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What Do We Know About Economic Diversification in Oil-Producing Countries?[1]

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Abstract: countries dependent on oil and mineral exports are often advised to diversify their economies, yet surprisingly little is known about how this can be done. This paper reviews the recent literature on diversification in resource-dependent states and suggests it has been constrained by missing and inconsistent data, and a reliance on diversification measures that are relatively uninformative for resource-rich states. It then uses an improved measure of export concentration from Papageorgiou and Spatafora to document three empirical patterns over the last half-century: the divergence between oil-producing states and non-oil states; the reconcentration of exports in most oil and mineral producing states since 1998, caused by the boom in commodity prices; and the heterogeneity of the oil producers, marked by greater diversification in Latin America and Southeast Asia, mixed performances in the Middle East, and greater concentration in Africa and the former Soviet Union. While change in the former Soviet Union was spurred by large new discoveries, the diversification failure of all oil-producing states in both North and sub-Saharan Africa is striking, and stands in contrast to the region's non-oil producers. The paper concludes with a research agenda for deepening our understanding of this issue.

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Introduction

Oil and gas exporting countries are routinely advised to diversify their economies in order to buffer themselves against commodity price volatility, create new jobs outside the resource sector, prepare for future resource depletion, and ward off a broader "resource curse."[3] The drop in oil and gas prices since mid-2014 has led to hardships in many oil-exporting states and triggered a renewed interest in diversification.

Despite its popularity as a policy recommendation, surprisingly little is known about economic diversification. A recent IMF study notes that diversification may be desirable, "but there is only limited analysis as to which aspects of diversification are important, under what conditions it is desirable, and how best to promote it (International Monetary Fund 2014, 6)." Moreover, much of the sparse research on diversification may not be applicable to resource-exporting – particularly oil-exporting – low and middle income countries, who face a distinctive set of challenges.[4]

This paper reviews recent studies of diversification in oil-exporting states and documents broad diversification trends over the last five decades. It suggests that we know relatively little about this issue for two reasons. The first is missing or unreliable data: economic data on oil-exporting states tend to be unusually scarce and some of the existing data are misleading, making it difficult to know the true level of diversification in the domestic economy, and to a lesser degree, in the export sector (Ross 2012). The United Nations Industrial Development Organization (UNIDO) Industrial Statistics database – a widely-used source of manufacturing data – has data on a relatively small number of oil exporting countries. Some oil-dependent countries report impressive growth in their manufacturing exports because their governments misclassify refined oil products as "manufactured goods" (Battaille and Mishra 2015, 16). As McMillan, Rodrik and Verduzco-Gallo (2014) note, employment data by sector – which is necessary to estimate employment diversification – tends to be sparse, inconsistent, and difficult to obtain, particularly in sub-Saharan Africa. Their important analysis, using a cross-national database on employment, value added, and labor productivity disaggregated into nine economic sectors, covers just 38 countries, only seven of them significant oil producers.

The second is that even export diversification – which is easier to measure than other forms of diversification – is typically measured in ways that are noisy or uninformative for oil exporters. Diversification is defined by the IMF as "the shift to a more varied production structure, involving the introduction of new or expansion of pre-existing products, including higher quality products (International Monetary Fund 2014, 10)." Standard measures of export diversification account for three factors: the number of products exported, the number of export markets, and the relative value of each product.

A country whose exports are dominated by a single product whose price is volatile will experience large swings in the value of this product, creating the appearance of large changes in export concentration, even if there is no change in volume of goods exported, the number of exported products, or the number of trading partners. For example, in a period of rising prices an oil exporter will see the fraction of its exports from oil rise, causing its nominal export diversity to fall; when prices fall, the fraction of its exports from oil will also drop and

[3] See, for example, Auty (2001), Collier and Page (2009), Lederman and Maloney (2006), Ross (2012), and Sy, Arezki, and Gylfason (2011).

[4] I use the term "oil" in this paper to refer both to oil and natural gas.

nominal export diversity will rise. Hence changes in an oil exporter's diversification index can be dominated by changes in the global oil price, obscuring changes in the number of products exported or the number of trading partners.[5]

To gain a clearer picture of the challenges facing the oil-exporting countries, I then describe some key patterns among the oil and gas producing countries over the last five decades. I use a dataset developed by Papageorgiou and Spatafora (IMF 2014) that uses data on bilateral trade flows to measure export diversity; the utilization of harmonized data from exporters and importers sharply reduces the incidence of missing (and presumably, misreported) observations. Like other measures it fluctuates mechanically with oil prices, which I display graphically. Recognizing the challenges of causal identification, my analysis is descriptive.[6] To avoid selecting on the dependent variable (by only examining states dependent on oil exports, which by definition are relatively undiversified) it examines the 40 countries that averaged at least $300 in oil and gas income per capita in the most recent twenty-year period (1995-2014).[7]

I document three important trends. The first is that from 1962 to 2010 there was a divergence in export concentration between oil producers and the rest of the world. The pattern is unaffected by the exclusion of the advanced industrialized states, and all states that began production after (or obtained sovereignty after) 1990. By 2010 the fifteen countries with the highest export concentration scores in the world were all oil exporters. If export concentration is only a problem for states with extreme values, and almost all countries with extreme values are oil exporters, then export concentration is almost exclusively a problem among oil-exporting states.

Second, the oil producers moved sharply toward greater export concentration during the recent price boom, much as they had during the price shocks of the 1970s. Only eight states managed to diversify between 1998 and 2010, and four of them did so due to resource depletion or economic sanctions. This underscores the degree to which export concentration levels in oil-exporting states are driven by global price shocks.

Finally, there has been considerable heterogeneity in the diversification trajectories of the oil exporters, which is graphically demonstrated by country plots that display both concentration

[5] Researchers have developed several measures of export diversification to address gaps and inconsistencies in previous measures. Perhaps the most sophisticated is the Economic Complexity Index, which is designed to provide a more complete measure of the complexity of each country's export basket (Hidalgo et al. 2007, Hausmann et al. 2014). Yet even the complexity scores of the oil-exporting states are strongly influenced by changing world oil prices. See, for example, the changing scores of major oil exporters like Algeria, Libya, Oman, Qatar, Saudi Arabia, and Venezuela.

[6] For inferences about the causes and effects of oil dependence, causal identification is especially challenging. Oil dependence is the result of both fixed geological factors and a wide range of policies and institutions that influence both the oil economy and the non-oil economy. According to the voluminous literature on the resource curse, oil dependence may also affect these policies and institutions (van der Ploeg 2011, Ross 2015). But in this case instrumental variables are of limited use. Oil dependence is one of several proximate consequences of large hydrocarbon discoveries – including the expansion of rent-seeking opportunities, rapid growth in revenues and the size of government, the crowding out of the private sector, and changes in trade and security relationships with other countries – any of which may also affect policies and institutions. Hence even if an exogenous instrument has a strong first-stage correlation with oil dependence, it is hard to satisfy the exclusion restriction, which would stipulate that the instrument only affects the outcome by causing resource dependence.

[7] In 2014, 88 countries extracted at least $5 of oil and gas per capita. The $300 per capita threshold is arbitrary, but is meant to distinguish countries where oil is more likely to have economic significance from those where it is less likely.

trends and oil income trends. The trends tend to be regionally clustered: there has been significant diversification in almost all oil-producing countries in Europe, North America, and Latin America; a mixed pattern in the Middle East; and growing concentration among almost all states Africa and the former Soviet Union. The rising concentration in the former Soviet Union can be easily explained by new discoveries in the 1990s and 2000s, but the concentration in all the African oil producers – relative to African non-oil producers – is not.

While I do not attempt to explain these varied outcomes, I show that changes in economic concentration during the recent boom are not strongly associated with obvious factors like population, government effectiveness or government accountability. I also investigate the relationship between diversification and the domestic price of fossil fuels, proxied by a new measure of domestic gasoline prices. In general, cheaper fuel is associated with greater economic concentration, although there is considerable variation around the mean trend.

The remainder of the paper proceeds as follows. The next section reviews recent scholarship on the causes and consequences of oil dependence, as well as common policy prescriptions to reduce it. Section Two contains the empirical description of diversification among the oil producing states, and the final section outlines a research agenda that could help scholars address some key analytical problems.

Past Research

Trade theory is based on the idea of comparative advantage, which suggests countries should specialize rather than diversify. Hence there is no consensus about the value of economic diversification, except in the special case of countries with very high concentration levels. Here I review past studies of the causes and consequences of a specialization in oil exports, and what countries are typically advised to do about it. [8]

The general study of export concentration offers little insight into the special problems of oil-producing countries. An influential study by Imbs and Wacziarg (2003) suggests that low income countries tend to diversify as they become wealthier; beyond some threshold their exports become more concentrated. Although the reasons for this non-monotonic relationship are not clear, it has been confirmed by subsequent studies and become central to the framework for understanding the relationship between diversification and development (Koren and Tenreyo 2007, Cadot, Carrere, and Strauss-Kahn 2011, IMF 2014).

It is unclear, however, whether oil-exporting countries follow a similar pathway: Cadot, Carrere, and Strauss-Kahn (2011) reports that "minerals exporters" (a category that here includes oil and gas exporters) show the same pattern of diversification and reconcentration, with two large caveats: although the non-monotonicity is similar, it occurs at much higher levels of export concentration; and it only applies to countries where minerals make up less than 70 percent of total merchandise exports. These conditions are far-reaching: in 2014, for example, the latter condition would exclude 16 oil-exporting countries. A subsequent study of commodity exporters by the IMF (2014) found no clear pattern of diversification or reconcentration with higher incomes.

[8] I do not attempt to summarize the broader literature on economic diversification, income, and development. For a recent survey, see Cadot, Carrere, and Strauss-Kahn (2013).

What are the causes of oil export dependence?[9]
In a classic Heckscher-Ohlin model, countries with a relative abundance of natural resources will specialize in their export, although it is theoretically unclear whether this should eventually lead to diversification. The Prebisch-Singer hypothesis suggested that low-income countries that specialized in commodity exports were subject to declining terms of trade and unable to diversify (Prebisch 1949, Singer 1950). The staple theory of growth, which was popular in the 1950s and 1960s, suggested that when resource booms occur in low-income regions they subsequently draw in labor and capital, and ultimately spur investment in local value-added industries that bring about diversification (Innis 1956, Watkins 1963).

More recent approaches suggest that a specialization in mineral resources – particularly oil – might become an obstacle to diversification. The most commonly-cited reason is the Dutch Disease, through which cash windfalls can lead to currency appreciation and a loss of competitiveness in other tradable sectors (Corden and Neary 1982).[10] Hence a boom in the extractive sector of a country with a diversified export portfolio will lead to a rise in resource dependence through both a direct channel (an increase in the value of resource exports) and an indirect channel (a decline in the value of non-resource exports). There is strong empirical evidence of the Dutch Disease, and the crowding-out effect can be large: Harding and Venables (2013), for example, find that for each additional dollar of resource revenues, countries tend to see a decrease in non-resource exports of 75 cents.[11]

Hausmann and Rigobon (2003) suggest a second way that oil dependence could be self-perpetuating; in their model, a specialization in resource exports leads to greater volatility, which deters investment in other types of tradable goods and hence exacerbates the dependence on resource sector exports.

Finally, oil might be uniquely hard to diversify from because there are few other products that require similar skills; hence the learning-by-doing that occurs in the oil sector may generate relatively few spillovers into other sectors.[12] This is implied by the framework developed by Hidalgo et al. (2007) and Hausmann et al. (2011), which suggests that countries diversify by moving from products they specialize in to others that require similar capabilities and hence occupy an adjacent "product space." To measure the location of products they use their economic complexity index to capture both the export diversity of the countries that produce it, and the number of countries that export it. The complexity index is designed to indicate how easy or difficult it is for countries that specialize in a given export to diversify into other categories of exports. Crude oil has by far the lowest complexity rating of all products: it shares the fewest characteristics with other products and inhabits the most isolated sector of the "product space," making it the single most difficult category of goods to diversify from.[13]

[9] I use the term "oil dependence" below to denote a specialization in the export of crude oil, refined oil products, and natural gas.

[10] Battaile, Chisik and Onder (2014) develop a model in which the Dutch Disease is heightened by inequality in the distribution of resource rents.

[11] Freund and Pierola (2012) find that surges in manufacturing exports (defined as significant increases that are sustained for at least seven years) are preceded by large depreciations in the real exchange rate that leave it significantly undervalued, which is consistent with a Dutch Disease effect. Still, it is unclear whether the Dutch Disease reduces economic growth; the meta-analysis by Magud and Sosa (2010) finds little convincing evidence of a growth-reducing effect. Matsen and Torvik (2005) argue there may be an optimal degree of Dutch Disease.

[12] Torvik (2001) shows, however, if this assumption is eased and both the traded and non-traded sectors can generate learning spillovers, the result is a depreciation in the exchange rate.

[13] This argument is consistent with the findings of both Ahmadov (2014) and Lederman and Maloney (2012)

Beyond this framework – that oil specialization is initially the result of factor endowments, and then becomes self-perpetuating – a large number of other factors could help explain the degree to which oil-endowed countries remain oil dependent. For example, oil exporters might find it easier to diversify if they have larger domestic markets, which allow local firms to expand, and provide them with learning-by-doing opportunities that allow them to become competitive in world markets. Democratic governments and the rule of law might also help diversification if they make it easier for domestic firms to compete on economic rather than political merit.

Since oil dependence is defined by the relationship between oil exports and non-oil exports, anything that affects the oil and non-oil sectors differently will also affect oil dependence. For example, violent conflict or political instability may cause investment in manufacturing (which is relatively mobile) to flee to other countries, while investment in oil, gas, and mining (which is relatively immobile) remains behind.[14] The result would be a heightened dependence on oil.

Although these theories are testable, empirical studies have rarely tried to explain varied diversification outcomes among resource rich countries. One of the few is Ahmadov (2014), which estimates the effects of variables measured from the period 1960-2000 on export concentration in the 2001-2010 period, using a cross-section of 65 developing states that received at least modest levels of resource rents.[15] It reports that diversification is lower in countries with autocratic institutions, weak rule of law, landlocked or mountainous terrain, and that are located in the Middle East or Africa. In this restricted sample of resource-dependent countries, oil wealth is associated with less diversification, while an abundance of non-fuel minerals, coal, and forest resources is associated with greater diversification.

What are the effects of oil dependence?

