, 2004; Robinson, Torvik & Verdier, 2006; Mehlum, Moene & Torvik, 2006). The curse in that area seems to be explained by three main hypotheses: the Dutch disease view, rent seeking and institutions. Given this framework, it seems that nowadays the GCC countries started undertaking a path of diversification of their economies, which should grant them growth beyond oil.

Comparing oil rich countries with other developing countries it is possible to see that they present better education, more market oriented economic policies, and more favorable investment-saving characteristics (Stijns, 2005). Hence this would give to the oil rich countries of the Persian Gulf a high potential for growing. This potential is underlined by the international interest which is translated in vast flows of FDI going toward the region. By the way, for achieving this substantial change in their economies, those countries need strong labor markets reforms (mainly to respond to the unemployment problem that characterizes the area, principally due to the high rate of population growth), as well as financial and educational ones.

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Cinti

In the occasion of the global financial crisis, most of the GCC countries showed to have a sound position, allowing them to perform well in response to the event. Within those countries the example of Saudi Arabia, for its peculiar internal characteristics, as well as for its leading position as oil producer, appears to be worth of investigation. Saudi Arabia is not only implementing significant reforms to some of the main sectors of the economy, it is also undertaking development projects that are well represented by the construction of the New Economic Cities (NEC). In this framework, due to the special state of the Saudi basins, the country's policy of energy production and the growing internal energy demand, the management of energy use for the completion of those cities as well as for the internal market appears fundamental for Saudi Arabia.

The aim of this paper is to delineate the correct policy of energy production specifically for the construction of the NEC in Saudi Arabia in order to fully exploit the potential for growth of the Kingdom. The policy is designed considering the current state of the Saudi economy and following previous studies of Mehrara (2007) on the effects of the internal energy consumption in Saudi Arabia and its GDP growth, together with the concept of physical depreciation of oil basins firstly presented by Banks (2004) in his effort to design the functioning of different aspects of oil management, and specifically referred to Saudi Arabia by Cinti (2008).

The paper is organized as follows: firstly, in order to define the economic situation of the world region, it presents the current state of the GCC economies and their response to the global crisis, focusing then on Saudi Arabia. At this point it reviews the particular relationship that links internal energy consumption and GDP growth as investigated by Mehrara (2007), presenting then the state of the physical depreciation of the Saudi oil basins and its possible effects on the future oil market. In this framework the energy production policy to follow for the Kingdom in order to take advantage of the different aspects affecting its economy is designed. The paper will show how, depending on the oil production policy adopted, the NEC could be either a blessing or a curse for the Kingdom.

2. The Financial Crisis and the GCC Countries

The global financial crisis that started in 2008 had its consequences on the GCC countries. Because of the little production capacity of those countries in the non-oil sectors, which puts them in a foreign countries' dependence, and because of the investments of their oil revenues in the global economy, accompanied by the investors' caution in the high volatile oil market, the crisis negatively affected the GCC countries' economies. Three main drivers of slowdown were present in the area: assets eroding, liquidity shortages and the tightening of the access to credit. The problem of assets eroding derives from the fact that Gulf sovereign wealth funds invested billions of dollars in U.S. financial institutions, and that the value of the assets acquired by the Gulf investors fell sharply, as well as investments in real estate. Kuwait and the Emirate of Dubai were the countries principally affected by this issue. Liquidity was another major problem for the Gulf. Despite the large amount of liquidity that characterized the area in recent years due to the high oil prices, the low prices of the second half of 2008 and the beginning of 2009 did not grant the progress of the development projects undertaken in the area, which need a price of oil of at least 47\$ per barrel, such that the 60% of those projects across the region was postponed or cancelled. Another natural consequence of the crisis was the

Cinti

tightening of the access to credit, which combined with the lower liquidity, made very hard for the Gulf countries the chance to smoothly carry on their projects. United Arab Emirates' financial situation was troubled by the crisis more than the other countries of the Gulf, which for answering the crisis relaxed their monetary policies and implemented expansionary fiscal policies, with an increase in government spending in social services and in the raise of the minimum wage of national workers. The strategy of increase in government spending limited the drop in growth of the region, putting the GCC countries in a better economic situation than other developing countries.

