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# Challenges for research on resource-rich economies

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## **Challenges for Research on Resource-Rich Economies**

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# Challenges for Research on Resource-Rich Economies

GUY MICHAELS\*

## Abstract

The scope for economic research on resource-rich countries has widened considerably over the past two decades. While examination of market-based channels mechanisms (such as spending effects and exchange-rate appreciation) and resource price volatility are still important, other issues are coming to the forefront. These include the risk of depletion or technological changes that may reduce demand for natural resources or production factors, issues related to migration and inequality, and concerns regarding the use or misuse of revenues from natural resources and power struggles over them. Concerns about the effects of resource-abundance also extend beyond national borders, covering such diverse topics as conflicts over the control of resources and their possible contribution to climate change. I argue that progress in understanding these issues is constrained by the shortcomings of cross-country analysis as a way to model counterfactual scenarios and by the paucity of good data. The paper outlines specific gaps in the literature, pointing the way for future research on resource-rich economies in general and on the Gulf states in particular.

## Keywords

development; Gulf states; natural resources

JEL Codes: O13, Q30, N50

## 1. INTRODUCTION

People have been using nature's bountiful resources since the dawn of time. But despite considerable research on natural resources, their impact on economic development is still the subject of much debate among economists. Rather than summarize the vast literature on this subject, this paper takes a broad view of the issues and proposes directions for future research on resource-rich economies, with an emphasis on the oil-rich Gulf states.

While oil may be an especially important natural resource, the range of natural resources used by people is, of course, very broad. For the purposes of this article we can consider three types of resource. First, we may look at hydrocarbons (especially oil and natural gas) and other minerals which are widely considered 'non-renewable'. Non-renewable resources accumulated very slowly throughout the Earth's history and the only way to increase useable reserves is to discover new deposits or to develop better techniques for extraction. Second, we may consider other natural resources such

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as freshwater sources and fisheries. These may sometimes replenish themselves within decades or centuries, rather than eons. However, given humanity's growth and increased demand (which is especially strong in the Middle East), even historically abundant fisheries can no longer be treated as renewable for practical purposes. Third, we could examine natural attractions such as scenic mountains or coastlines. These are not harvested in the sense of being moved from their natural location.

Nevertheless, these resources are also used intensively for agriculture, tourism and residential or commercial construction. Such intensive use sometimes alters them and inflicts on them environmental damage. While most of the discussion in this paper applies to the first type of natural resources, and especially oil, some of the issues that arise are also relevant to the other two types of resource.

Having defined the types of natural resource on which to focus, we can now ask ourselves, which economies are rich in natural resources? While most Gulf states intuitively appear to fit the bill well, finding a good empirical definition of resource abundance is not as easy as it may seem. First, technology and demand affect the price of natural resources, changing the relative resource-abundance of different locations over time. Second, it is difficult to assess the physical quantity of economically extractable resources in many countries. Moreover, quantities currently extracted (and existing reserves) are endogenous to prices, technology, and political considerations. Measuring initial endowments, while conceptually better, is often difficult in practice. Third, even if we could measure the price and quantity of natural resources, it is not clear whether we want to normalize our measure of resource abundance by gross domestic product (GDP) or by population.

With these caveats in mind I try to characterize countries where natural resource extraction plays an important economic role. These include, along with oil-rich Middle Eastern countries, some African countries and some developed countries. But if measuring resource-richness is not straightforward, assessing its causal impact turns out to be even harder. Problems of endogenous extraction (today and in the past), spurious correlation with confounding variables and poor comparability of outcomes across countries have made it difficult to reach a consensus regarding the causal effect of natural resources on these economies. Along with efforts to overcome these challenges in the cross-country setting, this paper argues that analysis of case studies of natural resource discovery and of resource-rich areas within countries complements the cross-country analysis in important ways.

Having examined the attempts to assess the overall impact of natural resources in this section, I then examine specific economic channels through which natural resources can affect development (section 2). The third section of the paper begins by outlining the challenges that economies face in mapping their resource endowments and developing a resource extraction industry. I then examine some of the effects that a mature resource extraction industry may have on the economy. These effects include various forms of ‘Dutch disease’, generated by spending of resource income or by increased demand of certain sectors for production factors. Other economic effects might arise from a high volatility of natural resource prices. These effects might imply that non-oil sectors might be at a disadvantage in resource-rich economies, as might be the case in the Gulf states.

The accumulation of suitable production factors, such as physical capital, labour, and education is also a challenge for resource-rich economies, and it often involves absorbing considerable migration. If this is done well, resource-rich economies may benefit from the agglomeration of production factors, but integrating immigrants is not an easy task. Lastly, economies that have developed a sizeable resource extraction sector face risks of resource depletion, declines in demand and technological change that reduces demand for certain skills. Adjustments to such shocks often take time and they can be costly and painful.

The fourth section of this paper examines the roles of government in resource-rich economies, and the rules and strategies for procuring natural resource revenues and spending them. This section also examine various political economy channels, through which abundant natural resources might increase rent-seeking, patronage and waste, or shortened planning horizons due to increased political challenges to power. Finally, I briefly explore issues related to lobbying, colonial legacies, international relations and the political economy of migration. I conclude that despite considerable research effort, the importance of many of these mechanisms has not been convincingly identified, even in settings with good data. The paucity of good data on oil-rich economies, and especially on the Gulf states, further restricts our understanding of the issues particular to this region.

## **2. ASSESSING THE OVERALL ECONOMIC IMPACT OF RESOURCE ABUNDANCE**

This section begins by attempting to characterize the world’s resource-rich economies. I then discuss existing estimates of the effect of natural resources on

overall economic performance and potential concerns regarding the interpretation of these estimates. Finally, I discuss how evidence from case studies of different countries and from variation within countries can further inform our understanding.

As mentioned in the introduction, this paper examines the challenges faced by economies rich in natural resources, especially non-renewable resources, such as hydrocarbons and minerals. Given this focus, we can now ask, which economies are rich in natural resources? You might think that all we need to do to answer this question is to measure the endowment of each resource and to value it at market prices. But, as we shall see, measuring quantities is not straightforward. And fluctuations in prices imply that economies that are currently considered resource-rich were not necessarily considered resource-rich in the past (think about the Arabian Peninsula before the discovery of oil) and may not remain so in the future.