More is probably known about the consequences of oil dependence than its causes. Studies of these consequences can be divided into three categories: those that focus on volatility, those that focus on crowding out, and those that focus on broader effects on institutional quality, government accountability, and violent conflict. Many also consider the links among these problems.

Perhaps the most carefully-studied result of oil dependence is macroeconomic volatility. The more concentrated the export sector, and the larger the export sector relative to the domestic economy, the greater the economy's exposure to international price shocks. Oil and minerals tend to have volatile prices due to short-term inelasticities in both supply and demand. Hence a specialization in these commodities, if left unmitigated by policies or institutions, tends to produce macroeconomic volatility.[16]

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that export concentration is more strongly associated with oil than with other primary commodities.

[14] A recent study of foreign direct investment in the Middle East and North Africa between 2003 and 2012 was consistent with this mechanism: it found that political instability had little effect on investment flows into natural resource sectors, but significantly reduced investment flows into non-resource sectors (Burger, Ianchovichina, and Rijkers 2015).

[15] The study instruments for two potentially endogenous variables, trade integration and institutional quality.

[16] Jacks, O'Rourke, and Williamson (2011) show that commodity prices have been more volatile than the prices for services and manufactured goods since at least the 1700s. On contemporary oil prices and price volatility, see Kilian (2008), Hamilton (2009).

Several studies report that resource-based volatility tends to deter investment, which in turn may reduce economic growth (Ramey and Ramey 1995, Blattman, Hwang, and Williamson 2007, Aghion et al. 2006).[17] Van der Ploeg and Poelhekke (2009) decompose natural resource dependence into a direct economic effect, which they report is positive, and an indirect economic effect through its effect on volatility, which they find is negative and much larger. Cavalcanti et al. (2014) looks at the relationship between commodity terms of trade volatility and growth and reports a similar finding.

A small number of studies are less conclusive. Lederman and Maloney (2012) report a strong correlation between extractive exports and terms-of-trade volatility but no robust link to growth volatility. Busch (2011) uses country geographic characteristics to instrument for export concentration, and finds that instrumented export concentration is correlated with terms of trade volatility and export growth volatility but has no clear association with exchange rate volatility.

Resource-based volatility may also have consequences for the quality of governance and public service provision. Oil, gas, and mineral wealth tend to generate significant government revenues, typically out of proportion to their share of GDP (Ross 2012); price shocks in the resource sector hence tend to have large effects on government revenues. How these affect government services depends, in part, on the government's ability to stabilize its revenue flows through other means, like the use of stabilization funds or hedging instruments. At a minimum, revenue volatility places greater demands on the government's fiscal policies. More broadly, revenue instability may help explain why oil wealth has been linked in many studies to higher levels of corruption (Arezki and Bruckner 2011, Sala-i-Martin and Subramanian 2012, Caselli and Michaels 2013), particularly in autocracies (Bhattacharyya and Hodler 2010).

A second consequence of specializing in hydrocarbon exports may be the crowding out of other tradable sectors through the Dutch Disease. The crowding out of manufacturing may be undesirable if it generates greater positive externalities from learning-by-doing than other sectors, and these externalities contribute to human capital accumulation (Krugman 1987). Rodrik (2012) reports that manufacturing industries tend to converge across countries in their labor productivity, which implies that having a large manufacturing sector will help low-income countries grow more quickly. According to McMillan, Rodrik and Verduzco-Gallo (2014), trade openness leads some countries to specialize in raw materials exports, which limits their incentive to diversify into the export of higher-valued products, such as manufactured goods. This may cause the country to forgo the benefits of structural change that come from the transition into export-oriented manufacturing.

Export-oriented manufacturing may also have consequences for gender equity. Sectors differ in their propensity to absorb female labor. In the United States, for example, the sector that is most intensive in female labor is textile manufacturing (Do, Levchenko, and Raddatz, 2016, Table 1). In many other countries, low-wage manufacturing has played an important role in drawing women into the workforce. For example, Morocco's textile industry accounted for three-quarters of the growth in female employment in the 1990s (Assaad 2004). Ozler (2000)

[17] See the review of earlier studies in van der Ploeg and Poelheke (2009). For earlier and more general versions of this argument, see Hirschman (1958), Nurske (1958) and Levin (1960).

and Başlevent and Onaran (2004) find that export-oriented factories in Turkey are more likely to employ women than firms that produce similar goods for the domestic market.[18]

[Table 1 here]

Ross (2008) argues that since oil wealth tends to crowd out export-oriented manufacturing, it also crowds women out of the labor force under some conditions.[19] The reduced presence of women in the labor force, it suggests, also impedes the development of their economic and political rights.[20] Similarly, Do, Levchenko, and Raddatz (2016) find that countries with a comparative advantage in goods that are intensive in female labor (like manufacturing) show more rapid drops in fertility rates.[21]

Finally, oil dependence has been statistically associated with a wide range of undesirable political outcomes, including more durable authoritarian governments, higher corruption rates, and under certain conditions, the outbreak of separatist violence. But it is unclear from both theories of the resource curse and empirical research whether these outcomes are the result of oil dependence *per se* or caused by other attributes of resource wealth (Ross 2012, 2015).

Policies to mitigate oil dependence

Many studies offer policy advice to help oil-dependent countries diversify their economies. The evidentiary basis for these recommendations is necessarily thin, due to the paucity of research.

There are four common themes. First, that hydrocarbon-rich nations should get their fiscal and monetary policies in order (Sachs, 2007; De Melo, Diop, and Marotta, 2011; Gelb, 2012; McMillan, Rodrik and Verduzco-Gallo, 2014; Cherif, Hasanov, and Zhu, 2016). Fiscal discipline can help keep labor costs from rising too quickly, and help avoid the crowding out of private sector investment. Monetary discipline can help achieve long-term price stability and maintain positive real interest rates. Both fiscal and monetary tools can help limit currency overvaluation, smooth consumption, and offset macroeconomic volatility.

Second, they are encouraged to invest in human capital and infrastructure (Sachs, 2007; Collier and Page, 2009; Lederman and Maloney, 2012). Van de Ploeg and Venables (2011), for example, describe the need for capital accumulation as "the fundamental economic problem faced by resource rich economies." Bhattacharyya and Collier (2014) show that

[18] For the case of Tunisia, see White (2001); for the case of South Korea, see Park (1993), World Bank (2007). For the case of the US in the 19th century, see Smuts (1959).

[19] The most important condition may be the (in)ability of women to work in the nontradable sector: a resource boom will only crowd women out of the labor force if they are not able to move into the service sector, which tends to expand with resource booms. Ross also argues that oil windfalls can deter women from joining the labor force by boosting government transfers to families, which can raise unearned household income and hence reduce the family's incentive to generate a second income.

[20] Social theorists have long suggested that joining the labor force has a transformative effect on women's lives; one early proponent was Engels [1884] (2010). Many recent studies support this claim; see, for example, Brewster and Rindfuss (2000).

[21] There is evidence that other types of mineral wealth can also crowd women out of the labor force. A recent study of 874 mining areas in 29 countries in North and sub-Saharan Africa found that the opening of new mines had a similar labor-shifting effect, leading to a rise in jobs for men and a decline in jobs for women (Kotsadam and Tolonen 2016).

resource rich countries systematically underinvest in public capital. Human capital investments can improve labor productivity and help compensate for the absence of learning-by-doing spillovers from the oil industry. Physical capital investment can lower the cost of producing other tradable goods and help attract foreign investment in the non-oil sector.

Third, studies often encourage states to improve their private sector climate. Mazaheri (2016) notes there is a strong correlation between oil wealth and poor conditions for private sector growth. Improving the business climate through regulatory and tax reforms, and reducing legal and administrative costs for small businesses, may help foster sustainable economic diversification (Sachs, 2007; Collier and Page, 2009; Cherif, Hasanov, and Zhu, 2016).

Finally, there is commonly an acknowledgement that beyond some broad policy guidelines there is no one-size-fits-all policy intervention that is likely to succeed. Each country, in each period of its development, will face a unique set of binding constraints, which may range from technical policy challenges to entrenched political relationships. Policy advice must be grounded in a close familiarity with each country's distinctive challenges.

Oil and Export Diversification 1962-2010

To clarify the diversification predicament of oil-producing countries, this section uses a dataset developed by Papageorgiou and Spatafora (International Monetary Fund 2014) to describe trends over the last half century. A more complete analysis might cover other dimensions of economic diversification, including diversification of the domestic economy, employment diversification, and the size of the private sector; unfortunately, data for these phenomena are unavailable or unreliable for a large number of oil-producing countries.

Papageorgiou and Spatafora (hereafter PS) use a Theil index to measure export concentration, but rather than base their data solely on country exports they use bilateral trade flows, at the four-digit SITC (Revision 1) level, from the COMTRADE data base. The use of harmonized export and import data makes it possible to circumvent the missing-data problems that characterize other measures of export concentration, and may provide a check against government misreporting. Their dataset utilitizes 45.3 million observations on bilateral trade values and quantities.

Figure 1 illustrates the advantages of the PS data, using the case of Congo Republic. The blue line shows the PS export concentration measure while the black line shows a commonly- used measure of manufacturing exports (as a fraction of total exports) available in the World Development Indicators. The PS data has no missing observations, while the manufacturing data is missing for 19 of the 31 years. The PS measure shows consistently high levels of export concentration, with a steady rise in the 2000s during a period of rising oil prices and high oil production in the Congo; this is consistent with other reports on the Congolese economy, like the CIA World Factbook (Central Intelligence Agency 2016) and the 2010 IMF Article IV report (International Monetary Fund 2011), which suggest high and unchanging oil dependence. By contrast, the Congolese manufacturing data shows a sudden tripling of manufacturing export shares from 2008 to 2010, which ostensibly gave it a larger manufacturing export share than Brazil or Argentina and is not consistent with data from other sources.

[Figure 1 here]

I focus on the 40 countries that produced on average at least $300 per capita (in constant 2000 dollars) in oil and gas income over the most recent 20 year period, and list them in Table 1. The set of countries is somewhat different from those featured in studies of that employ the IMF's definition of "resource-rich" countries as ones in which oil, gas, or minerals make up at least twenty per cent of either merchandise exports or government revenues (e.g., International Monetary Fund 2012, Ahmadov 2014, Gelb 201x). Since diversification is the outcome of interest, defining the sample by low diversification levels could bias any inferences – for example, by excluding from the sample oil-producing countries that have successfully diversified, and including minor oil producers that have failed to diversify.

Oil producers have diverged from the rest of the world

The first notable pattern is that oil exporters have diversified more slowly than the rest of the world, although this pattern is sensitive to the choice of time frame. Figure 2 shows how export concentration changed for the 38 oil producers as a group since 1962, compared to the rest of the world.[22] Since different countries began production at different times, the trajectory of the full group (dotted gray line) is an imperfect measure, since some members were not oil producers before the 1990s or 2000s. To focus instead on the long-term oil producers, the red line (and all subsequent figures) excludes the eight states that only became significant oil producers after 1990.[23] The blue line includes all other countries.

[Figure 2 here]

The precise trajectory of each group depends in part on the choice of start and end years. Over the full length of the data (1962-2010), the non-oil states saw their export concentration fall from 4.05 to 3.13, a drop of about 23 percent; the oil producers dropped from to 4.2 to 3.97, a drop of about 5 percent. Since most of these 30 states were not producers in the 1960s, a later starting year might be more appropriate. If the comparison begins in 1970, the oil states have not diversified at all; if the starting year is 1980, they diversified at about the same rate as the non-oil states.

Imbs and Wacziarg (2003) show that export concentration first falls, then rises, as countries become richer; this implies that country trends might differ systematically for wealthier, industrialized states. Figure 3 excludes the advanced industrialized states from both groups.[24] While both lines shift upward, they continue to diverge as before, although somewhat less sharply due to slower diversification among the non-oil countries.

[Figure 3 here]

One consequence of this divergence is that highly-concentrated states without oil have found it easier to diversify than highly-concentrated states *with* oil. Figure 4 shows the trajectories of the twenty countries with the highest concentration levels in 1970. The group included eleven current or future oil producers and nine non-producers. By 2010, the eleven oil

[22] The PS data do not cover Brunei or Timor Leste.

[23] This includes the five oil producers that became sovereign after the break up of the Soviet Union (Azerbaijan, Kazakhstan, Turkmenistan, Uzbekistan, and Russia), along with Equatorial Guinea, Suriname, and Yemen.

[24] Excluded states are: Australia, Austria, Belgium Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States.

producers had become the eleven most concentrated states.

[Figure 4 here]

Since the 30 long-term oil producers range widely in their per capita oil income – from just over $300 to more than $15,000 – it is useful to distinguish oil-rich countries from oil-moderate ones.[25] Figure 5 divides the 18 long-term producers with more than $1000 oil income (red line) from the 12 with less (dashed green line). The high-oil group has much higher levels of export concentration, shows greater volatility, and has a flatter line; the low-oil countries are less concentrated than the non-oil countries, and have diversified over time, although somewhat more slowly than the non-oil countries.

[Figure 5 here]

Have the mineral producers followed the same path? Figure 6 shows the diversification trajectories of the long-term oil producers, the mineral-rich states, and the remaining countries of the world.[26] The comparison is imperfect: forty countries have at least $300 per capita in oil income, but only four have at least $300 in mineral rents. Still, it may be noteworthy that from 1962 to 1998 the long-term mineral producers diversified much more quickly than the oil producers, and from 1976 to 2000 were indistinguishable from the rest of the world. But like the oil producers, the commodity price boom after 1998 led to a reconcentration of exports.

[Figure 6 here]

Re-concentration after 1998

There is no ambiguity about the trend of the oil and mineral producers since 1998: they have become sharply more concentrated while the rest of the world has continued to grow more diversified. This should not be surprising: among the oil producers as a group, year-to-year changes in diversification have been closely correlated with year-to-year changes in the price of oil (Figure 7). From 1998 to 2010, the average price of oil rose from $18.47 to $86.41 in constant 2014 dollars (BP 2015).

[Figure 7 here]

It is striking how few oil-producing states have been able to resist this trend. Figure 8 compares export concentration levels in 1998 (X axis) and 2010 (Y axis), for both the oil producers (red) to the rest of the world (blue). The 45 degree line shows where countries lie if their concentration levels were identical in 1998 and 2010; eight oil producers are below the line (more diverse) and 28 above it (more concentrated), while two were unchanged. Concentration for the oil producers rose by an average of .38, while it fell for the non-oil states by an average of .05.