On the other hand the global crisis also had a positive effect on the GCC countries. In fact, although it led to a significant decrease of global FDI inflows (for instance from 2007 to 2008 the decrease was of 14.2%, trend that did not arrest in the subsequent 2 years), a clear shift of investments from the developed to the developing countries took place. For example during 2008 FDI inflows in developed countries fell of 29%, while an increase of 43% occurred in emerging economies. Although this is a phenomenon that interested several countries, the GCC countries were some of the principal recipients of those investments. The inward flows of FDI started growing before the global crisis. During the 1990s, while a huge movement of capital flows occurred toward developing countries, most of them from the private sector, all the Gulf countries experienced little flows of foreign investments. This lack prevented them to live the rapid growth that other emerging countries, as Latin America and East Asia, experienced. Generally the most FDI to developing countries are efficiency seeking and vertical. The oil countries were not often involved in the chain of production of the major direct investors mainly because of the composition of their labor force, which is not cheap and not high-skilled due to the low level of education. After the bad performance of the 1990s and the first years of the 2000s though, between 2004 and 2006, some of the oil producing countries experienced a big push on incoming investments, with a 25.5% increase of FDI during 2006, through a flow of \$43.3 billion. The most attractive countries were Saudi Arabia, Bahrain, United Arab Emirates, and in part Qatar, while Oman had just a medium grade of increase. United Arab Emirates, though, saw their FDI inflows drop by around 24%, from 10.9\$ billions on 2005 to 8,3\$ billion of 2006. Despite the fall, the UAE still ranked as one of the top recipients of FDI inflows as well as sources of FDI outflows, ranking third and second respectively out of the 14 economies in West Asia. The big push of FDI in the region was mainly due to the huge liquidity derived by the high oil prices which attracted foreign investors. Saudi Arabia figured as the second largest FDI target with a 51% growth in FDI over 2005 with \$18 billion. The Saudi Arabian General Investment Authority (SAGIA) stated that the most FDI were directed to energy-related industries and its derivatives, with a major increase by the three main investors, U.S., EU, and Japan, but that also a higher interest was demonstrated by other countries and toward different sectors.

In 2008, with the beginning of the crisis, GCC FDI inflows grew 31.5%, and the high oil prices that characterized the market until mid-2008 played a central role. The major recipient of FDI within the GCC countries kept on being Saudi Arabia, which received, only during 2008, FDI inflows for US\$ 38.3 bn. In the Kingdom, during the period 2003-2008, the FDI inflows grew of 117.9% on a compound growth basis, mainly because of the strategy of diversification that Saudi Arabia undertook and the opening of their financial market. It is true that in 2009 FDI flows to GCC countries decreased in comparison to the numbers of 2008. By the way it is important to

Cinti

analyze that data in the special context created by the global crisis and in a general view, as well as consider the particular situation that characterized the year 2008 itself, with the extremely high oil prices during the first half of the year and the serious consequences of the crisis in the global economy during the second half.

**Table 1. FDI flows measured in US Dollars at current prices and current exchange rates (millions).
Data from UNCTAD.**

	2005	2006	2007	2008	2009
World	985795,6	1459133	2099973	1770873	1114189
Developing countries	330129,9	434365,9	564929,9	630012,5	478349
Developed countries	624565,1	970098,1	1444075	1018273	565892
GCC	28317,96	38079,76	46911,3	60060,25	50851,41

These data show that a fall in FDI of 15% during 2009 in comparison to 2008 toward the GCC countries is indeed true. It also shows though that in the same year the global FDI decreased of 37%, with a fall for developing countries of 24% and for developed countries of more than 44%. Looking at the general picture it seems important to notice that the inward FDI share of developed countries decreased of almost 7% in 2009 (after a decrease of almost 11 percentage points in 2008), while developing countries experienced a FDI inflows raise of more than 7%. Within this category GCC countries' share had a net increase and compared to the global FDI flows this increase went from 3.39% in 2008 to 4.56% in 2009. It is then real the drop of incoming FDI flows for the GCC countries in 2009 in comparison to 2008, but analyzing the data in the context created by the crisis, and comparing the quantities of FDI in 2009 with the ones of 2007 and the previous years, it is still clear the shift of investments from developed to developing countries and, within those, to the GCC countries. Summing up, from 2005 the share of FDI going to GCC countries in comparison to the global FDI stayed more or less stable until 2007 and then increased in 2008 and again in 2009. When comparing their share with other developing countries' share the situation is the same: it is more or less stable until 2007, a sharp increase in 2008 and an equivalent one in 2009. In the meantime, the developed countries, which saw their share increase until 2007, experienced a sharp fall in 2008 and again in 2009, showing the shift of interest by investors to developing countries. It is then crucial to give 2008 the value of a very atypical year, and to consider that huge push on FDI to the GCC countries at least partially as a consequence of the extremely high oil prices of the first half of 2008, besides the new consciousness and lack of trust in developed countries by investors. Hence the fall of 15% that took place in 2009 should not lead to wrong conclusions, as GCC countries are still following a trend of increasing investment attraction looking at longer terms, as 2009 FDI are higher than the ones of 2007 and the previous year.

Hence the intuition behind what argued about the positive effect of the crisis in regard to the shift of the tendency of investors toward developing countries at the expenses

of developed countries and, among them, to GCC countries seems not to be affected by the fall in percentage of 2009.