In order to measure the economic importance of natural resources in different economies today, I first obtain population and GDP in historical dollars and purchasing power parities (PPP) for 2001 using the Penn World Table (PWT) data (Heston et al. 2006).<sup>1</sup> I then use data from United Nation (UN) Statistics Division (2009) to calculate the share of mining in each country's GDP in 2001.<sup>2</sup> These data allow us to calculate mining GDP and total GDP (and values per capita) for most countries, using 2001 data wherever possible. Of the 188 countries in the PWT dataset, I matched the mining share of GDP for 170 countries which were home to over 98 per cent of the total PWT-covered population and contributed more than 98 per cent of the PWT-covered GDP in 2001. Over all the countries examined, mining accounted for about 2.4 per cent of total GDP, but the unweighted average across countries was about 6.8 per cent, suggesting that the effect of mining can be sizeable

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<sup>1</sup> We chose 2001 for two reasons. The first was availability of data on mining GDP, which we shall discuss later, and the second was that 2001 did not stand out for particularly high or low commodity prices. For five countries – Seychelles, Guyana, Libya, Haiti, and Angola – PWT does not provide 2001 GDP data, so we used 2000 data on GDP and population instead.

<sup>2</sup> UN data covers fewer countries than PWT. We calculated 2001 shares (or 2000 data for the five countries for which PWT had only 2000 data) of mining and quarrying (to which we shall simply refer as 'mining') in GDP from table 2.1 (Heston et al. 2006): value added by industries at current prices. For many countries, the table includes multiple data series over time. Each series represents a combination of various accounting categories for each country, such as currency, system of national accounts, and fiscal year type. Since using any single series would have resulted in omitting many countries, we took both total GDP and mining and quarrying GDP for each country from the highest numbered series that was available, since higher numbered series used more up-to-date methodology. For some countries 2001 data was unavailable, so we calculated shares based on the closest year to 2001, selecting the earlier of two years if both were equally close to 2001.

for many relatively small countries, even without taking into account its effects on industries that provide services to mining or use mined products as inputs.

Table 1 shows the top thirty countries, ranked according to their mining GDP per capita measured using 2001 US dollars. I also ranked the countries using PPP (rather than US dollars) and using the share of mining in each country's GDP. Among

**Table 1. Resource-rich economies**

Country	Popu- lation, 2001 (million)	Per capita GDP (\$000, 2001)	Per capita mining GDP (\$000, 2001)	Total mining GDP (\$bn, 2001)	Share of mining in GDP	Rank using per capita mining GDP (\$, 2001)	Rank using per capita mining GDP (PPP, 2001)	Rank using share of mining in GDP
Qatar	0.8	23.0	13.29	10.2	0.58	1	1	2
United Arab Emirates	2.4	28.9	8.60	20.7	0.30	2	4	15
Norway	4.5	37.5	7.63	34.5	0.20	3	5	20
Kuwait	2.0	17.0	7.29	14.9	0.43	4	3	4
Brunei Darussalam	0.3	12.2	4.86	1.7	0.40	5	2	7
Oman	2.6	7.5	3.19	8.4	0.43	6	6	5
Bahrain	0.6	12.4	3.07	2.0	0.25	7	8	18
Saudi Arabia	22.8	8.1	2.70	61.5	0.34	8	7	11
Libya	5.1	6.7	2.28	11.6	0.34	9	10	10
Botswana	1.6	3.2	1.49	2.4	0.47	10	9	3
Trinidad and Tobago	1.1	7.9	1.37	1.5	0.17	11	12	22
Canada	31.0	22.8	1.22	38.0	0.05	12	15	49
Gabon	1.3	3.7	1.14	1.4	0.31	13	11	13
Australia	19.3	19.7	0.95	18.4	0.05	14	16	53
Iran	66.8	5.6	0.86	57.5	0.15	15	21	23
Venezuela	23.9	5.3	0.74	17.7	0.14	16	19	24
Iraq	23.3	0.8	0.68	16.0	0.91	17	13	1
Denmark	5.4	29.9	0.68	3.6	0.02	18	28	71
Netherlands	16.0	25.1	0.63	10.0	0.02	19	24	65
Algeria	31.7	1.7	0.60	19.2	0.35	20	14	9
United Kingdom	58.9	24.4	0.57	33.3	0.02	21	31	69
United States	287.0	35.1	0.41	118.7	0.01	22	36	88
Malaysia	22.2	4.0	0.38	8.5	0.10	23	18	32
Angola	10.1	0.9	0.30	3.0	0.33	24	27	12
Chile	15.3	4.5	0.29	4.5	0.07	25	22	44
Republic of the Congo	2.9	1.0	0.27	0.8	0.28	26	39	17
Syria	16.7	1.2	0.25	4.1	0.20	27	37	21
Namibia	1.9	1.7	0.23	0.4	0.13	28	25	26
Azerbaijan	7.8	0.7	0.22	1.7	0.30	29	17	16
South Africa	42.6	2.8	0.21	9.0	0.08	30	26	42

*Note.* The share of mining in GDP calculated from United Nations (2009) and the other variables are taken from Penn World Tables (Heston et al. 2006). PWT data are for 2001, except where this data was missing; the exceptions that appear in the table are Libya and the Republic of the Congo, for which we used 2000 data instead. The share of mining in GDP is computed using 2001, except where data was unavailable; the exceptions that appear in this table are Angola (for which the mining share was calculated using 1990 data) and Gabon and the Republic of the Congo (for which the mining share was calculated using 1989 data).

these top thirty countries, oil-rich countries, including the Gulf states, are prominently represented. The concentration of revenues from resources in particular countries is an important, though not surprising, stylized fact. As I discuss later, this makes identification of the effect of natural resources more difficult. At the same time there are also some developed countries (such as Norway, Canada and Australia) that qualify as ‘resource-rich’ using the ranking by per-capita mining GDP.

The correlation between the ranking of countries according to per capita mining GDP using dollars and using the PPP adjustment is 0.96, so adjusting for local prices appears to matter relatively little. The correlation between per capita mining GDP in dollars and the share of mining in GDP, however, is only about 0.71. While, as we shall see later, none of these measures is ideal, these correlations suggest that the choice of normalization (by population or GDP) may have important consequences for assessing the effects of resource-richness.