[Figure 8 here]

[25] A country's oil (and gas) income is the volume of oil produced multiplied by the world price, plus the volume of gas produced, multiplied by the world price.

[26] I define "mineral producers" as states that generated at least $300 per capita in minerals rents from 1995 to 2010. Only four states meet this criteria (Australia, Suriname, Zambia and Mongolia). Since Mongolia passed the $300 threshold after 1990, I treat it as a "new producer" and exclude it from the aggregate measure.

Figure 9 offers a closer look at the oil producers. The largest increases in concentration were in Azerbaijan – where production soared, exacerbating the price effect – along with Venezuela, Trinidad, and Russia. Of the eight states that diversified, at least four did so under duress: Iran was subject to economic sanctions, while reserves were depleted in United Arab Emirates, Syria, and Bahrain.

[Figure 9 here]

Variation among the oil producers

The oil producers vary dramatically in both their levels of concentration and changes in these levels. This is partly due to differences in their oil wealth: Figure 10 shows concentration levels in the final year of the data (Y axis) and mean oil income per capita over the previous twenty years. The fitted line shows the positive correlation between oil income and export concentration (along with the 95 percent confidence interval), but with considerable deviation around the trend.

[Figure 10 here]

Countries are placed in one of three categories: "high concentration," meaning the it fell in the top export concentration decile, including the full population of oil and non-oil countries (red dots); "low concentration," indicating it fell in the bottom five deciles (green squares); and "moderately concentration," if it fell between the two, in deciles six through nine (blue circles).

The tripartite division suggests several patterns: all of the advanced industrialized countries are in the "low concentration" category, except for oil-rich Norway, which is moderately concentrated; all of the African states – both North and Sub Saharan Africa – are "highly concentrated." Latin American and Middle Eastern states are scattered across all three categories.

Figures 11, 12, and 13 show changes in diversification over time for the 30 long-term oil producers, displaying export concentration on the left vertical axis and oil income per capita (log) on the right vertical axis. Among the ten highly-concentrated countries (Figure 11), export concentration and oil income fluctuate in tandem, except in three case where concentration remains high even when oil income dips (Nigeria, Angola, and Gabon). There are no highly concentrated long-term producers that show a clear diversification trend, by definition.

[Figures 11a-c here]

Among the nine moderately concentrated long-term producers (Figure 12), there are apparent diversification trends in four states (Qatar, Iran, Oman, and Colombia), all of which would have been classified as highly-concentrated in the past. Several of the other states may also be characterized as "diversifying" although the patterns are less obvious. Among the eleven less concentrated producers (Figure 13), three have transitioned from "moderately concentrated" in the 1970s and early 1980s to "less concentrated" by 2010 (Malaysia, Bahrain, and New Zealand), while the others have been less concentrated since at least the beginning of the 1970s.

[Figures 12a-c here]
[Figures 13a-c here]

Figure 14 shows the pathways of the remaining eight countries, which began production after 1990 and have had less time to adjust to their oil income. These new producers include the five oil exporters that became sovereign after the break up of the Soviet Union (Azerbaijan, Kazakhstan, Turkmenistan, Uzbekistan, and Russia), along with Equatorial Guinea, Suriname, and Yemen. Three of them are highly concentrated (Azerbaijan, Equatorial Guinea and Yemen), four are moderately concentrated (Kazakhstan, Turkmenistan, Russia, and Suriname), and one is classified as less concentrated (Uzbekistan). In six of the eight countries, the impact of their oil booms on export concentration is apparent; the two exceptions are countries that had relatively high levels of export concentration before they were oil producers, and produce only modest amounts of oil (Uzbekistan, Suriname).

[Figures 14a-b here]

The consistently high concentration levels of the African oil producers – in both North and sub-Saharan Africa – is especially striking. One possible explanation is that the failure to diversify is characteristic of the whole region, suggesting the oil producers are no different from their non-oil producing neighbors. This is not the case: Figure 15 compares the long-oil producers in sub-Saharan Africa to the region's non-oil producers. Export concentration has declined among the non-oil producers, but risen among the oil-producers. Interestingly, the African minerals producers are not diverging from the rest of the region: Zambia, South Africa, and Mauritania have all been diversifying over time.[27]

[Figure 15 here]

Correlates of change

Countries might find it easier to diversify if they have larger populations (if their larger domestic markets and greater human capital give rise to firms that can compete internationally), more effective governments (if they provide better public goods, which would encourage private sector development), and more accountable governments (if their interventions in the market are less arbitrary [Wiig and Kolstad 2012, Malik 2016]). Can these factors help explain why diversification trends vary so much across countries?

The simple answer appears to be either "no" or "not very much." Figure 16 shows all countries, both oil producers (red dots) and non-oil producers (blue circles), according to how much their export concentration changed during the period of rising prices (1998-2010), and the log of their population. For both oil and non-oil states, larger populations are weakly associated with less concentration.

[Figure 16 here]

In Figure 17, countries are plotted by their average "government effectiveness" score; for the oil producers (but not other states), effective governance has at best a weak association with

[27] The PS data do not report export concentration scores for the region's fourth minerals producer (using the same $300 per capita threshold), Botswana.

less concentration. Similarly, there is a slight negative correlation between government accountability and less concentration, for the oil producers only (Figure 18).[28] In simple cross-country OLS regressions, each of these factors is positively associated with reductions in export concentration among the oil producers, but none of the correlations are statistically significant.

[Figure 17 here]
[Figure 18 here]

Fuel prices and diversification

Do local fuel prices affect a country's success with diversification? To address this question I use data from Ross, Hazlett and Mahdavi (2017) on retail gasoline prices as a proxy for energy prices more generally. The gasoline price data are only available for the 2003-14 period, so I compare the average gasoline price across the 2003-14 period with the change in concentration.

Figure 19 shows the gas price and change in export concentration data for all countries, with the oil producers marked in red; the oil states tend to have markedly lower gasoline prices than the non-oil states. For both sets of countries, higher fuel prices are (weakly) associated with reduced concentration.

[Figure 19 here]

Still, there is considerable variation in outcomes among the oil exporters, displayed in Figure 20. In general, the countries with cheaper fuel also moved more strongly toward export concentration, notably Venezuela, Azerbaijan, Kazakhstan, Trinidad, and Saudi Arabia. There were a few countries that defied the trend – including Iran, Bahrain, and Uzbekistan – although none seem like good diversification models for other oil-producing states.

[Figure 20 here]

Conclusion and future priorities

We know surprisingly little about economic diversification among the oil-exporting states, despite its prominence as a policy goal. This paper suggests past research has been hindered by poor and scarce data, and a reliance on indicators that fluctuate mechanically with oil prices and are hence minimally-informative for oil-dependent states.

It also shows that oil-dependent states have increasingly had extreme levels of export concentration, and are hence the states for whom high-quality data is most important.

It also describes unconditional diversification trends among 38 of the 40 states with the highest per-capita oil and gas income flows. Over the last half century, these states have diverged from the rest of the world, diversifying more slowly or in some cases not at all. This is illustrated by the heightened concentration of fuel exporters at the top of the distribution: in 1998, they made up 8 of the 15 states with the most concentrated exports; by 2010, they made up 15 of the top 15 states. The oil producers have become the most highly-

[28] Since export concentration levels are not problematically high for the most non-oil states, it is unclear whether good governance or accountability should be associated with changes in their export concentration. Measures of both "government effectiveness" and "voice and accountability" are taken from the World Bank's World Governance Indicators, and I use the mean score for each country for the period 1996-2010.

specialized states in the global economy, and hence the most vulnerable to large price shocks.

The price boom that began around 2000 exacerbated this trend, causing about three-quarters of the oil producers to become more concentrated, regardless of the size of their populations or the quality or accountability of their governments.

Heightened concentration is not necessarily an indication of bad policymaking: states that experienced large increases in oil and gas production – like Equatorial Guinea, Chad, Iraq, Timor Leste and the oil-exporting states of the former Soviet Union (Russia, Azerbaijan, Kazakhstan, and Turkmenistan) – necessarily grew more concentrated, and oil and gas came to dominate their exports. Some well-governed long-term producers – like Malaysia, Norway, and Canada – tolerated high concentration levels during the price boom to capture the available rents.

Still, over the longer term, a non-trivial number of oil producers – in Latin America, the Middle East, and Southeast Asia – have become more diversified. Some of these diversifiers may hold important lessons for the other oil-producing states. The oil producers of both North and sub-Saharan Africa have uniformly failed to diversify and are of special concern.

There are several projects that could help address the gaps and move the literature forward.

Data Gaps

Even with the Papageorgiou-Spatafora data, it is difficult to measure and diagnose diversification success or failure when the data are relatively weak. Constructing more complete data for the oil-exporting states would give scholars and policymakers a more reliable picture of the diversification landscape and enable them to better estimate the factors associated with both success and failure. It could also attract new scholars to a topic whose real-world importance dwarfs the attention it receives from social scientists.

There would be special value in addressing five data gaps:

a. Bringing missing oil-exporting countries into the data by mining alternative sources – particularly for data on domestic diversification, such as employment by sector, manufacturing and manufacturing value-added, and entrepreneurship.
b. Correcting misclassified oil products. According to Bataille and Mishra (2015), several countries report improvements in their manufactured exports only because they misclassify processed petroleum products. Fixing these errors would allow us to better distinguish between true and untrue stories of successful diversification.
c. The development of fuel price-corrected measures of diversification, to allow distinctions between nominal diversification (which may be driven by fluctuating oil prices) and the export of new product lines.
d. More complete and accurate measures of domestic diversification, including employment diversification and the size of the non-extractive private sector.
e. Data on service sector performance, including the trade in services. As Bataille and Mishra (2015, 5) suggest, “a key question for (resource-rich economies) is how sustainable any service sector growth is, and how it links to other sectors of the economy, especially if it is driven largely by consumption of resource rents versus a more sustainable move to more modern sectors.” Conceivably the service sector could provide oil-exporting states with an alternative route to diversification; if service sector growth is driven largely by consumption of resource rents, however, the

diversification would be illusory. These and other critical questions could be addressed by obtaining firm-level data, and building on newly-available service sector data (e.g., Eichengreen and Gupta 2013, Loungani et al. 2016).

Improved measures would be especially valuable to deploy in studying the Sub-Saharan African countries whose diversification records are strikingly different from countries in other regions. Of special interest are Nigeria, Angola, and Congo-Brazzaville, all of which have export concentration levels significantly higher than might be expected from their per-capita oil endowments. While the policy challenges of these states have been studied extensively, obtaining data that is comparable across a significant number of oil-producing states will facilitate a more rigorous comparative analysis.

Causal identification

The causes and consequences of economic diversification have been particularly difficult for scholars to study because of the aforementioned challenges of causal identification. There may be no easy solutions, but any research agenda on this topic should pay close attention to this problem and look for innovative ways to address it.

Hydrocarbons and Gender Specific Diversification

Ross (2008) shows how oil production can crowd out female labor force participation through two channels, one that reduces the demand for female workers, and a second that reduces the supply of women choosing to enter the labor force. While it does not consider the implications for economic diversification, it may nonetheless have important consequences. Low income countries often develop their manufacturing sectors by relying on low wage female labor, and any mechanisms that reduce their supply may also inhibit the development of an export-oriented manufacturing sector. New data on sectoral employment by gender has become available, which could make a disaggregated look at oil, gender, and export diversification fruitful. Moreover, any findings on this topic could have significant policy implications: while some factors that inhibit export diversification (like the Dutch Disease) are difficult to change, policies that help bring women into the labor force are more tractable.

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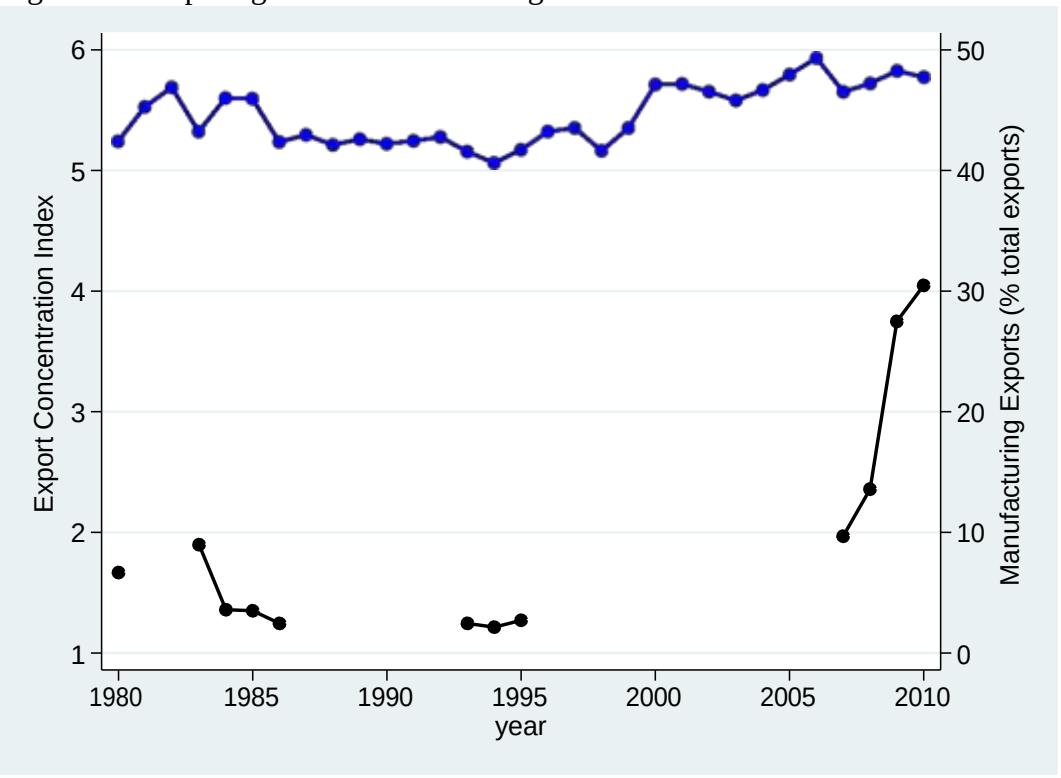
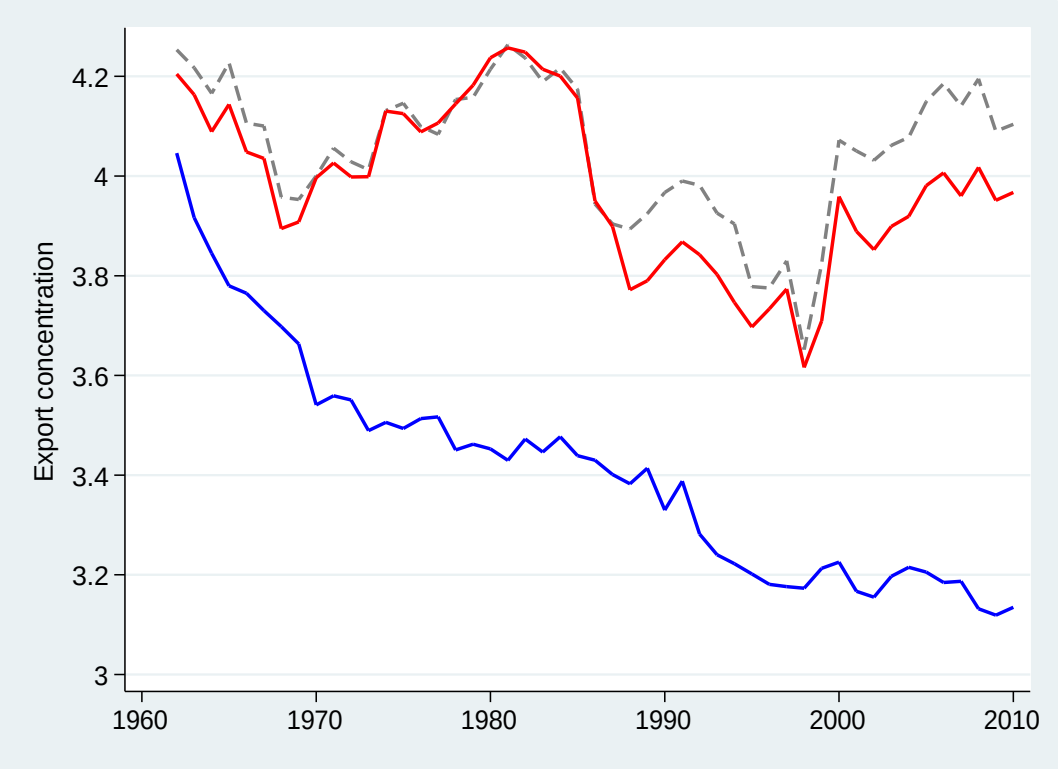
Figure 1: Comparing data sources on Congo Brazzaville