3. Saudi Arabia

Saudi Arabia is the world largest producer and exporter of total petroleum liquids. For its particular position in the oil market and for the path of new regulations and projects undertaken it is often addressed to be the leading country in the process of growth within GCC countries. Its main characteristics are the big internal market of the country, its leading position in oil production, and the fact that it is the major recipient of FDI in the region. What the Kingdom is developing in order to grant itself a long-term path of growth is the concentration on savings, demographic bonus and infrastructure spending, as well as the reform of that crucial sector which is the educational system. A very innovative policy that probably marks out the new conceptual economy of the State is the openness of its financial market to foreign countries, which can result not only in growth but also in integration. This process for Saudi Arabia starts from a sound position, which allows the Kingdom to implement generous budget spending for the renewed economic vision. Diversification is the core part of the process. Saudi Arabia has a completely oil-based economy, which leaves the Kingdom, as the rest of the GCC countries, in a high dependent position from foreign countries, due to the significant share of import for commodities. The revenues from oil export are the main source of wealth for the country, accounting for around 90% of total Saudi export earnings and State revenues, and being above the 40% of the country's GDP.¹ However, as previously mentioned, a clear issue of the current times is oil depletion; the peak of oil production will be preceded by a peak in exports, and this will lead the oil revenues, source of richness, to drastically fall, especially in the case of a country, as Saudi Arabia, where the internal demand for energy is consistently increasing over time due to several reasons, like population growth and the increasing waste of energy in the internal market. Hence, if Saudi Arabia wants to have a long-term growth, it has to diversify. This consciousness is demonstrated by the Kingdom's performance which shows the growth of its non-oil sector during 2009 of 3.6% despite the fall in oil production.

It is important to understand the current economic situation of the country in order to comprehend the feasibility of the future growth plans. As already said Saudi Arabia has a sound position which allowed the Kingdom to answer to the global crisis with large budget spending and internal investments supporting the country, and which derives from a series of surplus since 2002 due to the beginning of the high oil prices era. The Saudi budget of 2010 reflects the quick recovery of the Kingdom after the crisis slowdown. The budget spending is going to be 13.7% higher than in 2009, where 48% of the budget will be addressed to capital investments projects, underscoring the will for diversification, and to the educational reform and training, in order to support the young population of the Kingdom. A significant percentage of the budget will be destined to improve infrastructures as roads, ports, airports, and so on, in order to create a favorable business environment in the country, such to attract foreign firms and investors. This is a relevant strategy to correct some of the main non-trade barriers that characterize the GCC countries, whose typical environment was non-favorable for international business, and it is also relevant to sustain the international integration that the Gulf region is seeking through different instruments, as free trade agreements and the joining of WTO by the majority of the oil producing countries. A major role concerning the effects of the crisis on the country was also

Cinti

played by the composition of the real estate sector in Saudi Arabia, which was not driven by external capital and expatriate flows, as it was instead in the other GCC countries, avoiding hard consequences at least on this sector.

From this position Saudi Arabia is ready to face the future growth implementing its original development projects, or at least most of them. One of the big tools on which the Kingdom is counting for its growth, integration and development, is the construction of the NEC. One of the big goals of those cities is to increase employment, which is a major problem in the Kingdom because of the extremely high population growth rate that the country is facing. As previously mentioned when talking about the general employment situation of the GCC countries, the national labor force is not favored in being employed as it is not high-skilled nor cheap. Moreover, in the case of Saudi Arabia the working age population is vast and it is keeping on growing resulting in high rates of unemployment and under-employment. By the way the NEC are not just meant to be a vector for employment. King Abdullah Economic City, for example, is the first opportunity for foreign property investors. The stock market of Saudi Arabia was always extremely closed and this is the first time that foreigners are allowed to own a property in a city constructed in the country, which gives a strong sign of the willingness for integration and development. In the case of NEC foreign investors will be able to buy as individuals as well as companies. NEC are designed in order to develop a partnership between the oversized public sector and the private one, serving as a push for the development of the latter. Those cities are thought to be paid by the private sector, while the State provides cheap land and energy as well as participation in the projects. Hence they collect institutional internal investments, FDI by the participants on the cities' construction, as well as by investors in smaller projects pertaining to the new cities "revolution". A number of agreements with private investors were already signed not only for King Abdullah Economic City, but also for otherwise located cities, stressing the potential of those projects. In fact King Abdullah Economic City is the biggest of a compound project involving the development of different kinds of cities. Although, as already pointed out, Saudi Arabia performed well in responding to the crisis, even this project was slightly affected, mainly due to the participation of private foreign investors, with a little percentage of homebuyers that found themselves not in the position to afford the programmed purchase anymore, along with the delay of the construction of some buildings in the city due to the general slowdown of the real estate sector. After this first delay sales increased again and the project started running as originally planned or even faster. One central aspect of the NEC is that at least part of them will imply the research and development of renewable sources of energy technologies. One of those cities will be completely dedicated to this activity and the main source of renewable energy investigated will be solar energy, due to the peculiar geographical position and composition of the country. The city is the King Abdullah City for Atomic and Renewable Energy (KACARE) which will be based on the capital's region Riyadh. The project of the city is accompanied by the opening of the King Abdullah University of Science and Technology, whose main research is focused on energy and environment; both projects have received the financial backing of the King. This is a big step even concerning the reform of the educational system, and Saudi Arabia is not the only country in the Gulf which is aiming in creating centers of excellence for science, also the United Arab Emirates, for instance, already started, in collaboration with the MIT, with the establishment of the Masdar Institute for Science and Technology completely dedicated to energy and environment research.