The UN data allow us to look at natural resources’ share not only in GDP, but also in employment.<sup>3</sup> Comparing the fifty-two countries which report both employment shares and GDP shares suggests that the average employment share of mining was about 0.6 per cent, compared with the average GDP share of mining of about 4.6 per cent. The ratio of GDP share to employment share of mining had an average of about 7.1, a median of about 1.9 and an interquartile range of approximately 1.1 to 4.8. This finding suggests that labour productivity in mining is much higher than in the rest of the economy; this probably reflects the mining sector’s intensive use of capital and technology. Moreover, the mining sector’s role in many national economies goes beyond its direct contribution to GDP. The share of exports and government revenues that is due to natural resources is often much higher than its share in GDP. Overall, hydrocarbons are clearly the most important source of revenues, although diamonds, bauxite, iron and gold are also important in some economies.<sup>4</sup> It is worth noting that oil and other extractive industries often demand intermediate inputs and may thus also contribute to the development of other closely related industries. But this does not necessarily imply that these related industries will develop within the resource-rich countries themselves.

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<sup>3</sup> United Nation Statistics Division (2009), table 2.3: Output, gross value added, and fixed assets by industries at current prices. We use the item ‘Employment (average, in 1000 persons)’.

<sup>4</sup> For details on the contribution of various natural resources to government revenues and exports see Appendix I in International Monetary Fund 2005.

An alternative to measuring countries' resource output is to examine their proven reserves of natural resources, especially of oil. As mentioned above, oil plays a disproportionately important role among natural resources today and examining countries with large resources is instructive. The US Energy Information Administration (2009) lists the following countries as having the largest proven oil reserves (in billions of barrels, as of 2007): Saudi Arabia (262.3), Canada (179.2), Iran (136.3), Iraq (115.0), Kuwait (101.5), United Arab Emirates (97.8), Venezuela (80.0), Russia (60.0), Libya (41.5), Nigeria (36.2), Kazakhstan (30.0), and the United States (21.8). A comparison of the countries in this list with those that appear in Table 1 reveals problems with assuming that the output measures of 'resource richness' are exogenous. For example, political considerations may prevent some countries (such as Iraq in 2001) from realizing their potential as major oil producers, while other producers (such as the United States and Norway) were still important oil producers in 2001 despite having exhausted much of their reserves. But this final example also demonstrates that not only oil output but also current reserves are highly endogenous to economic conditions.

A more promising candidate for an exogenous measure of resource abundance is their natural endowment, which includes the quantity extracted over time and current reserves (for a within-country analysis of oil endowments in the US South see Michaels 2006). But for the time being, measuring endowments in a cross-country setting remains a challenge. When can this plausibly be achieved? One requisite is that each relevant country (and the oceans near it) has been surveyed carefully enough for us to be confident that a good approximation to the actual endowment is known. Another requisite is that incentives to disclose the correct estimates are in place, so that we can expect the reserve estimates to be authentic.

The discussion above gives the reader some appreciation of the challenges to be met when assessing the causal impact of resource abundance on economic performance. The early empirical literature found evidence of a negative correlation between the share of natural resources in countries' GDP or exports and their economic performance (see Auty 1993) and especially their growth over the past few decades (see, for example, the influential studies by Sachs and Warner (1995, 2001)). Although some of the more recent evidence is consistent with these findings (for a recent survey see Humphreys et al. 2007), other researchers criticise both the methodology and the robustness of the results. Much of the criticism is related to

disagreements regarding the appropriate measurement of resource abundance, as discussed above. Stijns (2005) and Lederman and Maloney (2007) discuss alternative measures of resource abundance and conclude that the negative correlation between ‘resource richness’ and economic growth is not robust. Brunnschweiler and Bulte (2007) use World Bank data on assessments of the value of the current stock of natural resources available in each country, and also conclude that resource abundance is not correlated with growth.

A more nuanced view of the effect of natural resources is reflected in Mehlum et al. (2006), who argue that resource abundance has a positive effect in countries with strong institutions and a negative effect among countries with weak institutions. The idea that economies can benefit or lose depending how they utilize the resources and what they do with the rents is an important question which I shall revisit.

But even if the precise mechanisms through which resource abundance affects economic outcomes are not fully understood, how is it possible that researchers cannot agree on the overall effect of resource abundance, and oil abundance in particular? Beyond the issues regarding the endogenous determination of known measures of resource abundance, two other issues stand out. First, there is a possibility of omitted variables bias: natural resources are not evenly spread across the globe, and their location might be spuriously correlated with other factors that affect economic outcomes. For example, the Middle East is oil-abundant, but its institutions and economic outcomes were very different from those of Europe even before oil was discovered (Pamuk 2006). It is quite possible that this region would have experienced different growth rates from other regions in the twentieth century even if no oil had been discovered there. Second, differences in measurement and the uneven quality of data on outcomes of interest across countries and over time make it even harder to identify oil’s causal effect.

In order to make progress towards causal identification, some researchers have complemented the cross-country approach using case studies of resource-abundant countries or resource discoveries. For example, Botswana has been hailed as a successful resource-rich economy (Acemoglu et al. 2003) while Nigeria remains a poster child for failures (see Sala-i-Martin and Subramanian 2003).<sup>5</sup> But even this literature has found it difficult to construct good counterfactuals for countries: how

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<sup>5</sup> Auty (1993) also examines case studies of economies that experienced resource booms.

would the economies of Saudi Arabia and Kuwait have evolved over time in the absence of their oil endowments? The limited number of countries we can analyse in this way restricts our ability to draw firm conclusions. But the emerging picture suggests considerable heterogeneity in the causal effect of natural resources, depending on how they are developed and used.

In search of a better counterfactual for resource-rich economies, some recent studies use variation within countries instead of variation between countries. In the context of the Gulf states such studies are currently very difficult to undertake, since good data are hard to come by. And evidence from other parts of the world cautions us against drawing far-reaching conclusions from one setting to another. For example, I studied the long-term impact of oil abundance in Southern US counties and found mostly positive effects: higher per capita income, no adverse effect on income inequality, and increased population growth, reflecting the attractiveness of the oil-rich areas relative to their vicinity (Michaels 2006). By contrast, in Caselli and Michaels (2009) we studied the impact of oil on Brazilian local governments. While we found no adverse effects on non-oil GDP, we found that the local governments spend oil revenues in ways that provided little benefits to the local population, and documented evidence that some of the oil money may have ‘gone missing’. The quality of institutions in most Gulf states appears to be somewhere between the United States and Brazil (Transparency International 2009), suggesting (very tentatively) that those countries may have benefited more than Brazil but less than the United States. But there are, of course, many caveats to this tentative conclusion. For example, some important mechanisms cannot readily be extrapolated from the local level to the national level.