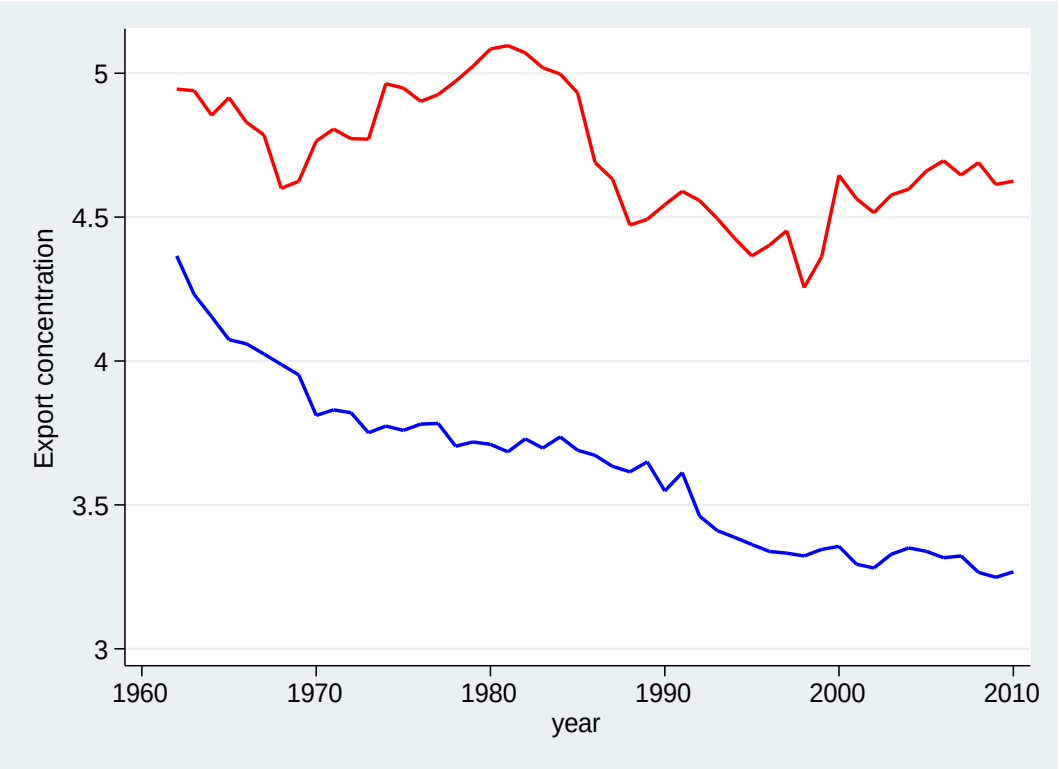
Sources: IMF 2014, World Bank 2016

Figure 2: Export concentration in the oil producers and the rest of the world



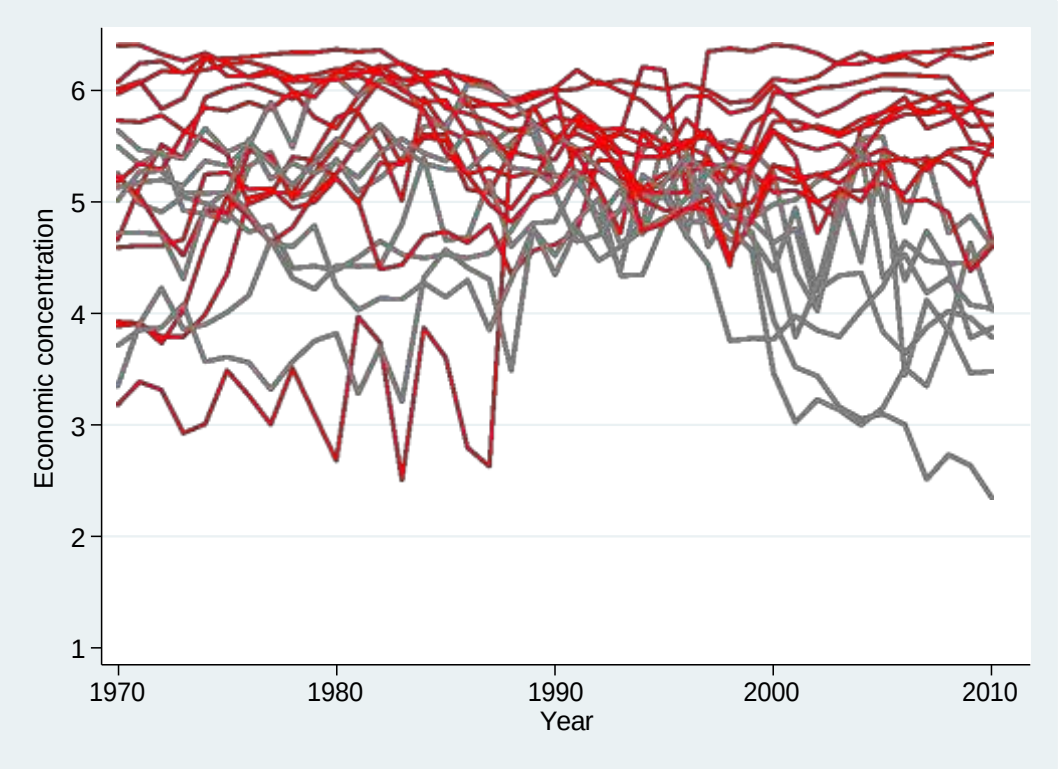
Note: the gray line includes all 38 oil producers, the red line includes only the 30 long-term producers, and the blue line includes all other states. Source: IMF 2014, Ross and Mahdavi 2015.

Figure 3: Export concentration in the oil producers and the rest of the world, excluding advanced industrialized states



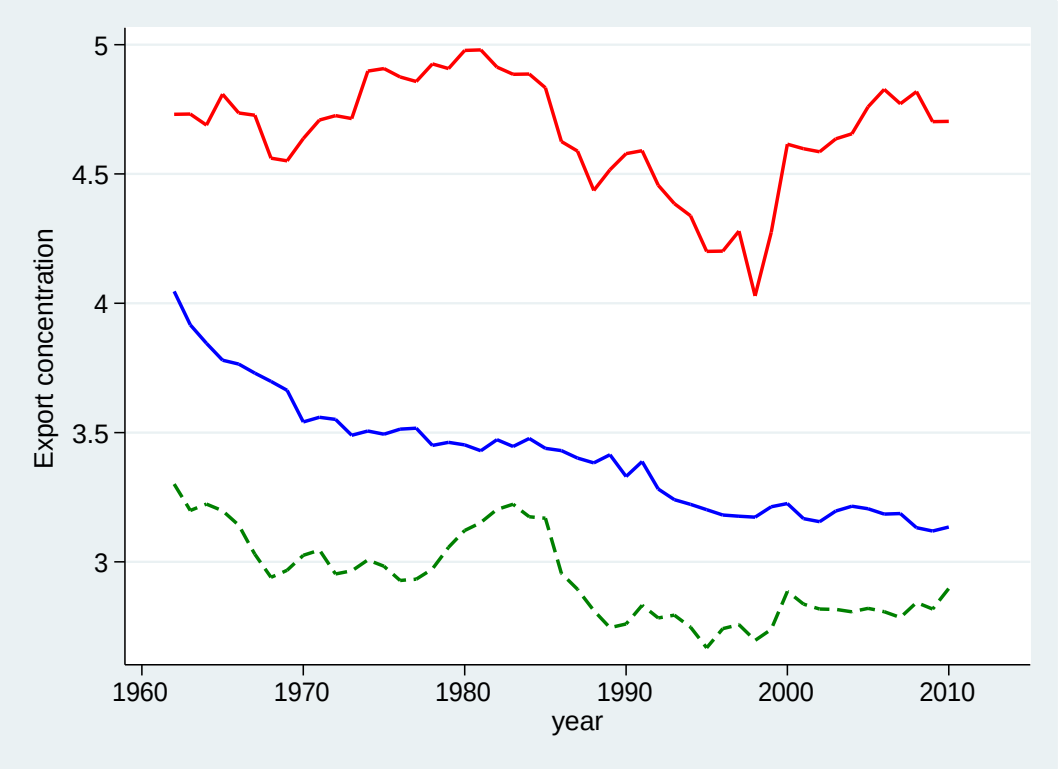
Note: the red line includes the 30 long-term producers, and the blue line shows all other states, after the advanced industrialized states have been removed from both groups. Source: IMF 2014, Ross and Mahdavi 2015.

Figure 4: Top 20 countries in export concentration in 1970



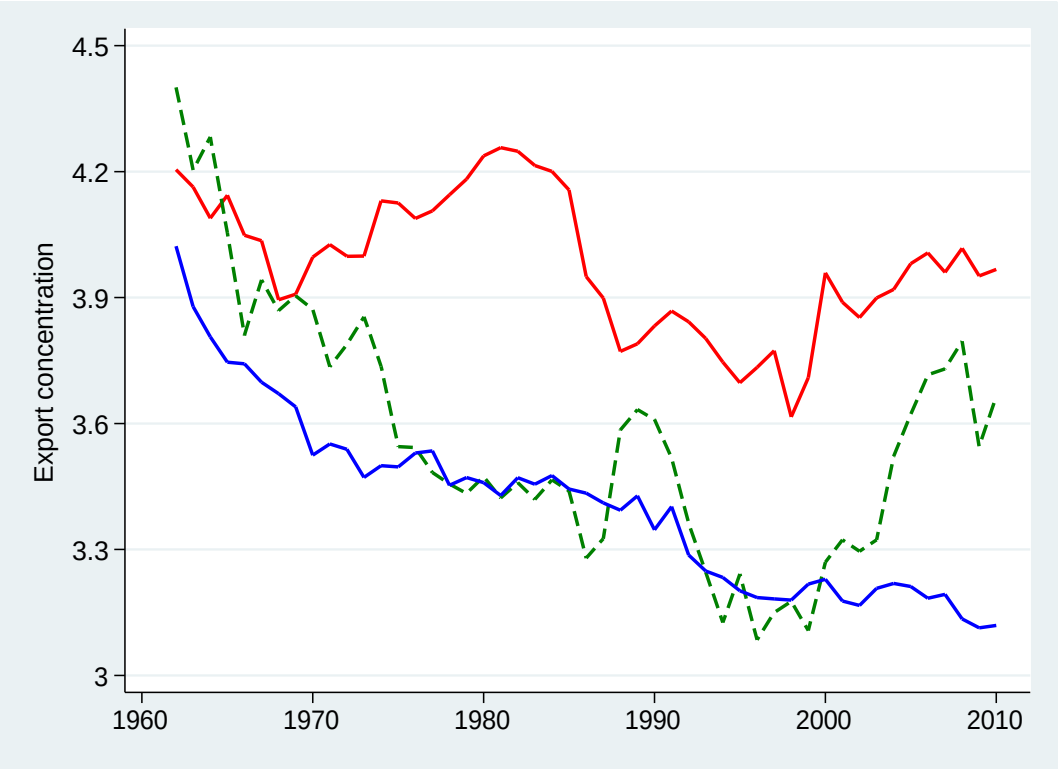
Note: the red lines indicate the country were or became significant oil producers (generating at least $300 per capita in oil and gas income from 1995 to 2014). The gray line show non-oil producers. Source: IMF 2014, Ross and Mahdavi 2015.