Cinti

The main goal of Saudi Arabia in terms of renewable development is addressed to solar energy because the country is characterized by high solar intensity and minimal cloud cover; the Kingdom already invested in the past a good amount of funds for the theoretical and experimental development of this renewable, and feasibility investigation. Solar energy plants would also help to solve the problem of distribution that characterizes some parts of the State; although the majority of the population is concentrated in urban areas, where distribution is not a problem, there are also mountain regions where the transportation and power transmission is difficult. With the implementation of solar plants directly in those regions, that problem would be avoided. In the field of solar energy, what seems to be more favorable for Saudi Arabia is the implementation of Photovoltaic technology. This technology could be used by the Kingdom to generate electricity, satisfying the internal part of demand, which is constantly increasing as previously mentioned. Rehman, Bader & Al-Moallem (2007) showed that experiments conducted in the area dealing with the economic feasibility analysis of this kind of energy production reach the conclusion that all the usually considered indexes, the internal rate of return (IRR), simple pay-back period (SPP), years to positive cash flow (YPCF), net present value (NPV), annual life cycle savings (ALCS) and profitability index (PI) show a positive connotation for the use of this kind of energy in the Kingdom of Saudi Arabia, stimulating the idea of its use for satisfying the internal energy demand. On average Saudi Arabia can currently produce renewable energy through this technology for a cost of 0.25 cents², and the scientific research in the country should be aimed at increasing the competitiveness of this production.

4. A Policy of Energy Production for Saudi Arabia

This paper aims to design a rational policy of energy production for the construction of the NEC in the Kingdom of Saudi Arabia. For understanding which is the most appropriate policy in this paper the use of a combined analysis of two main aspects concerning this issue will be taken into account: the relationship between internal energy production and GDP growth in the country presented by Mehrara (2007), also considering the case of its inapplicability, and the relevant physical depreciation phenomenon which seems to be currently taking place in the Saudi oil basins (Cinti, 2008). The policy is designed in the framework of the oil depletion discussion (Ivanhoe, 1997, Bardi, 2003, Campbell and Laherrère, 1998, Campbell, 2003, Heinberg, 2004, Kazim, 2007). The paper takes as assumptions the projections of global oil demand increase up to 2035 with a subsequent raise of the oil prices in real terms up to the same period, as projected by the IEA (2010).

This policy of energy production, although might be applicable for serving the entire internal market, is addressed specifically to the construction of the NEC, which is an energy intensive activity currently taking place in the Kingdom. The plan of construction of the NEC pictures this activity to go on within the next twenty years, hence in a period coherent with the one used for oil prices projections by the IEA.

4.1 Saudi Arabia Energy Consumption and Oil Depletion

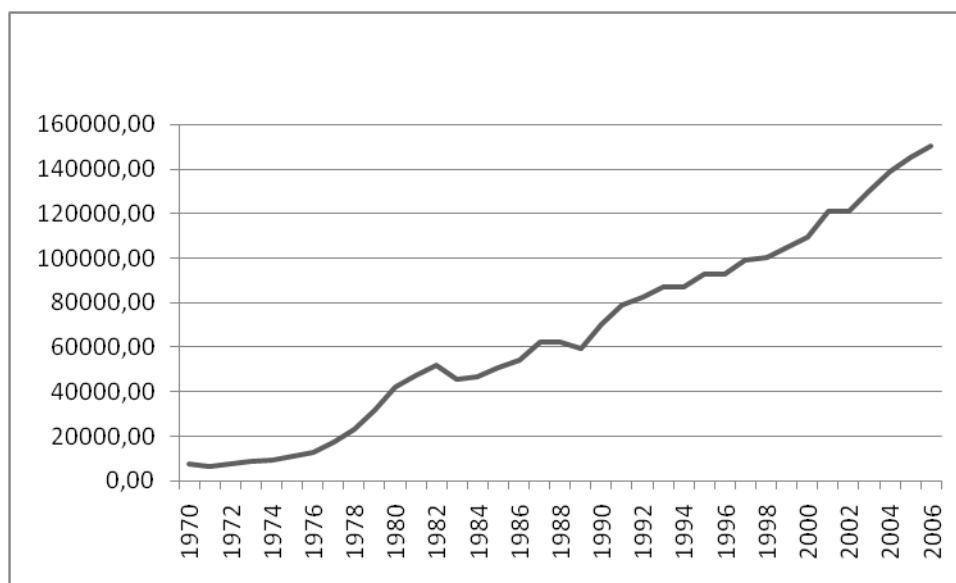
The oil producing countries of the Gulf, including Saudi Arabia, have suffered an energy use growth rate far higher than the economic growth rate. Several factors participated on the generation of this fast energy consumption increase in the region, as for example the high population growth, the development of energy intensive

Cinti

industries, as petrochemicals and cement, the low control and scarce management on energy demand side, and the generous subsidies present in the internal markets of oil producing countries pertaining to the Gulf, where the price of the resource is only a fraction of the global price, leading to misallocation of resources, waste and overconsumption of energy products. Saudi Arabia does not perform better than other countries in this sense, and its internal energy demand is currently increasing by 8% per year. In 2006 Saudi Arabia was the 15th largest consumer of total primary energy, of which 60% was petroleum based.³ The power consumption is projected to grow from a 179 terra watt per hour in 2009 to 208 by the end of the year 2014⁴ hence there will be the need to increase the power generation for satisfying that demand which so far was satisfied through oil and natural gas, precisely the 63% by oil and the 37% by natural gas.