Clearly, more work is needed to determine the causal economic effect of natural resources in different countries. In particular, future research should strive for more careful identification in different settings. While obtaining data on some countries, especially in the Middle East, seems difficult (see for example Ross in Humphreys et al. 2007: 238–9), doing so could substantially enrich our understanding of the impact of natural resources. In particular, the different experiences of resource-rich economies may reflect the varying importance of different channels through which resource abundance affects the economy.

### 3. ECONOMIC CHANNELS AND ISSUES

As we have seen, an assessment of the overall effect of resource abundance has so far proved elusive. But, at the same time, the literature has successfully shed light on some important economic issues pertaining to resource-rich economies.

While some discussions of the effects of resource abundance treat income generated from natural resources as ‘free money’, it is worth noting that considerable investments need to be made to develop and sustain resource-intensive industries. This section explores some of the steps involved: finding suitable locations and estimating their economic potential, developing or adopting extraction technologies, and accumulating the appropriate physical and human capital. Once production takes place, economies need to cope with the effect of resource-intensive industries on local prices and price volatility, on the development of industries related to the resource-intensive sector, and on income distribution. Further down the road lie issues of resource depletion, risks of a permanent decline in demand for a given resource, technological changes and the need to deal with potential hazards to health and to the environment.

#### *3.1. Discovery and development of resource-extraction industries*

This section begins by examining the requirements for utilizing natural resources. While the distribution of natural resource endowments across the globe is uneven, the relative economic attractiveness of different locations has varied considerably over time. In agricultural economies, fertile farmland was particularly important. Technological innovations, such as the steam engine, made locations abundant in coal particularly attractive. The automobile has made oil-rich locations important, while decreasing the importance of coal. Thus the definition of what constitutes a ‘resource-rich’ location has changed considerably with technology and consumer demand.

Once an area is considered to have economic potential, efforts to assess this potential may begin. The early search for natural resource endowments was typically unsystematic and was often conducted by entrepreneurial individuals. As economies developed, firms and governments took on greater roles. For example, the United States Geological Survey (USGS)<sup>6</sup> was established in the late nineteenth century, but systematic mapping of natural resources in less developed countries occurred later. In the Middle East, for example, the slow mapping and development of oil deposits

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<sup>6</sup> [www.usgs.gov/aboutusgs/who\\_we\\_are/history.asp](http://www.usgs.gov/aboutusgs/who_we_are/history.asp).

delayed the rise of Saudi Arabia and Iran as major producers of oil (US Department of Energy 2008). Even in recent years large deposits of oil have continued to be discovered, especially in developing countries. For both academic and policy-oriented researchers, getting good data on the location and quantity of natural resource endowments is vital for analysing their effects.

Related to resource discovery is the issue of the development of oilfields, mines or other natural resource extraction sites. Whether development and extraction is to be performed by a large single player or through competition, the choice of the developer(s) – local or foreigners, firms or governments, could be important. Despite a long history of both foreign and domestic oil operations in developing countries, we still know relatively little about the merits of these different strategies. Knowing more could inform the ongoing choices of governments and citizens (for example, Iraq has recently auctioned the rights to extract some of its oilfields).

For countries and local firms that choose to extract at least some of the mineral resources by themselves, raising capital is an important issue. The problem is not restricted to poor African countries – it might also apply to heavily indebted oil producers. And it can be important, given the capital requirements and technological intensity of the petroleum industry – especially when it comes to offshore oil operations. Understanding the role of financial institutions and institutional design in the development of natural resource industries is an interesting area for future work.

The discussion of the cost of capital involved in developing resource-intensive industries gives rise to another related question – how to overcome the incentive to governments to expropriate firms that have invested, once the investment has taken place. Historical examples suggest that property rights protection may be important for the development of extractive industries. For example, development of extractive industries in the US South was slow relative to the North, despite the South's abundance in oil (Wright 1986; Pratt 1980). Yet some recent research actually suggests that contract enforceability may be relatively unimportant in oil extraction, so that countries with poor institutions may specialize in oil or in other resource-intensive industries because of comparative advantage (Nunn 2007). This difference in perspectives raises the need for more research on the importance of various institutional constraints for the development of resource-intensive industries.

While much of what we know on the institutional constraints on the development of resource-intensive industries comes from historical studies,

there are also some recent theoretical contributions. Stiglitz (in Humphreys et al. 2007) discusses some of the issues involved in the design of contracts for oil exploration, to ensure that the state (and the public) does not give up rents from natural resources unnecessarily. Countries can design different auction schemes, such as royalty bidding (where firms bid on the percentage of production that the government is to receive) or bonus bidding, which can be used to increase competition or reduce information asymmetries. In designing the incentive schemes, ensuring genuine competition between firms can sometimes be a challenge, especially where a small number of firms dominate the industry (as in some Gulf states, for example). Governments may also choose to reduce royalties over time (to prevent companies from shutting down production when oilfield productivity falls) or offer checkerboard leases that reveal more information about oil endowments.

Just as having a suitable institutional infrastructure may be important for developing a resource extraction industry, obtaining a suitable labour pool can also play a significant role. While some of the work in resource-intensive industries does not require very specialized skills, technological change in the industry means that skilled workers are often in high demand. Thus education and migration policies are potentially important in locations where skills are scarce, as I discuss below. But before discussing migration we should first concern ourselves with other issues that typically arise after production begins.

### *3.2. The effects of developed resource-extraction industries*

The onset of substantial extraction of natural resources creates new challenges for resource-rich economies. One potential challenge may arise from a wealth effect (sometimes called a ‘spending effect’ in the Dutch disease literature). The mineral riches trigger a surge in demand for consumer goods. To satisfy the extra demand for non-tradables resources are reallocated from the (non-resource) tradable to the non-tradable sector, while the extra demand for tradables is accommodated through increased imports (financed by the resource exports and, in some cases, external debt). This mechanism is sometimes fuelled by (and contributes itself to fuelling) an exchange-rate appreciation that further causes the non-resource export sector to shrink. A further effect of the wealth effect is that it potentially depresses overall labour supply, leading to a combination of higher wages and lower overall non-resource GDP. Other types of Dutch disease mechanisms include a reallocation

of production factors across sectors due to direct demand by the resource-intensive sector or its employees, which may drain the non-resource part of the economy.<sup>7</sup> For these reasons, most Gulf states have developed economies with considerable dependence on oil. While this may be fine in the short and medium run, it might impose some longer-term costs.