Figure 5: Export concentration in oil-rich states, oil-moderate states, and the rest of the world



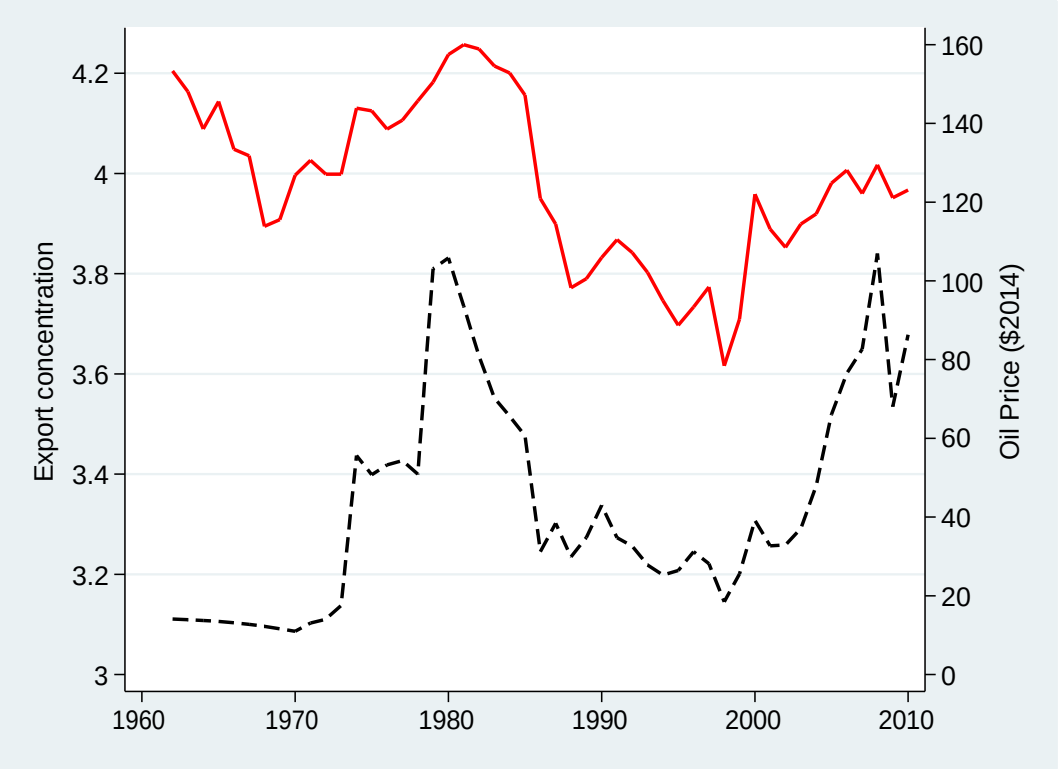
Note: the red line shows the 18 countries with high oil income (>$1000 per capita), the dashed green line shows the 12 countries with moderate oil income ($300-1000 per capita), and the blue line shows all other countries.

Figure 6: Export concentration among the oil producers, minerals producers, and the rest of the world



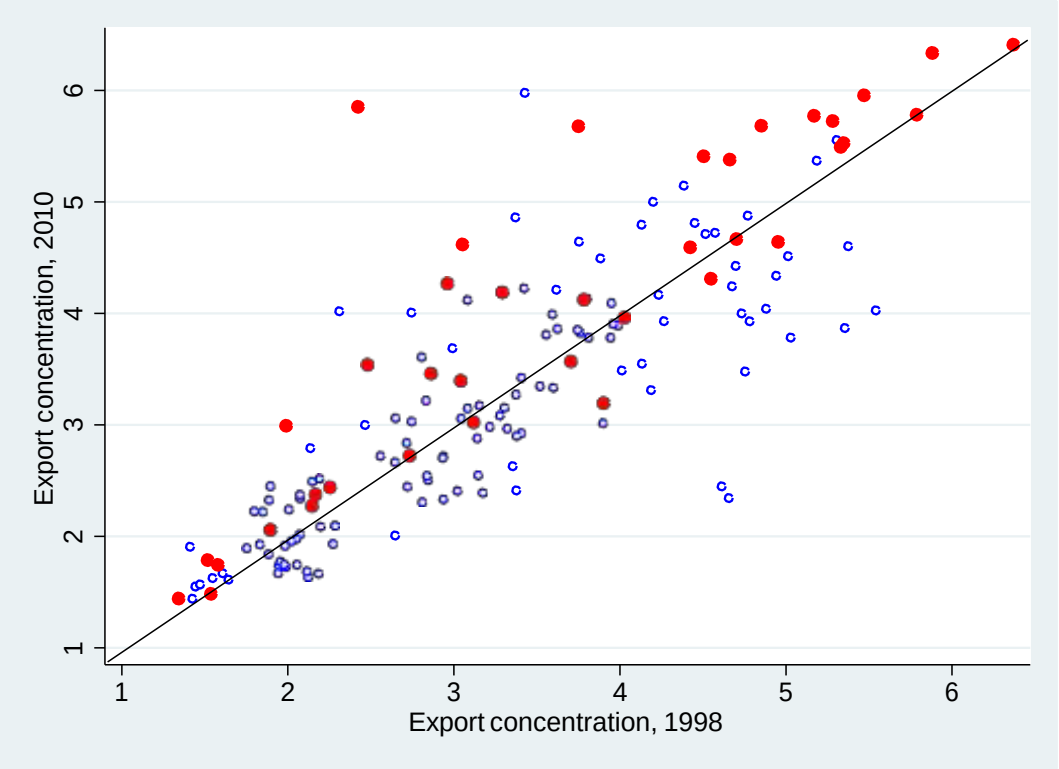
Note: the red line includes the 30 long-term producers, the dashed green line shows the three minerals producers, and the blue line shows all other states. Source: IMF 2014, Ross and Mahdavi 2015, World Bank 2016.

Figure 7: Export concentration in the oil producers and the real oil price



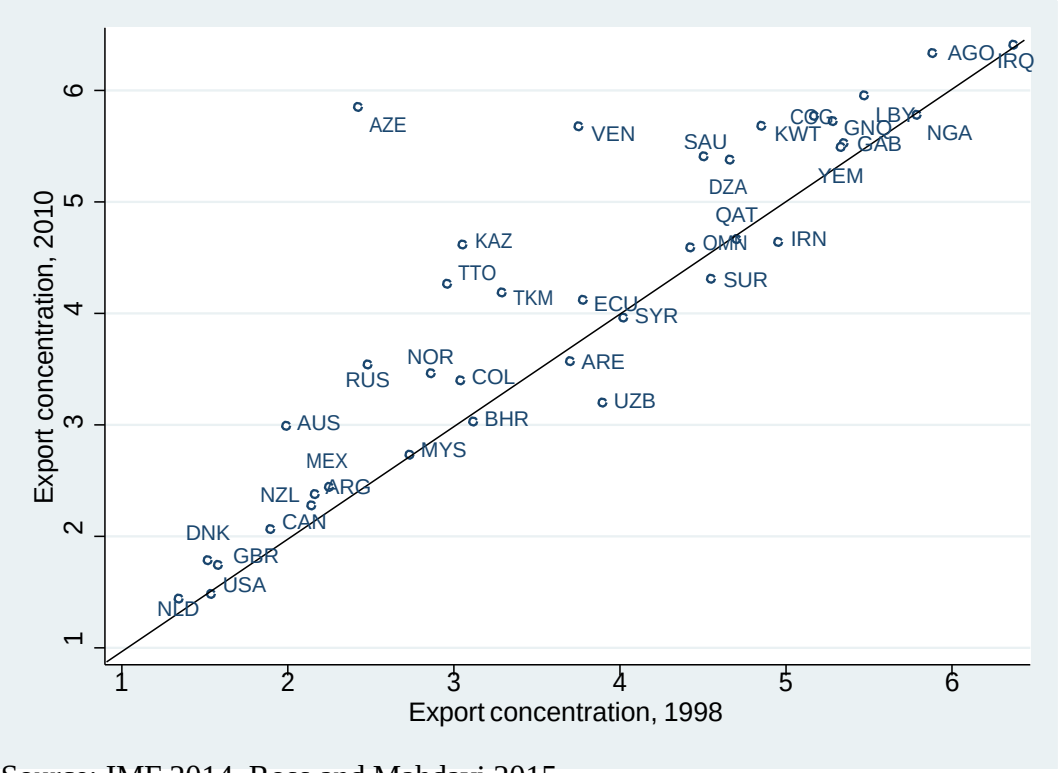
Note: the red line includes the 30 long-term producers (right axis) and the dashed black line shows the real oil price (right axis). Source: IMF 2014, Ross and Mahdavi 2015, BP 2015.

Figure 8: Export concentration in 1998 and 2010



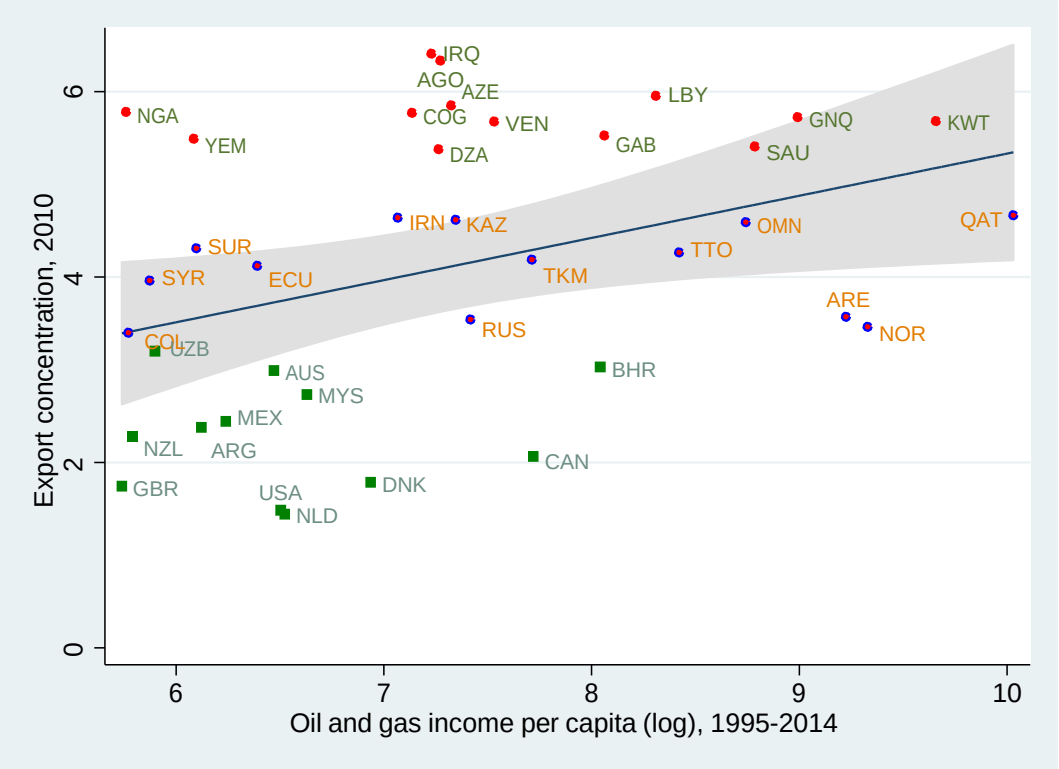
Oil producers are represented by red dots and non-oil producers by blue circles. Source: IMF 2014, Ross and Mahdavi 2015.

Figure 9: Export concentration in 1998 and 2010 (oil producers only)



Source: IMF 2014, Ross and Mahdavi 2015.

Figure 10: Export concentration & oil income per capita (oil producers only)



Countries are colored according to their export concentration decile (where deciles are calculated using both oil and non-oil states). Countries in the top decile are marked with red dots, countries in deciles six through nine are marked with blue circles, and countries in the bottom five deciles are marked with green squares. Source: IMF 2014, Ross and Mahdavi 2015.

Figure 11a: Export concentration and oil income trends for high-concentration countries

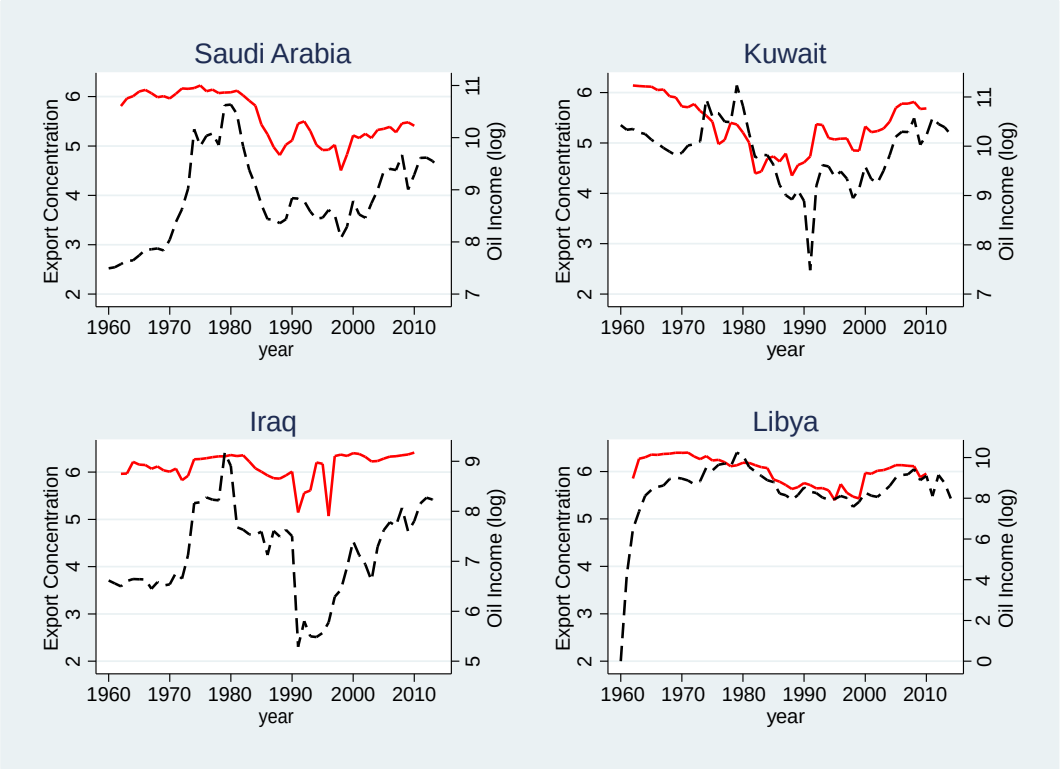


Figure 11b: Export concentration and oil income trends for high-concentration countries