This graph clearly shows the direction of the internal energy consumption trend of Saudi Arabia⁵:

**Figure 1. Saudi Arabia, energy consumption. Thousand metric tons of oil equivalent.
Data from SESRIC.**



It is important to understand the meaning of this vast internal energy use for Saudi Arabia. The relationship between energy use and GDP has always been of great interest in the literature; nowadays the general accepted view implies the neutrality hypothesis of energy consumption in respect to economic growth. According to Mehara (2007) this is not the case for Saudi Arabia. In his analysis he uses two different methods for the estimation of the relationship, namely the error correction model and the Toda-Yamamoto (1995) procedure. The results of his study show the presence of a unidirectional causality relationship that goes from GDP to energy in Iran and Kuwait, while he shows a causal relationship that goes from energy use to GDP growth in Saudi Arabia. Following this reasoning the fast growth in internal energy consumption would play a central role in granting Saudi Arabia fast GDP growth, and the Kingdom would not have any incentive in developing conservation policies for energy. Not mentioning the consequences that this kind of energy management has on CO₂ emissions, this is also a very important aspect for the oil market. In fact, as long as energy demand keeps growing with the growing population

Cinti

and the development of industrialization plans, as those related to the New Economic Cities, with Saudi Arabia having no incentive for attempting to the conservation of oil, the consequences on the peak of oil exports before, and on of oil production afterwards, will be significant. Although the peak in oil production is forecasted by the most to take place at least not before the next ten years, the peak in oil export will take place even earlier due to the internal energy use of the oil producing countries. Following different studies on oil depletion the shape of the descending part of the Hubbert curve⁶ will be mainly due to factors concerning the oil management decisions. The export curve reproduces the shape of the production curve. What follows will demonstrate that even if Saudi Arabia has no incentive in implementing conservation policies for the direct effect of energy use on GDP or for environmental concerns, the development of solar energy usage for serving the internal market would allow Saudi Arabia to gain the most from its resources. On the contrary, keeping the current attitude of energy consumption based on oil production would harm the country wealth by more than the proportional effect on export dedicated oil quantities, and the construction of the NEC could result in a curse instead of a blessing due to the oil production management.

4.2 The Physical Depreciation of the Saudi Oil Basins⁷

The oil market has always been characterized by a very high level of volatility. Saudi Arabia always played a central role in its regulation and, being the swing producer within the OPEC countries with the production of the 30% of oil of the organization, played the predominant role concerning global oil supply, with its 10% share of production in the global market. Saudi Arabia possesses the world's largest and most important oil field, Ghawar, as well as the world's largest offshore oilfield, Safaniya. It is the only country which is supposed to be able to increase supply in the short-medium run because of its large quantity of reserves, as well as because of its spare production, being also facilitated by the fact that Saudi Arabia has the lowest cost of oil production in the world; those are the reasons why it always played a significant role in the control of short-term spikes in prices, intervening on its own output quotas with the increase or decrease of oil supply. The Saudi strategy always went to the direction of market stabilization for granting long term revenues. The export activity in this sector is crucial for the country, as previously stated indeed the oil revenues are the main tool for diversification and development Saudi Arabia can use. We already saw though, how the internal energy demand is growing in the country, and for a direct consequence, the more oil production is destined to the internal market, the less oil revenues will be available for the country, because of lower exports. On the other hand, following Mehrara (2007) a decrease in the internal energy demand would also have a negative impact on GDP growth. Not considering the importance that oil preservation covers for the global oil supply it becomes clear how a correct oil production management is crucial for the internal growth of the country, and how Saudi Arabia needs to find a way to conciliate two phenomena that apparently go towards two opposite directions. This is why the development of solar energy, through the implementation of Photovoltaic plants, takes a central role. But the reasons that are behind this approach are more than the obvious ones. Saudi Arabia apparently experienced physical depreciation in its oil basins, decreasing the availability of the resource in its oil fields. Following Banks (2004) the ratio linking oil reserves and oil production in every basin should be always kept around a particular fix value, which changes for every basin; on the contrary, pumping out more oil than the efficient level derived by the ratio, meaning overexploiting the well, would damage

Cinti

the basin itself, leading to its physical depreciation, resulting in less oil to extract. This happens because producing more than the rational quantity for any given period reduces the pressure inside the basin, physically damaging its geological formation and making the extraction activity up to uneconomical. Hence, this means that if at the time t one basin contains R quantity of oil and there is the extraction of $\bar{q} + q_E$ (where \bar{q} is the rational quantity derived by the ratio that should be extracted from the well, and q_E represents the excess in extraction) the quantity available for future extraction will not be

$$R_{t+1} = R - \bar{q} - q_E$$

but

$$R_{t+1} = R - \bar{q} - q_E - \lambda$$

with

$$\lambda = f(\underset{-}{R}, \underset{+}{q_E})$$

Where λ is the variable that represents the quantity loss due to the level of depreciation achieved by overexploiting the basin. It is negatively related to Reserves and positively related to the excess quantity of extraction. This process goes on over time, so at time R_{t+2} Saudi Arabia will have:

$$R_{t+2} = R_{t+1} - \bar{q}' - q_E' - \lambda'$$

so

$$R_{t+2} = R - \bar{q} - q_E - \lambda - \bar{q}' - q_E' - \lambda'$$

with the variables defined as above. Note that in this second equation $\bar{q}' < \bar{q}$ because the reserves R in the basin decreased, hence the rational quantity to be extracted decreases as well in order to keep the ratio at its critical value; for this reason, with the need to satisfy the growing global oil demand, $q_E' > q_E$. It follows from the definition of the variable that $\lambda' > \lambda$. This process goes on and on over time.