Matsuyama (1992) argues that in an open-economy setting a resource-rich economy may specialize in a resource-intensive sector and forego the development of other sectors where learning by doing is important.<sup>8</sup> In this case, being resource-abundant may actually be harmful in the long run, if demand for the resource-intensive good grows more slowly than demand for other goods. While assessing the actual cost implied by this type of mechanism for oil rich economies in the Gulf states is a difficult challenge, it would be interesting to examine whether knowledge accumulation and technological change outside the oil sector has been slower.

The model discussed above assumes that demand for natural resources may grow relatively slowly, but the empirical evidence is not as clear. Early work by Prebisch (1950) and Singer (1950) attributes much of the slow growth of some economies at the time to resource abundance and the relatively slow growth in the prices of resource abundant goods. But Cuddington et al. (in Lederman and Maloney 2007) suggest that price changes might not have been the culprit. More work on understanding the demand for natural resources over long periods may shed more light on this important issue.

In addition to the concern about the long-run trend in commodity prices, there has also been concern about the implications of price fluctuations.<sup>9</sup> Commodity price volatility presents challenges not only for the resource extraction sector; the sectors that are most directly affected are closely related upstream and downstream industries (in the case of the oil industry, for example, these may include production and servicing of oil pipelines, petrochemical plants, etc.).<sup>10</sup> Other affected sectors are non-traded industries that provide intermediate inputs to the resource-extraction sector and its employees. Important examples include transportation, business services,

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<sup>7</sup> For various combinations of these Dutch disease mechanisms see Corden (1984), Corden and Neary (1982), Krugman (1987), Torvik (2001), Wijnbergen (1984) and Younger (1992).

<sup>8</sup> For a similar view see Lucas (1988).

<sup>9</sup> See, e.g., Humphreys et al. (2007), pp. 6–8.

<sup>10</sup> To address the problem of price volatility, some countries (e.g. Brazil before 1997 – see Caselli and Michaels 2009) fixed the price of oil, achieving benefits from price stability at the cost of distortions in factor allocation.

construction, financial services and machinery manufacturers. Also affected are sectors that draw on the same pool of production factors when the supply of these factors is not perfectly elastic. Yet relatively little is known about the quantitative importance of these mechanisms in the context of the Gulf states.

Increased volatility from a large resource-abundant sector can affect not only factor demand. The high level of uncertainty can also deter investments (Schott 1998). More studies of these effects of resource abundance also seem important for determining whether resource abundance crowds out the development of other sectors in the economy.

The discussion of prices so far has assumed that each economy has relatively little market power. But this need not be the case if one country has a large market share worldwide or if several countries can form a cartel, such as the Organization of the Petroleum Exporting Countries (OPEC). In this context it seems useful to go beyond the classic rule derived by Hotelling (1931), which states that the growth in the price of non-augmentable and non-renewable resources should equal the discount rate. In particular, it seems useful to examine the importance of political and strategic considerations and of the effects of new discoveries (or expectations thereof).

The ability of natural resource producers to organize across national borders also suggests that lobbying by firms within a country might also have important implications for resource-producing countries, potentially distorting other policies (e.g. trade). Similarly, workers in a resource industry might have a different propensity, to organize and create unions. Work by Holmes (2006) finds that in the United States unionization from mining establishments has spilled over to the rest of the (local) economy. While the conditions in the Gulf states are clearly different from those in the United States, the examples above suggest that understanding the institutional setting and market structure can be important for analysing economic performance.<sup>11</sup>

### *3.3. The accumulation of labour, human capital, and physical capital*

Changes in institutions and commodity prices may over time affect the accumulation of production factors – labour, human capital, physical capital and technology. Initially, increased demand for local labour may be satisfied by locals who live

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<sup>11</sup> A very different institution that has received considerable attention in the context of resource-intensive industries is slavery. I discuss this further in the next section.

in the resource-abundant part of the economy. Eventually, higher wages may attract internal migration.<sup>12</sup> But in some economies even the national labour pool is too small to satisfy the demand of the resource-rich industry, of closely related upstream and downstream industries, and of the government. In those cases foreign migration becomes an important aspect of economic development of resource-rich economies, such as those in the Gulf states. Immigrants present significant potential benefits to landowners (they tend to raise demand for housing), and they can also mitigate the price increases of some local services, partly offsetting some of the effects of Dutch disease discussed above.

But the challenges brought about by migration are numerous. For example, when demand for property increases, renters may suffer. And while locals may benefit from certain aspects of the diversity brought about by the immigrants, migration also creates potential social and political tensions, as I discuss in the next section.

In some countries, labour shortages in some sectors are not the main problem – rather, there are shortages of workers with particular skills. The resources at the disposal of governments and individuals provide an opportunity that some resource-rich economies have used to bolster their educational systems. Yet Jones (2008) suggests that even the type of educational investments undertaken may be important – general skills may be harder to accumulate than one may think. It remains an important challenge for future work to assess empirically the implications of natural resource income on the extent and nature of educational investments in the Gulf states.

In some developing countries the accumulation of local education and skills may be slow, so that migration of skilled workers from developed countries may become important. These foreigners may also affect the development of technology through universities and the private sector, and innovation. Of course, technology transfers to developing resource-rich economies may occur not only through migration. Yet we have relatively little empirical evidence about the importance of foreign direct investments or trade in facilitating such knowledge transfers. Moreover, there may be barriers to the adoption and diffusion of technologies in developed countries that affect the productivity of the resource-extractive sectors. And yet, over time, some resource-rich economies may themselves develop technologies to

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<sup>12</sup> Such internal migration may suggest that locals in resource-extraction regions are benefiting, most likely through higher wages.

overcome production problems (David and Wright 1997; Wright 1990) and eventually export their knowledge. Exporting oil-related services and technology may provide a route for economic diversification for the Gulf states.

The potential for the accumulation of know-how and the production factors in economies or regions rich in natural resources also create a potential for agglomeration in those locations. This idea has been examined in the economic geography literature (see for example Krugman 1991b; Fujita et al. 1999). The ‘home market’ effect, where transportation costs make locally produced goods more attractive, may contribute to such agglomerations.<sup>13</sup>

Historical examples for agglomerations built around natural resources include the United States’ Manufacturing Belt (Krugman 1991a), which developed in a region rich in coal, industrial centres in the north of England, or the Ruhr region in Germany (Pounds 1952). Some oil rich Gulf states (such as Saudi Arabia and Dubai) have in recent years started to build ‘economic cities’ to try and capture some of the potential benefits of agglomeration. Unlike most of the historical examples mentioned above, however, the new economic cities rely on centralized planning more than on market forces. And given the structural shift of the world economy from manufacturing to services over the past decades, the economic cities’ core business is often farther removed from natural resources than that of their historical counterparts.