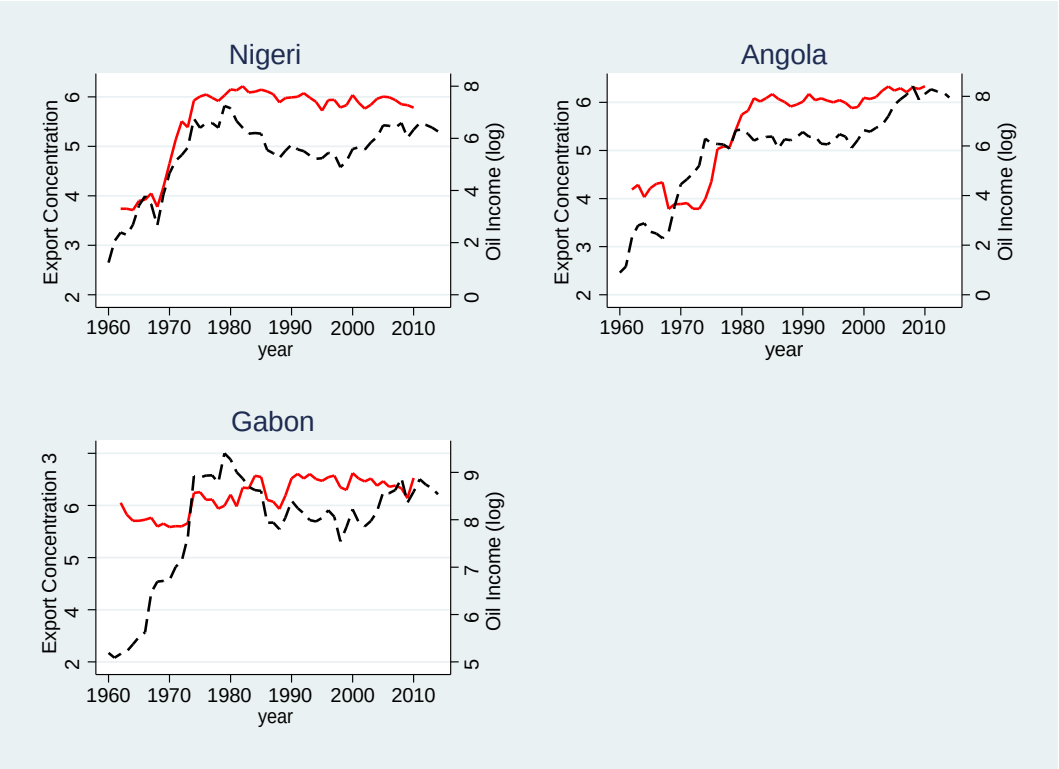
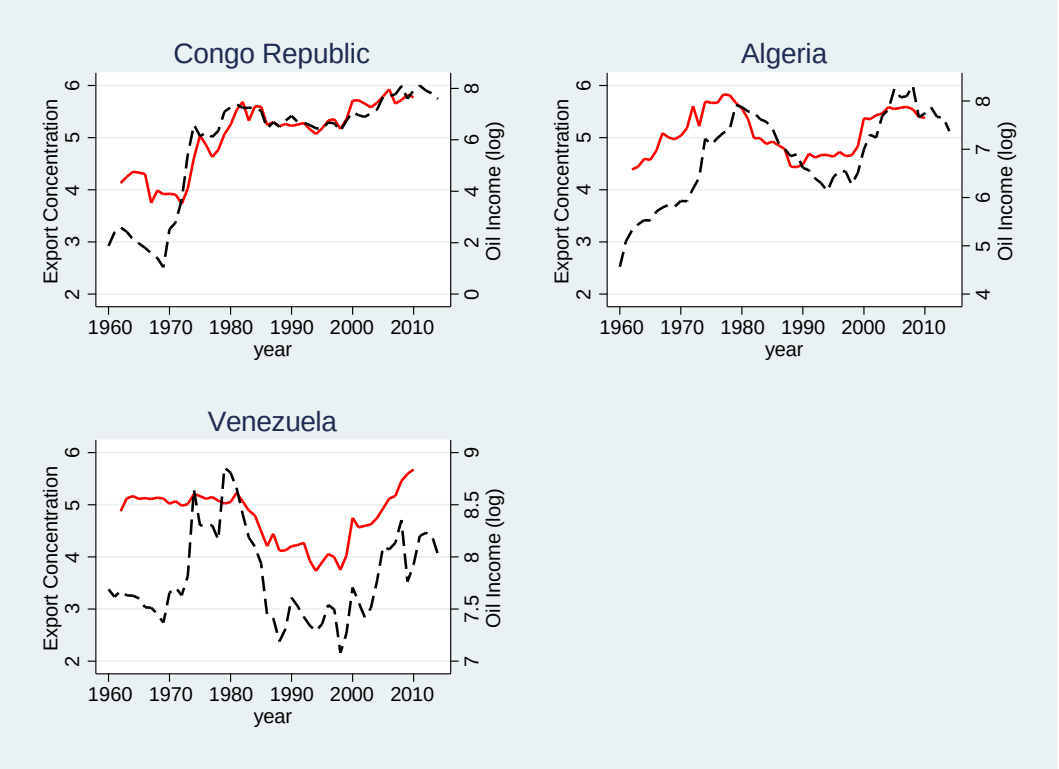


Figure 11c: Export concentration and oil income trends for high-concentration countries



Source: IMF 2014, Ross and Mahdavi 2015, BP 2015.

Figure 12a: Export concentration and oil income trends for moderate-concentration countries

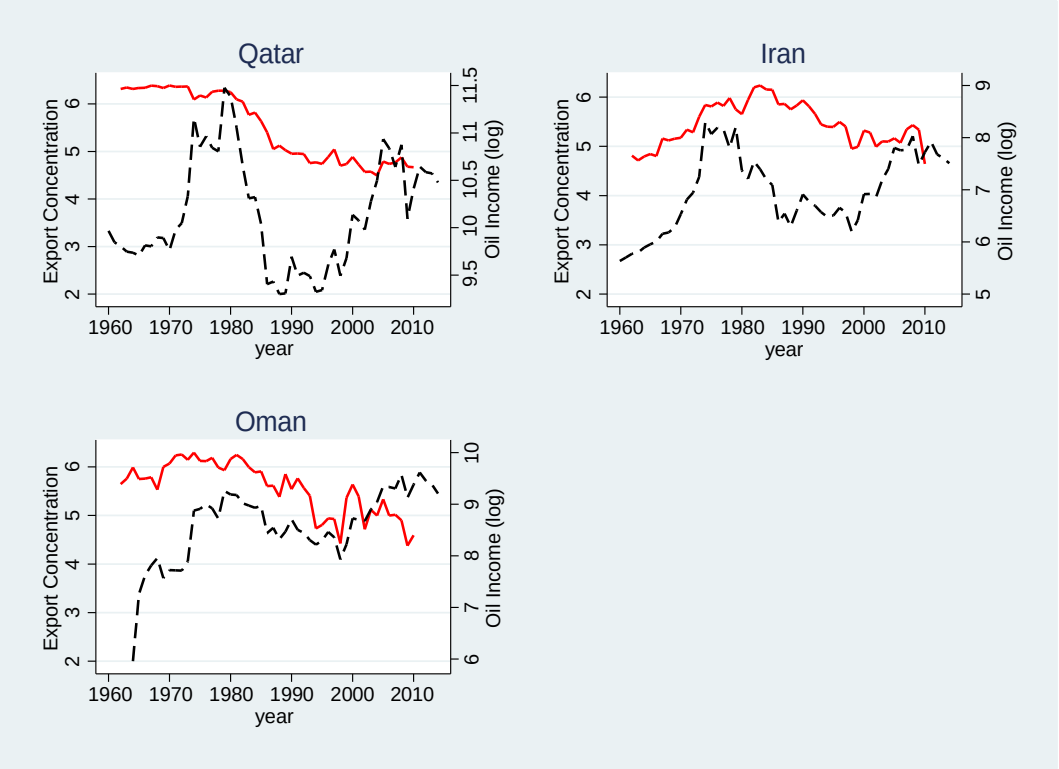


Figure 12b: Export concentration and oil income trends for moderate-concentration countries

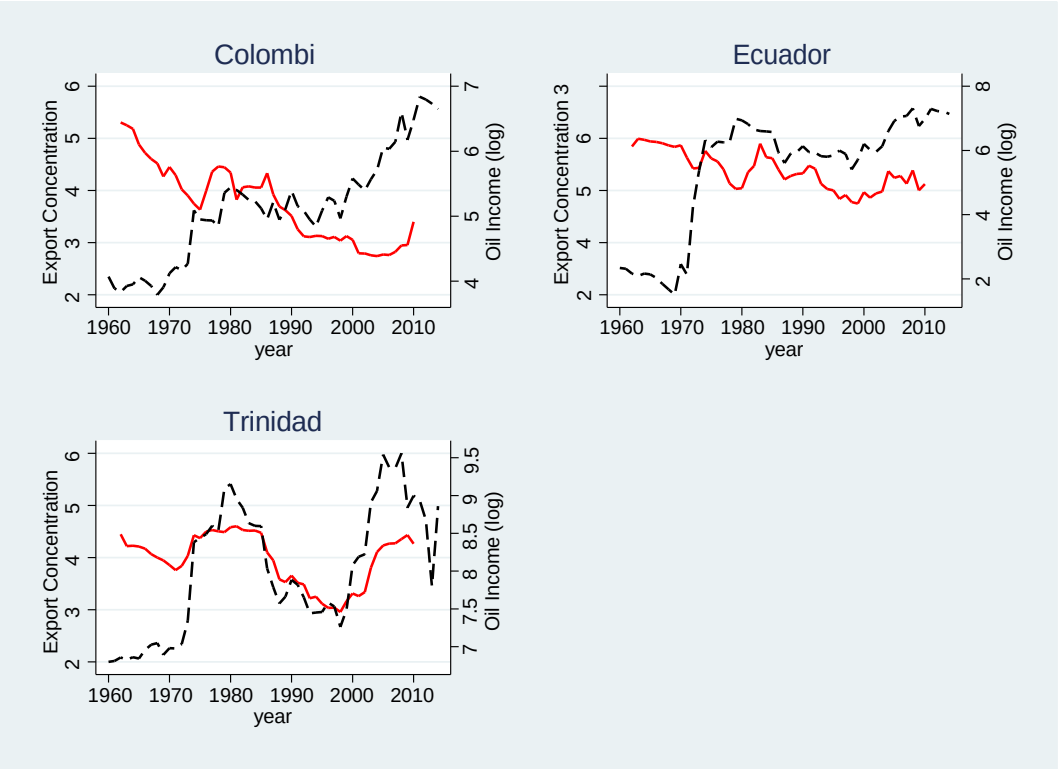
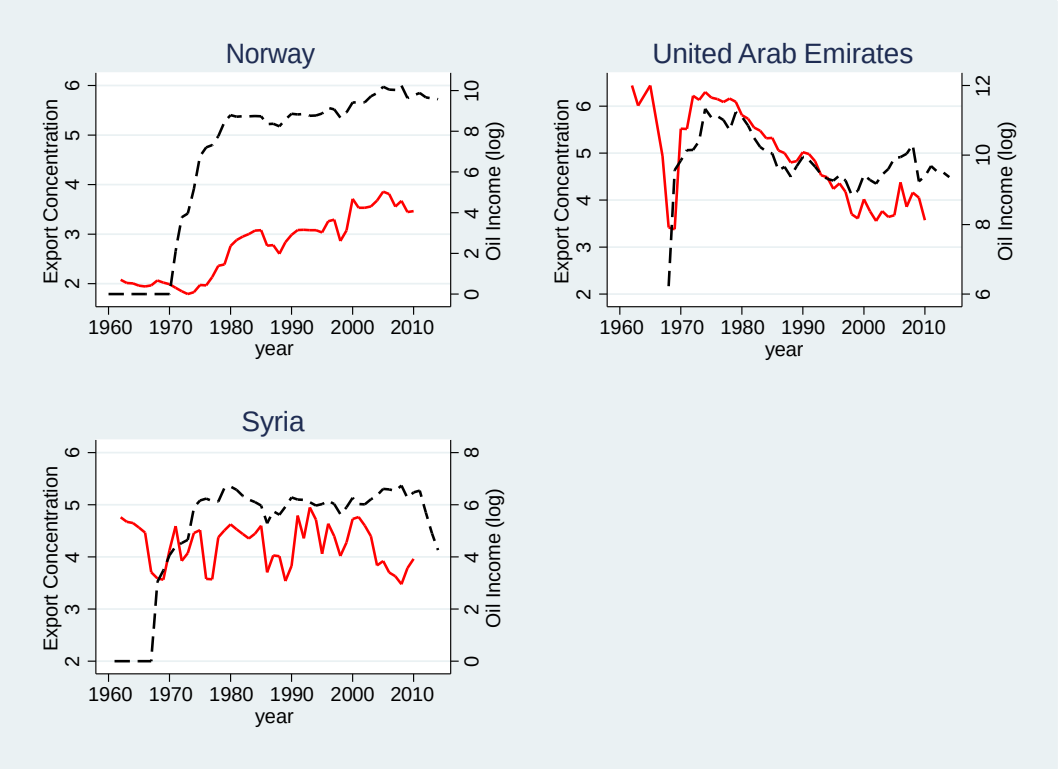


Figure 12c: Export concentration and oil income trends for moderate-concentration countries



Source: IMF 2014, Ross and Mahdavi 2015, BP 2015.