Hence, by operating under the critical value of the R/q ratio, the ultimate flow of oil is reduced. With a serious state of damage inside the basin, even with higher profits due to high prices of oil invested in technologies, extraction would not occur. The quantity lost due to the physical depreciation of the oil basin (λ) would be, if not lost, theoretically dedicated in part to serve future domestic demand, and in part dedicated to future export. By the way, because of the need that the country has to fully satisfy the growing demand from the internal market (and it does that through oil production) the quantity loss (λ) would entirely be quantity taken away from future export. With the repetition of the process over time, it is clear which magnitude of deterioration the oil quantities available for future export can reach and hence the direct damage concerning oil revenues that the country experiences. The production path of Saudi Arabia goes totally in the direction of physical depreciation; Saudis indeed, not only kept their level of production over time without the addition of substantial new reserves (a typology of production path that is impossible following the Reserves-to-Production critical value view), they even increased production, for compensating the lack of production by other countries that failed in covering their quotas over time, for

Cinti

regulating the market, as it happened during 2008, and for serving the internal growing demand. Evidence shows that the period when the Kingdom started operating the highest number of oil rigs is coincident to when its extraction started declining the most, and the quality of oil substantially downgraded as well, showing exactly what argued in the physical depreciation view. Therefore it is absolutely clear how the internal growing energy demand acquires even more than the usual importance in the oil management framework. In fact it will not only reduce the quantity of oil available for exports by its level of demand, but this effect will be amplified through the physical depreciation process, with serious consequences on oil revenues, hence, on the welfare of the country.

Summing up, the country has to respond to foreign and internal oil demand. The increasing internal demand leads the country to push up production. Pushing up production actually decreases the flow of oil available over time. Hence, in the future, when the reserves of the Kingdom will be declining (Saudi Arabia is conducting exploration since long time for finding new quantities of oil with no substantial success), the oil available will be destined mainly to respond to internal demand and production will be already corrupted because of the physical depreciation of the basins, causing an even faster decline in export. This will not only affect oil importing countries, which will see their demand of oil at least partially unsatisfied, and it will most probably be accompanied by spikes in prices, but it will also negatively affect Saudi Arabia itself as revenues from oil exports are the main tool for their long term growth plan as said, and the availability of those revenues will be shortened. On the other hand, high internal energy consumption seems to have a positive effect for the growth of the country, hence serving the internal market by solar energy could be a reasonable solution, for keeping the level of demand without damaging the oil basins. With this structure, the policy of construction of the NEC acquires a new strategic role where it is very important to evaluate the correct creation path which can grant both, oil preservation and GDP growth.

4.3 Policy Implications

It seems clear from what previously analyzed that Saudi Arabia should solve the dilemma concerning the level of internal demand and the damage of the oil basins through overexploitation with the subsequent loss of part of the oil available, which translates in future wealth. A discussion could arise concerning the active positive causal relationship between internal energy consumption and GDP growth. Even eliminating this assumption, considering internal energy consumption as neutral on GDP growth, the paper will show why the correct way for the Kingdom to carry on the creation and development of the New Economic Cities, in order to be able to sustain its long term plan of growth, is to directly construct them through new sources of energy, namely solar energy because of the already mentioned Saudi characteristics and progresses in the field.

Let's consider two different scenarios. In the first scenario the internal energy consumption of Saudi Arabia actually has a positive impact on the GDP growth of the Kingdom. Policies for restraining the energy consumption would then not be in the interest of the country. On the other hand, not only the growing internal energy consumption takes away precious resources from the quantities of oil produced that could be available for exports, but it also participates to the physical depreciation of the oil basins previously mentioned, lowering even more the quantity available for