One potential cause for the historical rise of agglomerations in resource-rich areas is the existence of economic (input–output) linkages to the resource extraction sector. While there are historical accounts of the evolution of industries related to resource-intensive industries,<sup>14</sup> economic quantification of these mechanisms in specific contexts, such as the Gulf region, awaits future work.

The discussion of the impact on economic development and growth of natural resources has so far mostly ignored distributional issues. But distributional issues can be important, especially in developing countries with high levels of inequality and poverty.<sup>15</sup> Natural resource extraction firms are often quite large, possibly due to the need to pay large upfront costs and to limitations on borrowing by small firms. If ownership of resource extraction firms is concentrated, and if demand for local factors is low, then gains to the general population from resource extraction need not be

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<sup>13</sup> See, e.g., Venables in Lederman and Maloney (2007), p. 267.

<sup>14</sup> See the analysis of the US South in Pratt (1980) and of Scandinavian countries in Blomstrom and Kokko in Lederman and Maloney (2007), p. 216).

<sup>15</sup> For a related discussion see Leamer et al. (1999).

large. Unfortunately, it is difficult to examine oil's effect on income distribution, because many resource-rich economies do not report data that allow a careful examination of inequality.<sup>16</sup> Obtaining high-quality data to examine this issue remains an important challenge, especially for those studying Middle Eastern oil producers.

#### *3.4 Long-term costs and risks to resource-rich economies*

Along with the challenges discussed thus far, resource-rich economies may also at times contend with long-term risks to their economic success. There is a range of potential risks, but here I will focus on three in particular. The first is the risk of natural resource depletion, the second is that of a permanent drop in demand for a particular natural resource, and the third is that of technological change in the process of resource extraction. Of these three risks, depletion can often be anticipated (at least by some) and adjustments made accordingly. But while this may be true in theory, examining the ratio of output to proven reserves does not always provide us with as much insight as we may hope to get. For example, a recent estimate (ANP 2007) suggests that for the Middle East as a whole depletion might still be thirty years away, while for specific countries, such as Yemen and Oman, it may occur much sooner. For the world as a whole, ANP figures suggest that 2006 oil reserves would allow for about fifteen more years of production at the current rate, a figure which has remained almost unchanged since 1997. This apparent postponement of the depletion of the world's oil supply reflects in part the discovery of new oilfields, improved extraction technologies and changing prices. But Luciani (2008) also points out strategic considerations (regarding internal and external parties) that affect the willingness of major producers such as Kuwait and Saudi Arabia to disclose their best estimates of their existing reserves. Such considerations cloud the picture regarding the onset of oil depletion, both in the world as a whole and in many specific countries.

While oil depletion may be a relatively gradual phenomenon, in other settings 'depletion' may occur fairly rapidly, as with some cases of fishery depletion, destruction of forests or the erosion of formerly rich soil. One historical example related to mining is that of Centralia, Pennsylvania, where slow-burning fires destroyed local anthracite coal mines (Quigly 2007). Another example is Kiribati, a Pacific island that lost its phosphate income around the time of its independence in 1979, and is now one of the world's poorest countries (US Department of State,

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<sup>16</sup> See discussion in Ross, in Humphreys et al. (2007), p. 239.

2009). Given the discussion above of the quality of existing data, oil depletion may also come as a surprise, at least to some individuals and firms. Their response may include changes in technology and industry structure, changes in private and public savings, and outward migration. These are important issues, and more research is needed on transition experiences of formerly specialized economies – both national and local – in order to shed light on the future transition of oil-rich economies in the Middle East when oil is depleted.

Along with resource depletion, declines in demand may also pose a significant challenge, since economies typically have little control over them and are often less able to anticipate them. In the past, such episodes have not been very numerous, since rapid growth in world GDP has often offset declines in the demand share of particular natural resources.<sup>17</sup> Historically, the world has witnessed declines in the importance of some sources of energy, such as peat (in the Middle Ages) and water power (in the nineteenth century, following the rise of steam power; see Rosenberg and Trajtenberg 2001). Perhaps more potentially relevant is the recent ‘rusting’ of the US manufacturing belt, which was built (at least partly) around coal, iron and rivers, and whose cold climate now makes it less attractive. This decline may serve as a warning for agglomerations built in the oil-abundant parts of the Middle East which also suffer from adverse weather conditions.

Alongside changes in demand, changes in technology may also have large economic effects on resource extraction industries, even when demand does not decline sharply. For example, US total coal output fell by only 26 per cent from 1944 to 1964. But this decline masks a large compositional change, as underground mining declined by 42 per cent, and surface mining (especially strip-mining) production actually increased. Partly as a result, the decline in hours worked in US mines was much more rapid: hours fell by 77 per cent over these twenty years. And while US coal output has since increased considerably, employment never fully recovered (in 2007 output was higher than in any previous year while the number of hours worked in US coal mines was actually slightly lower than in 1964). The permanent loss of so many jobs has had a large impact on parts of the United States.<sup>18</sup> One can only imagine how devastating the effect might have been were it not for the overall

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<sup>17</sup> An interesting study is Black et al. (2005), which examine the effect of the energy boom and bust in the coal producing areas of the United States.

<sup>18</sup> US Department of Labor, Mine Safety and Health Administration (2008)

growth of the US economy and the creation of many new jobs in other industries and areas. Careful analysis of such episodes may teach us how workers in resource-rich economies could prepare themselves for possible technological changes in skill demand.

The above discussion of the coal-mining industry brings to mind other concerns that have materialized over long periods in resource-rich economies. Among these are issues related to health risks and possible environmental damages, such as oil spillages. Mandatory purchase of insurance by producing (or shipping) firms against foreseen risks is one way to mitigate these concerns, but some risks may be too highly correlated to insure against. Moreover, extracting firms that caused such damages may be out of the country (or out of business) by the time the costs are realized. More research into designing institutional mechanisms to mitigate these problems can be important to resource-rich economies.

Of even wider potential importance are broader environmental concerns related to resource-intensive industries. In particular, potential global externalities such as humanity's contribution to global warming are of great importance (Stern 2006). Resource-intensive industries may be involved through producing fuels or logging forests, both of which might contribute to the problem. But at least some of the proposed solutions, such as carbon capture and storage, may also involve know-how developed in extractive industries (e.g. mining). Assessing the economic scale of the externalities involved and designing institutions and strategies to deal with these externalities are an important challenge for future work.