Figure 13a: Export concentration and oil income trends for low-concentration countries

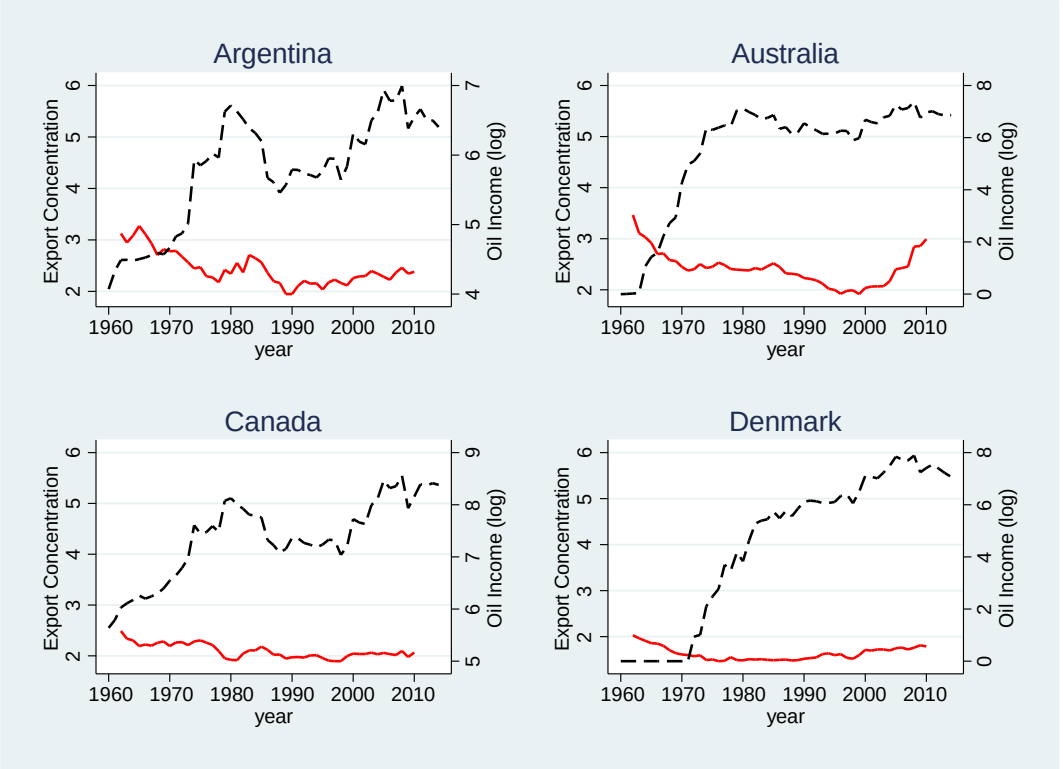


Figure 13b: Export concentration and oil income trends for low-concentration countries

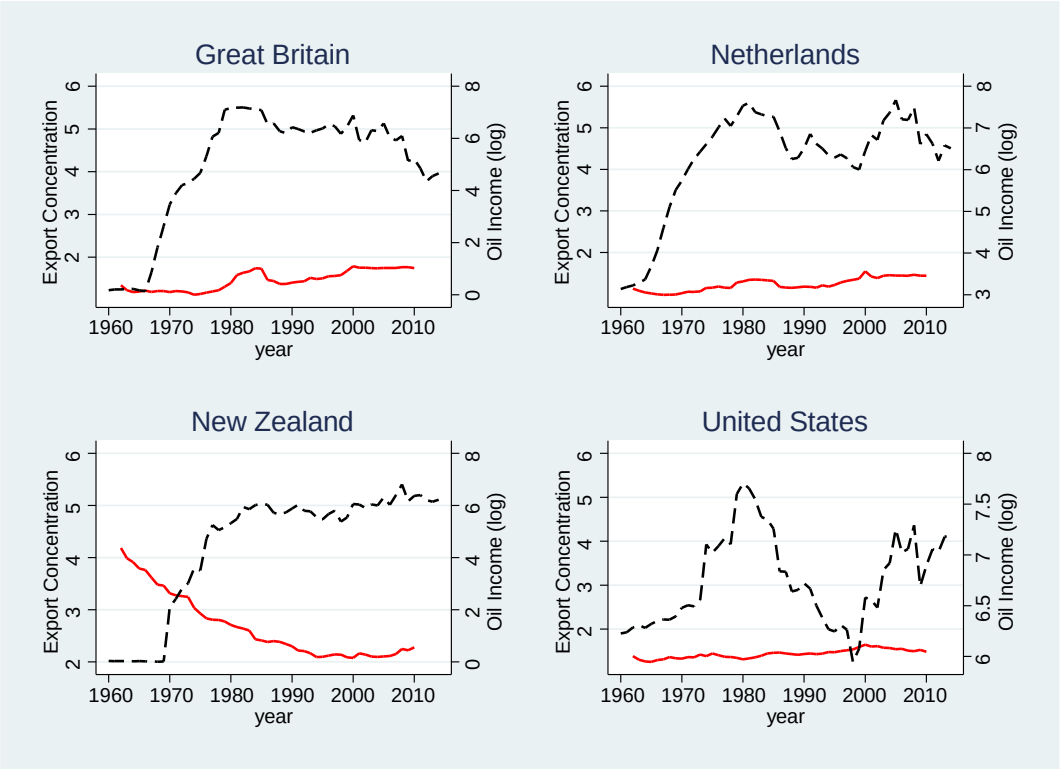
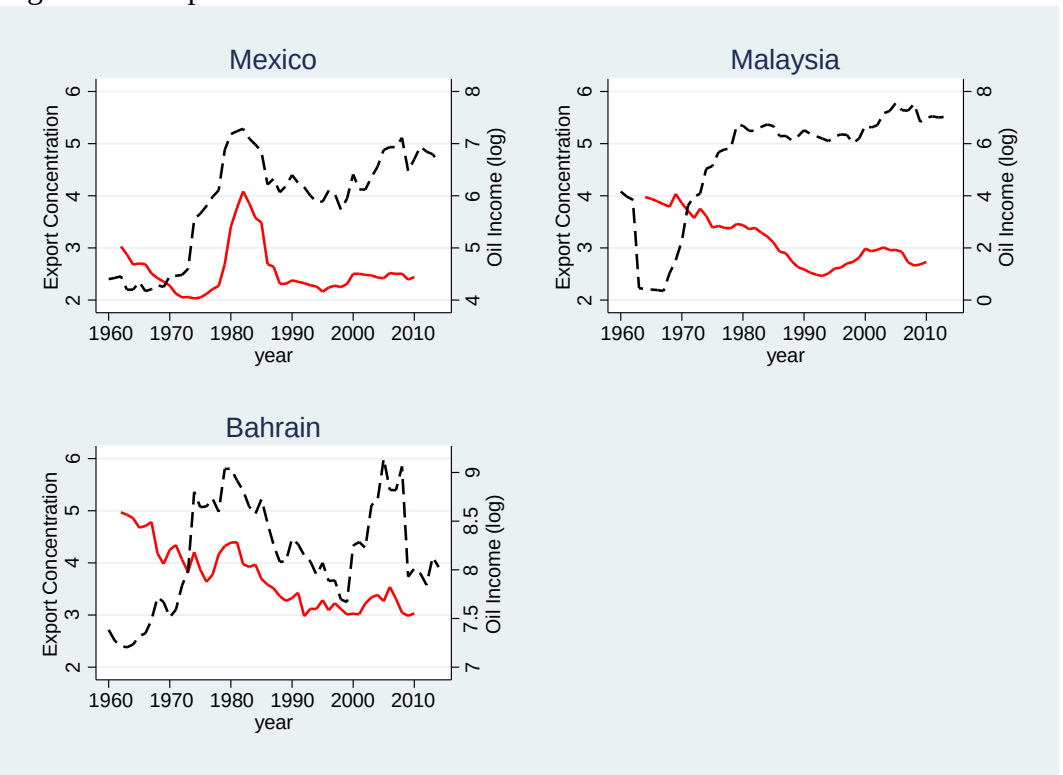


Figure 13c: Export concentration and oil income trends for low-concentration countries



Source: IMF 2014, Ross and Mahdavi 2015, BP 2015.

Figure 14a: Export concentration and oil income trends for newer oil producers

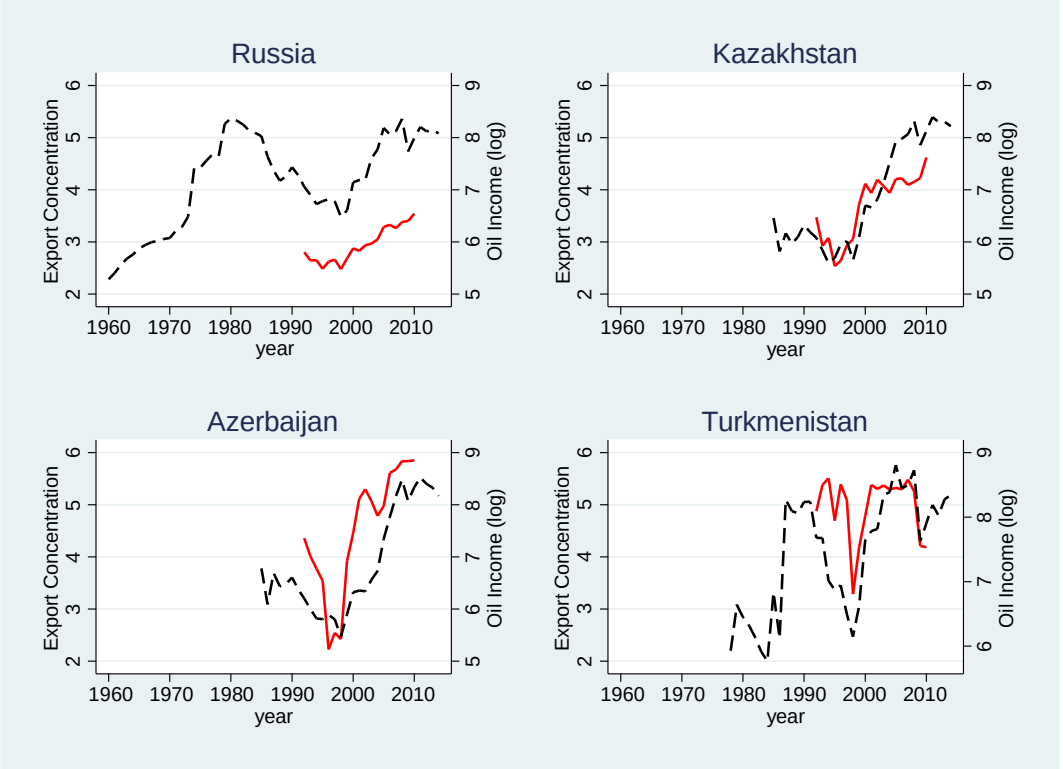
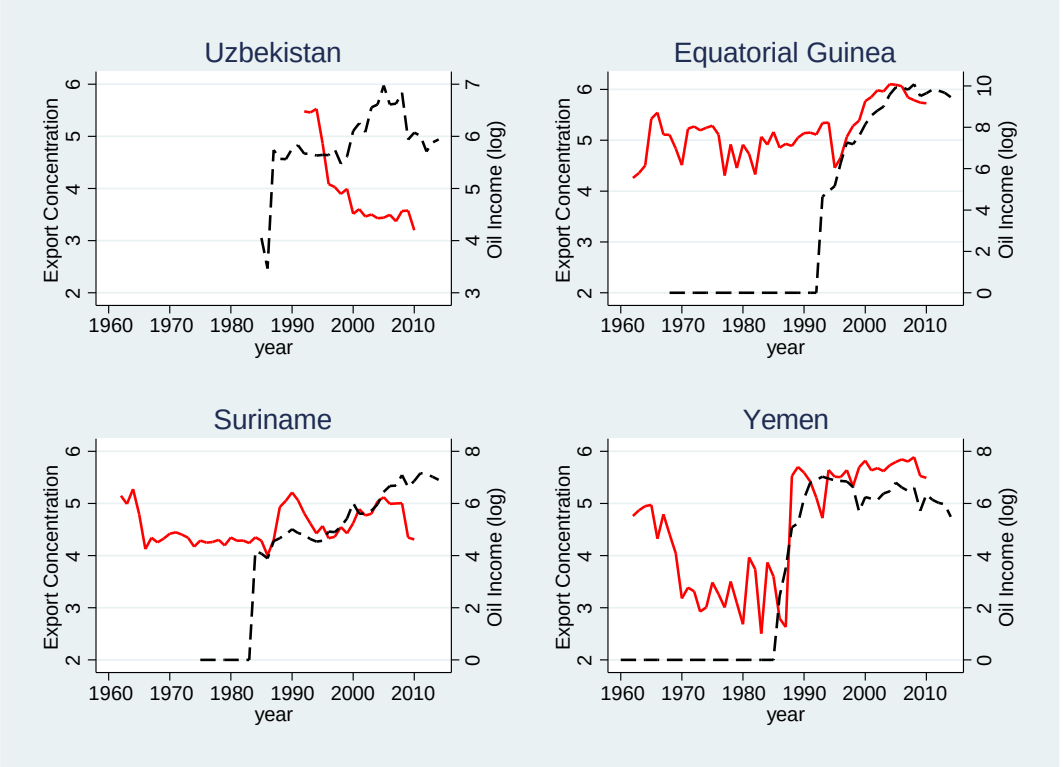
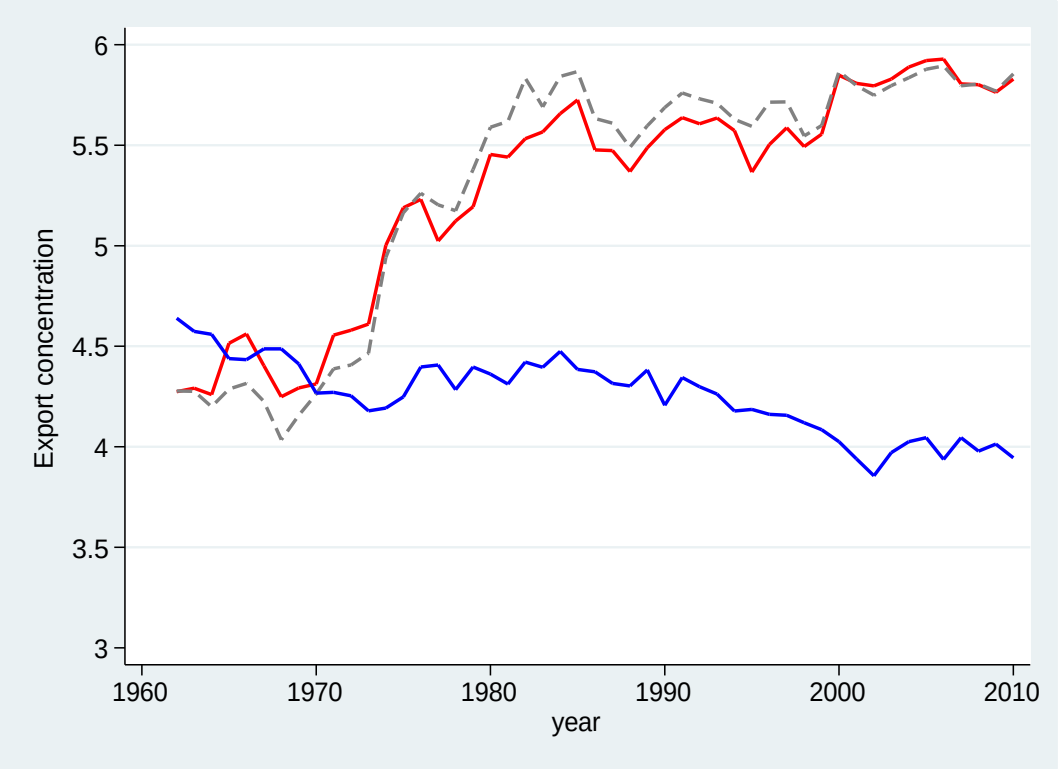