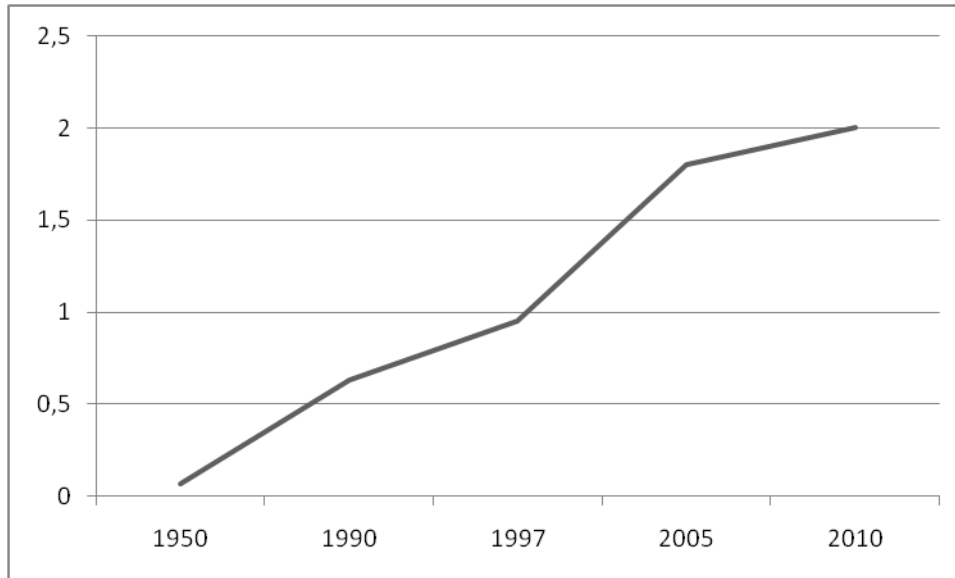
Cinti

exports, intervening in the peak of oil exports in a negative way, and letting Saudi Arabia with less oil rents available for internal investments dedicated to development. The construction of the NEC is an energy intensive activity, which would play a positive role for the GDP growth in this scenario. The construction of the cities would favor growth not only through the channel of development and international contribution planned by the Kingdom for them, like the creation of new jobs and the foreign participation that would favor integration, together with the gaining from the technological and knowledge spillovers that result from the international involvement through FDI, but they would also boost growth through the construction itself and the energy consumption that it requires, because of the positive relationship between the internal energy use and GDP. On the other hand though, the second result would be that this intensive energy production would rapidly destroy important quantities of oil present in the Saudi basins, according to the physical depreciation problem. This way the quantities available for exports would lower, but the quantity left available for the internal energy consumption would lower as well over time; the time-lag depends on the level of overexploitation. One important aspect concerning the physical depreciation of the oil basins is that the lower the level of the reserves-to-production ration, meaning the higher the overexploitation, the worse the depreciation, hence the fastest the resource is depleted. As Saudi Arabia is the main oil producer, the state of its basins strongly puts a strain on the global peak of oil exports. What does this mean for Saudi Arabia? The first thought is that with lower quantities of oil available the price of the commodity will increase leading to higher oil rents for Saudi Arabia. But this is not a sustainable solution for the market. With the prices increase oil importing countries will shift to other energy sources at a certain time. With a high grade of physical depreciation Saudi Arabia would lose the ability of regulating the oil market not being able to intervene on its output quotas anymore, and the high volatility that always characterized this market, would be out of control. When the oil prices will be too high to be sustained, Saudi Arabia would be tempted to push production even more, in order to regulate the market, and that would cause an even steeper physical depreciation of the basins. Hence, in the very short run, Saudi Arabia would probably result with higher oil revenues due to the high oil prices, but the Kingdom would pay the price of those actions in the medium/long run. In fact, at one point Saudi Arabia will no longer be able to serve the international market, and will dedicate its production to the increasing internal energy demand. Then oil revenues, the major tool for the long-run growth plan of the Kingdom, will be lost, and the government will no longer be able to invest in education, infrastructures and all the other plans that should grant the Kingdom development and integration. What is then the solution? Saudi Arabia should shift to the production of energy dedicated to the internal market deriving it from solar energy and not from fossil fuels. It is obvious that the price of energy production would rise comparing it to oil derived energy, eliminating at least part of the subsidies present in the internal market, probably reducing to some extent internal energy consumption. On the other hand, also the cost of energy derived from oil is increasing in the Kingdom. It is true that Saudi Arabia has currently the lowest cost of oil production in the world, but this is increasing over time, due to the state of the oil wells. As Biederman (1961) well describes, the cost of oil production, is mainly dependent on drilling costs, well operating costs, and costs of physical waste and depletion. It is well clear then that the physical depreciation of the oil basins leads to even higher production costs, and the higher the production costs, the higher the price of energy production, the lower the internal subsidies of the Saudi market. The steep of the increase in energy production costs directly depends on the level of physical depreciation, as the latter

Cinti

would increase proportionally all the components of the costs function previously described. As said Saudi costs of production are already increasing: starting from a cost of 7 US cents/b in 1990, Saudi Arabia is currently producing at 2 U.S.\$/b.⁸

Figure 2. Saudi Arabia, costs of oil production. Data from SESRIC.



Hence it seems important to consider that while solar energy production costs have the projection of declining through the dedicated research of the Kingdom and through the possible knowledge acquirable from foreign partners, oil based energy costs are supposed to rise over time, and even more (and faster) if considering the problem of physical depreciation. Hence, as mentioned, even keeping on producing energy through fossil fuels will lead to a drop in internal energy consumption because of the elimination of internal energy subsidies in the market, and in that occasion Saudi Arabia will result in not having enough oil to export from where to take oil revenues to reinvest and in a lower internal energy consumption that could not push GDP growth. With the construction of the NEC through renewable energies instead, as it is already happening in the United Arab Emirates that are building the Masdar city, the internal energy use would re-adjust because of the new costs of production, but the energy intensive activity would keep the demand at a high level boosting GDP growth, and this policy of production would not result in the physical depreciation of the oil basins, granting the Kingdom a higher quantity available for exports for a longer period of time, that is translated in higher and longer availability of oil revenues.