#### **4. THE ROLES OF GOVERNMENT IN RESOURCE-RICH ECONOMIES**

The previous discussion of possible market failures related to natural resource industries invariably brings up a discussion of the roles of government. Many governments have much at stake when it comes to revenues from natural resources. According to the International Monetary Fund (IMF, 2005), natural resource income accounted for more than 50 per cent of the fiscal revenues in at least nineteen countries.<sup>19</sup> All but one of these countries was in the Middle East or in Africa, and in all except one country hydrocarbons were the most important natural resource. Comparing these figures with the figures on natural resources' share

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<sup>19</sup> Natural resources were also responsible for 20 per cent or more of fiscal revenues in thirteen additional countries.

of GDP suggests that these resources figure more in government revenues than in the overall economy. As we shall see later, this reflects in part a tendency to tax natural resource income at fairly high rates. But before turning to the revenue side, I consider the roles played by governments in generating revenues from natural resources.

The potential roles of governments on the productive side of a resource-rich economy are numerous. For example, governments may contribute to the development of natural resources by promotion of infrastructure development, reducing trade costs, providing a legal framework that allows producers to gain access to labour, physical capital, human capital and technological inputs, and setting labour practices. In empirical research it is often difficult to tease out the relative importance of these different interventions, which come ‘bundled’ differently in different countries.

Even the question of how much a government should ideally invest is clearly a difficult one. Early work by Hartwick (1977) and Solow (1974) defines the amount of investment in produced capital (buildings, roads, knowledge stocks, etc.) that is needed to offset the declining stocks of non-renewable resources. The goal of these investments is to ensure that the standard of living does not fall as society moves into the indefinite future. But given the many routes of public intervention and many potential goals that governments may strive to achieve, it seems difficult to define what good investment policies should be, and how much intervention the government should make, given the private investments. Yet the previous discussion of oil producers’ potential vulnerability to future shocks to the oil sector suggests that governments in resource-rich economies need to be especially prudent, flexible, and forward-looking in considering their investment decisions.

Recent work (Ploeg and Venables 2008) has focused more on assessing the optimal timing path for spending resource windfalls. Yet there is still much that we do not know about investment choices under uncertainty about future resource revenues.

Alongside normative analysis of spending of natural resource revenues, more evidence is needed on how governments actually spend resource income and on whether their spending decisions are affected by the presence of oil revenues. For example, some research suggests that the presence of natural resources may distort investment decisions (Caselli 2007). More evidence is required on the use of natural resource revenues in other settings, and on their contributions to welfare. For

example, while there is plenty of anecdotal evidence that oil money in the Gulf states has raised living standards, the magnitude of oil's contribution is currently unknown.

Another important question regarding the use of government revenues from natural resources is that of who gets to spend them: national governments or local governments? Countries differ in their allocation of revenues from taxes and royalties to the various government bodies. One important challenge is to assess whether payments to local governments are designed to compensate for production or transportation externalities incurred by the producing regions. Or, alternatively, are there political considerations (due to patronage, lobbying or electoral considerations) designed to increase co-operation from local politicians? For example, Brazilian municipalities that received large amounts of oil royalties and tax transfers because they happened to be located near offshore oilfields wasted a lot of this money (Caselli and Michaels 2009), and it is possible that some of the rents accrued to the local politicians.

When it comes to procuring revenues, natural resources are also often more heavily taxed than other forms of economic activity. Higher taxation is sometimes justified by the low elasticity of natural resource revenues and the sense that property rights on the natural resource rents belong to the population at large; this makes economic sense, although the benefits of such high taxation should be carefully weighed against its costs (Boadway and Flatters 1993).

One source of resource revenues for some governments is the auction of licences to extract natural resources from particular locations. In this context, it is important for the government to design auctions to extract rents from producing firms before information about the potential revenues is revealed as clearly as possible (see discussion by Stiglitz in Humphreys et al., 2007).

Once a natural resource industry has developed, the government might be tempted to expropriate it, assuming that this will have relatively little impact on subsequent cash flows, at least in the short run. Expropriation may take on many forms, from increased taxation or fees, through the introduction of new, publicly funded competitors who may be favoured, to placing various arbitrary restrictions on resource-extraction firms that are earning ex-post rents, and finally to outright nationalization. The perceived threat of such actions may be an initial impediment to the development of a resource extraction sector.

The presence of incentives for governments to expropriate or misallocate natural resource income suggests that the challenges for governments are larger in countries with weak institutions.<sup>20</sup> Other recent work also concludes that natural resources may impose costs related to government behaviour, especially in developing countries. For example, abundant natural resources may increase rent seeking (Tornell and Lane 1999; Halvor et al. 2006a, 2006b), patronage and waste (Robinson et al. 2002), or shortened planning horizons due to increased political challenges to power (Caselli 2007). But convincing evidence of a ‘corrupting’ effect of natural resource abundance is difficult to come by. One paper that sheds some light on this issue is the above-mentioned study of Brazilian municipalities (Caselli and Michaels 2009), which uncovers evidence that large oil revenues increase the odds of news and police investigations of alleged criminal activities involving mayors.<sup>21</sup> This evidence suggests that oil money might be more easily ‘stealable’ than other sources, perhaps due to opacity. To mitigate this problem, monitoring of actual oil money disbursement (and not just monitoring of balance sheet records), coupled with improved accountability, may increase the benefits to the population of oil revenues in many resource-rich countries.

Ineffective use of public funds derived from natural resource income is not restricted to corruption and waste. Another potentially severe problem of government budgets that are based in large part on natural resource income is related to commodity price volatility. The resulting volatility in a government’s income stream makes careful planning over the long term difficult. Moreover, rapid and unexpected declines in natural resource revenues may leave governments facing uncompleted projects and investments that have unexpectedly become unfeasible. For example, recent declines in oil prices have forced several oil-rich Middle-Eastern governments to rewrite their budgets. Declines in commodity prices also pose a threat of debt overhang that can cripple resource-rich economies (see Manzano and Rigobón on Latin America in Humphreys et al. 2007).

Sovereign wealth funds (SWFs) offer a possible way to reduce governments’ vulnerability to fiscal volatility that arises from commodity price shocks. If managed correctly, sovereign wealth funds allow governments to smooth the unpredictable stream of revenues from natural resources. These funds also mitigate the above-

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<sup>20</sup> See related discussion in Mehlum et al. (2006).