Figure 14b: Export concentration and oil income trends for newer oil producers



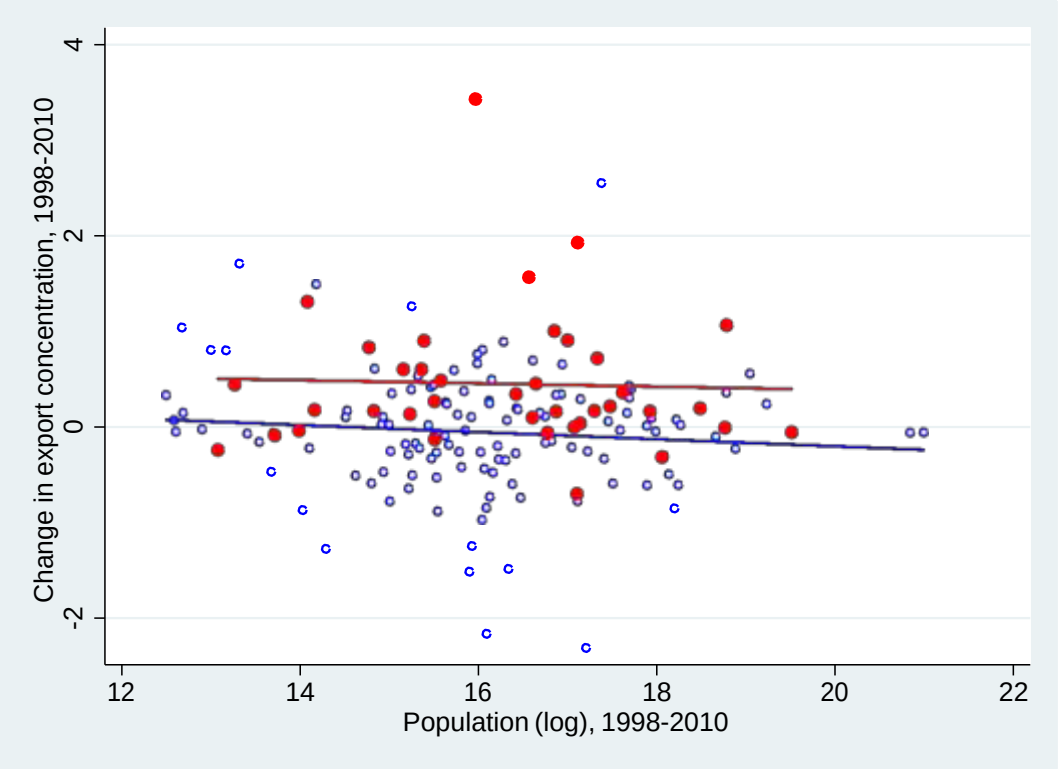
Source: IMF 2014, Ross and Mahdavi 2015, BP 2015.

Figure 15: Export concentration in Sub-saharan Africa



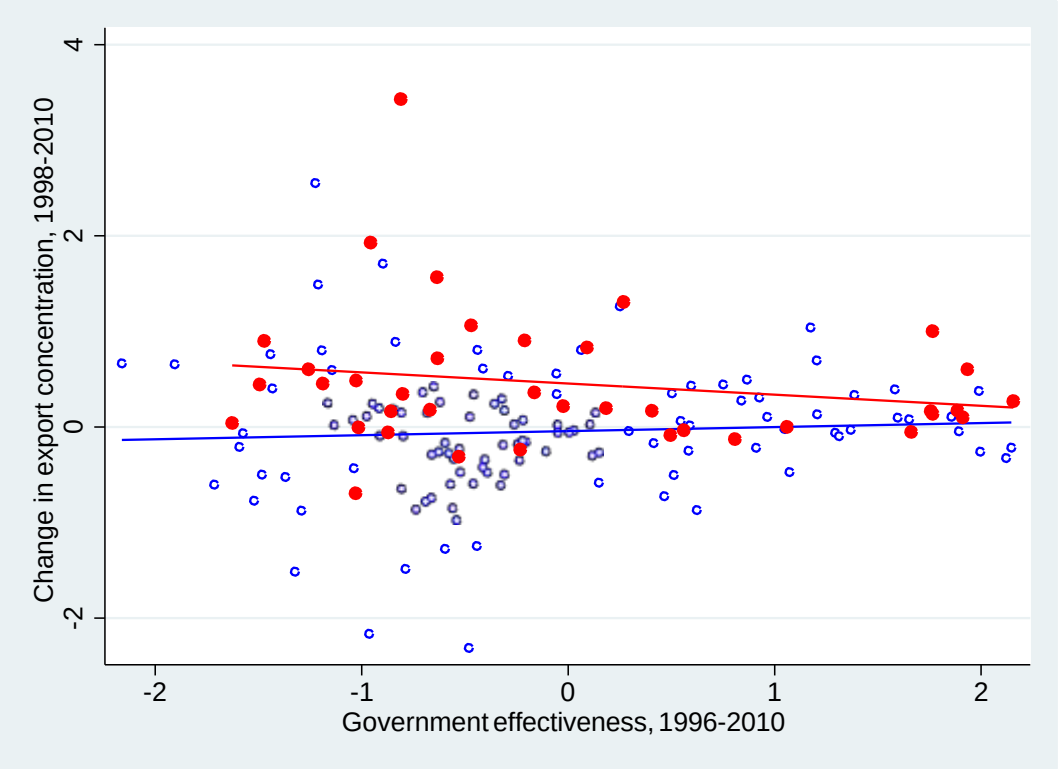
Note: the red line shows the long-term oil producers, the dashed gray line all oil producers (e.g., including Equatorial Guinea), and the blue line the non-oil producers. Source: IMF 2014, Ross and Mahdavi 2015, BP 2015.

Figure 16: Changes in export concentration and population



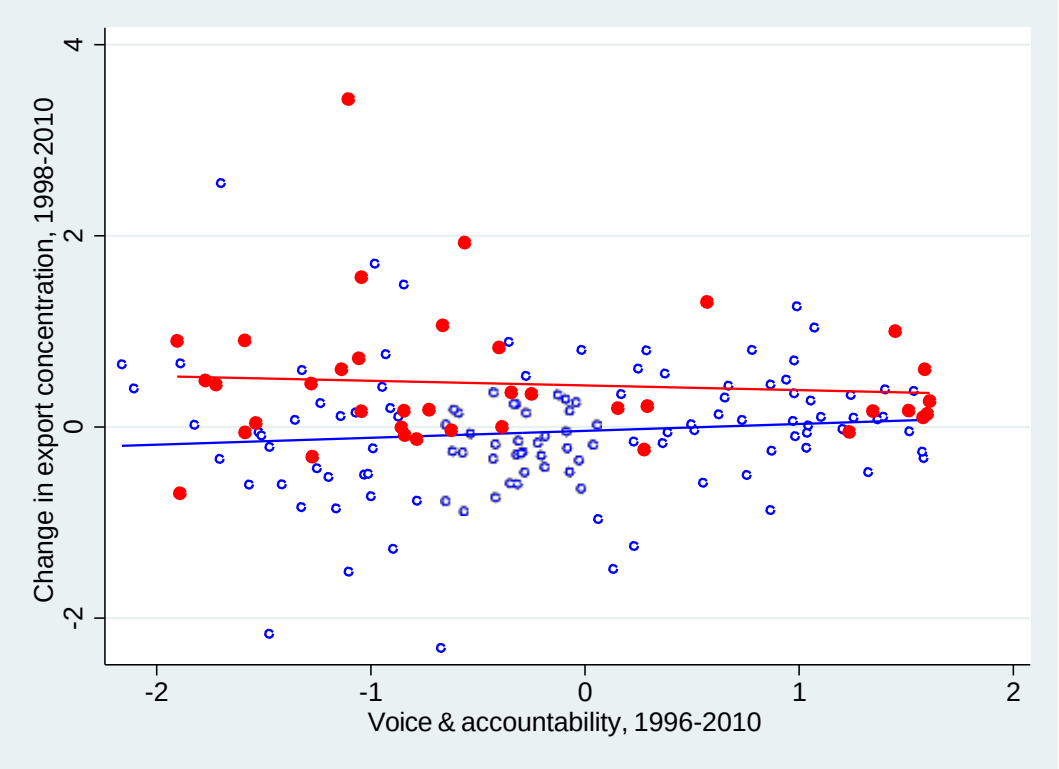
Oil producers are represented by red dots and non-oil producers by blue circles. Source: IMF 2014, World Bank 2016.

Figure 17: Changes in export concentration and mean government effectiveness



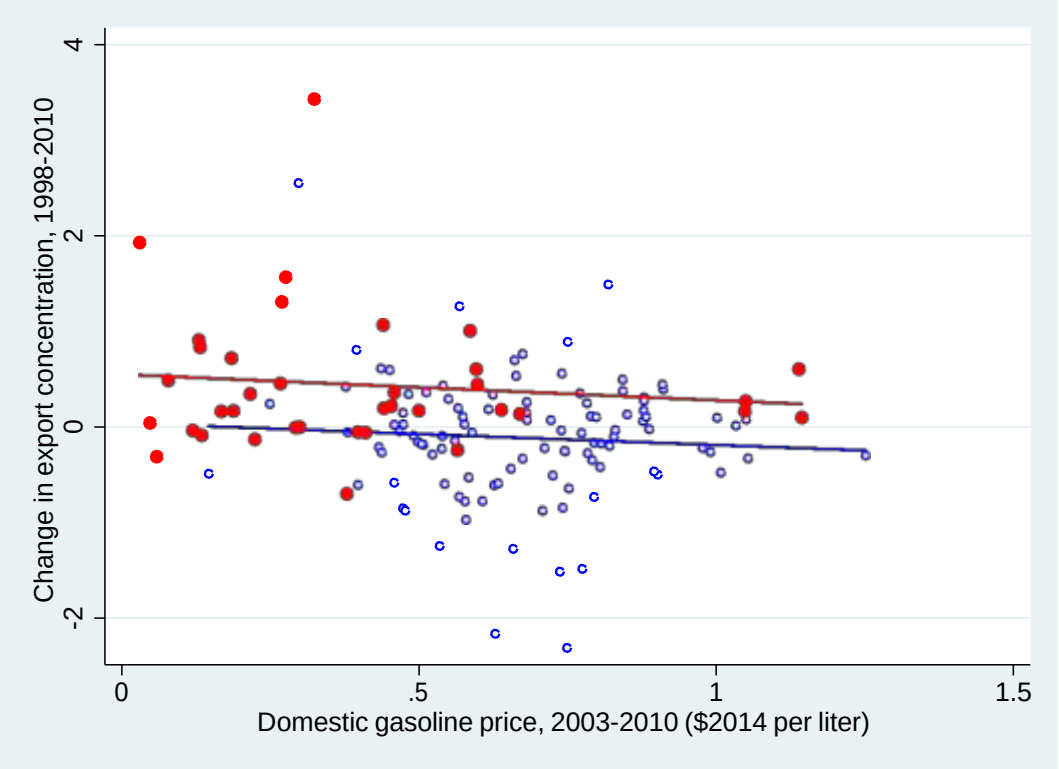
Oil producers are represented by red dots and non-oil producers by blue circles. Source: IMF 2014, World Bank 2016.

Figure 18: Changes in export concentration and mean government accountability



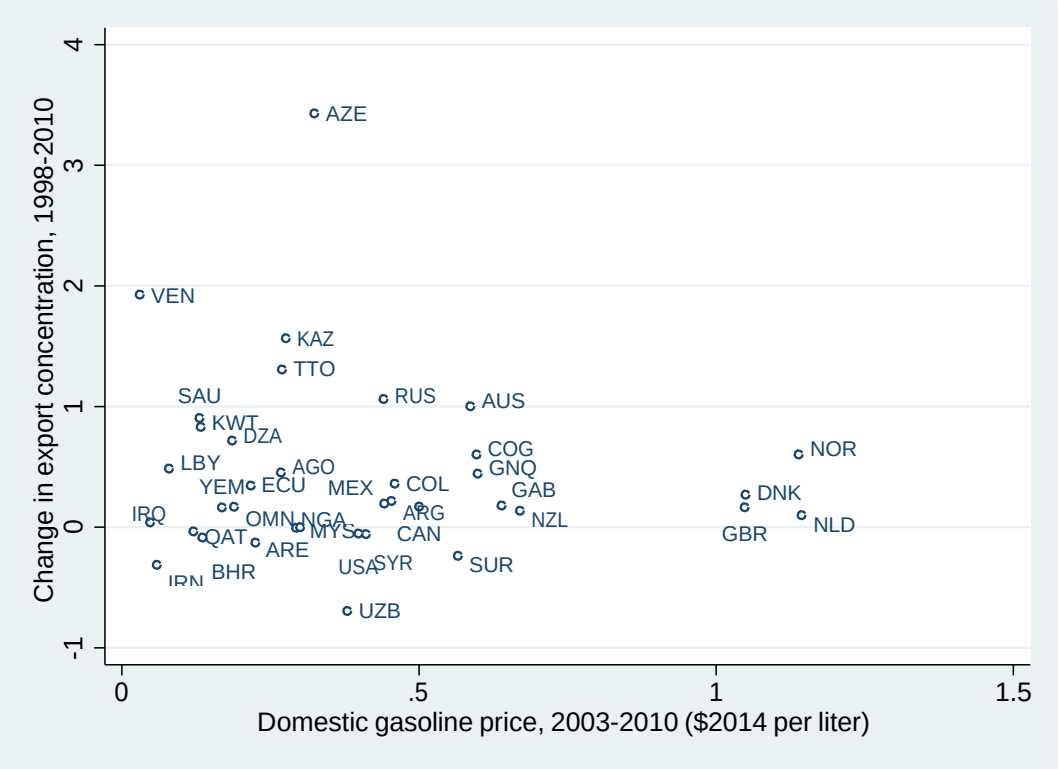
Oil producers are represented by red dots and non-oil producers by blue circles. Source: IMF 2014, World Bank 2016.

Figure 19: Changes in export concentration and mean gasoline price



Oil producers are represented by red dots and non-oil producers by blue circles. Source: IMF 2014, Ross, Hazlett and Mahdavi 2017.

Figure 20: Changes in export concentration and mean gasoline price



Source: IMF 2014, Ross, Hazlett and Mahdavi 2017.