In the second scenario the internal energy consumption of Saudi Arabia does not play a positive role on the GDP growth; this is indifferent in the medium/long-run. In this case there is no need to push internal energy consumption and adequate policies for energy preservation should be implemented in order to grant a major consciousness about energy waste, and environmental achievements. In this scenario the construction of the NEC through solar energy, as well as serving the internal market, with renewable energy will only intervene on the physical depreciation side of the problem. The quantities of energy that would have been dedicated to the NEC and to the internal market would then be available for oil

Cinti

exports, granting oil revenues for a longer period of time, keeping Saudi Arabia in the leading position concerning oil production and oil market regulation, and at the meantime would help alleviating the reserves-to-production ratio issue, with a positive result concerning the depreciation problem, as well as the welfare of the country.

5. Synergies and Future Research

Saudi Arabia is not the only country in the Gulf which is shifting to renewable energy production. Other countries are taking action in order to develop a different way of responding to energy demand and a different cultural approach to the energy issue. Among others, the United Arab Emirates surely play the role of protagonists in this new way of thinking energy. They started the development of the Masdar project years ago, the first zero waste, zero carbon emissions city in the world, with a strong focus on research and development of knowledge and technology related to renewable energies. Qatar has other plans for new sources of energy on his own. A cooperative policy in order to conjointly use the acquired knowledge and form a center of excellence regarding energy innovation seems to have the potential of granting the region an important success in this term, and a renewed leading position concerning energy production, even beyond oil. With the development of several knowledge institutes and the possible spillovers acquirable through the participation of international investors in the projects of development of the area, the Gulf countries have really the chance to make the difference for them and for the rest of the world. The joint exchange of experience and knowledge could lead them to a faster development of technologies and a faster implementation of the new sources of energy use in daily life. The fact that the Gulf countries formed a custom union makes the exchange of capital and labor easier and through that the spread of the new knowledge in terms of energy could be wider and faster. Through the participation in the projects by foreign investors this “new age” could be a big chance for everybody in order to integrate the renewable energy use with traditional energy. This seems to be a crucial moment for the region, in order to decide the place they will cover in the future energy game.

6. Conclusions

The GCC countries compose a high potential world region concerning growth. During the global crisis that started in 2008 they demonstrated the ability of responding well to that shock, managing to preserve their economies from hard negative consequences even gaining from it, with an increase of the international interest in the region. Saudi Arabia is often addressed to be the leading country for the Gulf future growth. The Kingdom managed to sustain its economy during the crisis, and with that, to sustain its future plan for growth beyond oil, which are strongly based on the construction of NEC for answering to different issues currently affecting the country, one above the others, diversification. This study is specifically addressed to the only construction of the NEC planned for the Kingdom of Saudi Arabia, taking into account the peculiar internal energy demand-GDP growth relationship characterizing the country and the physical depreciation currently affecting the Saudi oil basins. It is designed in the framework of the oil depletion issues, following projections giving an increase in the oil prices and global oil demand up to 2035 as presented by the IEA. A change in some of those aspects might lead to different conclusions about the correct policy of energy production to adopt.

Cinti

From this paper it seems clear that the attempt of constructing a diversified future economy, free from the strong dependency on oil of the country is extremely centered on the current oil production management. If the construction of the NEC is carried on by oil derived energy indeed the Kingdom could lose a major tool for its growth and development actually damaging the economy of the country. The use of renewable energy, namely solar energy through the implementation of photovoltaic panels, seems necessary in order to grant the success of this long term growth plan, keeping high the internal energy demand which might play a positive role on GDP growth and avoiding the overexploitation of the Saudi oil basins which results in their physical damage leading to the risk of losing high quantities of revenues. The increase of internal energy demand deriving from the construction of the NEC would indeed harm the quantities of oil left in the Saudi basins, with the risk of leaving the country in the position of not being able to export with the subsequent loss in revenues, and of not being able to satisfy the internal energy demand in the long run. Implementing the use of solar energy to construct the NEC first and to serve the internal market in a gradually increasing way then, would instead allow Saudi Arabia to complete its project of development without harming its economy.

Endnotes

¹ Source: U.S. Energy Information Administration (EIA).

² For the complete analysis Rehman S., Bader M.A., Al-Moallem S.A. (2007), "Cost of solar energy generated using PV panels", *Renewable and Sustainable Energy Review*, Vol. 11, pp. 1843-1857.

³ U.S. Energy Information Administration (EIA).

⁴ The Saudi Gazette (2010).

⁵ Data from SESRIC. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

⁶ Ivanhoe, L.F., 1996. "Updated Hubbert curves analyze world oil supply", *World Oil*, Vol. 217, issue 11, and Cinti V., 2008, *The Political Economy of Oil Depletion*, ASPO International.

⁷ For a deeper analysis see Cinti V., 2008. "Saudi Arabia and the Volatility of the Oil Market", *Geopolitics of Energy*, Vol. 30, no 12.

⁸ Data from APS Review Oil Market Trends.

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