<sup>21</sup> For more recent evidence on oil and corruption see Vicente (2008).

mentioned risk of strong inflationary pressures during demand booms. But sovereign wealth funds also pose new challenges. For example, can they effectively prevent the use of the funds to promote political goals? Or where should the money be invested, when information on overseas investments is harder to come by? Or can resource booms contribute to asset price bubbles (and busts)? These and other problems related to SWFs may be especially severe in developing countries, due to poor monitoring and transparency. Recent efforts to improve governance of SWFs (e.g. the Santiago Principles of October 2008) are perhaps somewhat counterbalanced by reports that resources from some Gulf states' SWFs (e.g. Kuwait Investment Authority) have been diverted to local use during the recent financial crisis.<sup>22</sup> The emergence of SWFs is a relatively recent phenomenon, so that their usefulness as a government tool has not yet been extensively researched.

Political interactions with the resource-intensive sector are not restricted to issues of the use of funds by SWFs. Some lobbying on the part of private firms interested in developing the resource-intensive sector seems almost inevitable. Close relations between firms and governments, especially when firms are large and well established and information is opaque, can aggravate problems of embezzlement and diversion of rents; beyond the direct losses to the public, the adverse effects on the overall quality and function of politicians and government employees are potentially a serious threat on which we still have relatively little empirical evidence.<sup>23</sup> At the same time, exchanges between private and public players can also bring about useful investments in public goods, such as mapping out the extent of the natural resources and laying out the institutional and physical infrastructure required for the development of the extractive industries. It appears that there may be a gap between the social benefits from such lobbying (which may be high when the resource-intensive sector is underdeveloped) and the private incentives and ability to undertake such lobbying (when the resource intensive industry is already strong and well developed). And empirical evidence on such lobbying may be harder to come by where the problems are particularly severe.

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<sup>22</sup> See Generally Accepted Principles and Practices (GAPP) – Santiago Principles, and Sovereign Wealth Funds Switch from Western Investments, *The Times*, 26 November 2008.

<sup>23</sup> Note that in most oil-rich Middle Eastern countries the largest players in the petroleum industry are state-owned firms, such as Saudi Aramco. But the problems of close relations between firms and governments apply to these state-owned firms as well as to (mostly foreign) private or commonly owned firms.

Alongside lobbying, another challenge for governments in some resource-rich economies is a legacy of inequality. Inequality may be related not only to current technology and institutions (as discussed in the previous section). There may also be, at least in part, a legacy from past episodes of resource extraction or early economic development. Inequality may, in turn, have affected institutional structures or interacted with them. Important examples of such institutions include slavery, poor education systems, or weak law enforcement (see, e.g., Engerman and Sokoloff 1997; Naritomi et al. 2007; and Bobonis 2008). Understanding the legacy of natural resources and its impact on current government performance in different countries remains an important challenge for future research.

The research on the legacy of resource-abundant economies is also related to the broader literature on the long-term effects of colonialism (Acemoglu et al. 2001, 2002). While intervention by foreign powers is often (but not always) subtler today than it has been in the past, its effects can nonetheless be important. Sadly, conflicts and even wars in areas of strategic natural resources (especially in the Middle East and in Africa) have continued to erupt even in recent years.<sup>24</sup> Evidence on the causal effect of natural resources on these conflicts remains difficult to pin down, and more research on this important topic seems warranted.

Just like their foreign policies, the domestic politics of resource-rich economies can be quite complex, even in times of peace. Migration is an issue of particular interest, especially in the Middle East. As discussed above, migration includes highly skilled and specialized workers, who are sometimes Westerners working in developing countries. While numerically small, this group may be politically and economically important and may give rise to considerable political opposition, especially when differences in ideology, religion and customs are substantial. These and other problems might also be associated with immigrants from less developed countries, who are often more numerous. Governments face serious challenges in ensuring the rights of these workers and their living conditions. Moreover, when this group becomes large and remains in the country over prolonged periods of time, some first- (or second-, or third-) generation migrants may seek rights of political representation. The resulting stand-off may make it harder to provide public goods (see, e.g., Alesina et al. 1999) or to develop democratic political

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<sup>24</sup> See, e.g., Collier (2003).

institutions, which may have important consequences for growth and equity. This issue is especially important in many of the smaller Gulf states.

## **5. CONCLUSIONS AND IMPLICATIONS FOR OIL-RICH MIDDLE EASTERN COUNTRIES**

Resource-rich economies face a multitude of challenges in leveraging these resources to improve the lives of their residents today and in the future. Many of the challenges outlined in this paper pertain to oil-rich countries in the Middle East and in the Persian Gulf, and I conclude by highlighting the following six considerations.

First, Dutch disease and the industry structure to which it has given rise (where few tradable goods other than oil are produced) may not be much of a problem today, but it poses a challenge for structural change in the event of oil depletion or technology-driven change in global demand for oil. The challenge here is to combine flexibility in developing new industries if and when the need arises, while ensuring sufficient (and credible) welfare nets for the population.

Second, governments and firms in the Middle East need better-informed strategies for coping with oil price volatility. Formulating such strategies requires carefully thought-out priorities and flexibility in meeting and evaluating them, in the light of the difficulty in relying on SWFs to smooth income flows.

Third, while the economic benefits of allowing many immigrants into the Gulf Region are substantial, dealing with the social and political challenges posed by this massive immigration raises important issues, especially in downturns and in the light of institutional changes towards more public involvement in decision making.

Fourth, there are concerns that oil revenues and reserves are more easily kept secret than other sources of revenue, and that the resulting opacity causes potentially valuable resources (not only due to oil) to be wasted or misused. Institutions should be better designed to address these concerns if oil money is to be used appropriately to improve people's lives.

Fifth, Middle Eastern governments should consider the potential impact of oil beyond their national borders. The strategic importance of oil appears to have fuelled conflicts and wars in the past, and more systematic evidence on the mechanisms that mitigate or aggravate this problem is needed if we are to avoid them in the future.

Finally, the possibility that the use of fossil fuels might be contributing to global warming could hasten the possibility of shifts in technology and demand away

from oil. Such a change may feed back into most of the challenges mentioned above and further aggravate them.

For researchers who wish to examine these and other issues discussed in this paper, many challenges also remain. In particular, many theoretical mechanisms have been put forth for explaining the effect of natural resources on economic performance and development. However, in many cases empirical evidence still lags behind the theory. Getting better data and cleaner identification of various channels of causation in different settings could make a real contribution towards formulating good policies and overcoming the development challenges faced by resource-rich economies.

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