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What do we know about export diversification in oil-producing countries?☆

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ABSTRACT

Oil-exporting countries are often advised to diversify their economies, yet surprisingly little is known about how this can be done. Research on this issue has been constrained by missing and inconsistent data, selection bias, and the use of uninformative measures of diversification. This paper uses a novel measure of export concentration from the IMF to describe diversification trends between 1962 and 2010 among the 38 largest oil producers. It documents three empirical patterns: a rising gap in export diversification between oil-producing states and non-oil states; the heightened concentration of exports in most oil and mineral producing states from 1980 to 2010; and the heterogeneous performances of the oil producers over the long run. Four striking patterns stand out: the oil exporters have developed the most narrowly-specialized economies in the global market, making them uniquely vulnerable to price shocks; among the oil exporters, the African states have the poorest diversification record; successful diversification is broadly associated with lower levels of oil wealth, which is consistent with a Dutch Disease effect; and success is not strongly associated with population, government effectiveness or democratic accountability.

1. 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." (Auty, 2001; Cherif et al., 2016; Collier and Page, 2009; De Melo et al., 2012; Giri et al., 2019; Lederman and Maloney, 2006; McMillan et al., 2014; Sachs, 2007; Sy et al., 2011, and van der Ploeg and Venables, 2011). The drop in oil and gas prices since mid-2014 has led to fiscal hardships in many oil-exporting states and triggered a renewed push for diversification.[1] Rising efforts in many states to reduce greenhouse gas emissions by reducing petroleum consumption makes diversification in the oil-exporters even more urgent.

Despite its ubiquity as a policy recommendation, surprisingly little is known about how states can achieve economic diversification (Wiig and Kolstad, 2012). A recent study by the International Monetary Fund (IMF) 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 (IMF, 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, whose diversification may be impeded by the Dutch Disease.[2]

We know relatively little about export diversification in the oil-producing countries for three 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). Some oil-dependent countries report impressive growth in their manufacturing exports because their governments classify refined oil products as "manufactured goods" (Battaile and Mishra, 2015, 16). Levels of domestic diversification are even more difficult to estimate (McMillan et al., 2014). In one recent study of diversification among 35 oil exporters, between 44 and 57 percent of the observations used for the regression estimates were missing (Alsharif et al., 2017).

The second is that export diversification is typically measured in

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[1] 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.

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

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ways that are contaminated by price volatility. When a country's exports are dominated by a single product with a volatile price, fluctuations in the price will mechanically cause fluctuations in export concentration – even when its export basket is unchanged. When oil prices are rising, oil producers will see a rise in their nominal export concentration; when prices fall, nominal export diversity will rise.

Researchers have developed several measures of export diversification to address some of these gaps and inconsistencies. 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, Hausman et al. 2014). Yet even the complexity scores of the oil-exporting states are strongly influenced by changing world oil prices.

A third problem is selection bias. Most studies of export concentration among the oil producers focus a set of oil-dependent countries, and then try to explain the causes of this oil dependence. Many researchers rely on 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., Ahmadov, 2014; Gelb, 2011). 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 by including minor oil producers that have failed to diversify.

Other studies decline to report how they select their cases: for example, the set of 35 oil exporters studied by Alsharif et al. (2017) puzzlingly excludes many countries with higher levels of per capita oil production (like Equatorial Guinea, Trinidad, Argentina, and Turkmenistan) and includes others with lower levels (like Cameroon, Belize, and Vietnam). This makes it difficult to draw conclusions about meaningful trends in the oil-producing world.

To gain a more complete picture of the diversification challenges facing the oil-exporting countries, I use a dataset developed by Papageorgiou and Spatafora and released by the IMF (2014) that uses data on bilateral trade flows to measure export diversity. The use of harmonized data from exporters and importers sharply reduces the incidence of missing and misreported observations. To facilitate interpretation, I graphically juxtapose changes in diversification with changes in per capita income from oil and gas. [3] To avoid selecting on the dependent variable (by only examining oil-dependent states), I examine the 38 countries that produced at least $300 in oil and gas income per capita in the most recent twenty-year period (1995–2014).[4] Recognizing the challenges of causal identification, my analysis is largely descriptive.[5]

I ask three broad questions: how much have the oil producers diversified over the last three decades, relative to the rest of the world? How much did they diversify during the post-1998 boom in commodity prices? How did their performances vary?

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. It also holds both across regions and within Latin America, the Middle East, and Africa. The trend is driven by countries with relatively high levels of per capita oil wealth, not low or moderate producers.

As a result, in 2010 the fifteen countries with the highest export concentration scores in the world were all petroleum exporters. If export concentration is largely a problem for states with very high values, and almost all countries with high values are oil exporters, then export concentration is largely a problem for 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 nine of the 30 long-term oil producers managed to diversify between 1980 and 2010, and four of them did so due to resource depletion or economic sanctions. This underscores how challenging it can be for oil exporters to diversify when prices are high.

Finally, over a longer time span there has nonetheless been heterogeneity in the diversification pathways of the oil exporters. The trends tend to be regionally clustered: there has been little diversification in Africa and the former Soviet Union, a mixed pattern in the Middle East, and relatively high diversification in almost all oil-producing countries in Europe, North America, and Latin America. The rising concentration in the former Soviet Union can be easily explained by new discoveries in the 1990s and 2000s, but the heightened export concentration in all the African oil producers – relative to African non-oil producers – is not.

While I do not attempt to explain these varied trends, I show that they tend to vary by a country's per capita oil income, which is broadly consistent with a Dutch Disease effect. I also show they are not strongly associated with population, government effectiveness or government accountability.

Data constraints in the past obscured the degree to which the oil producers have diverged from the rest of the world, and now dominate the list of undiversified countries. At the same time, there is more variation among the oil producers – especially those with moderate levels of oil wealth – than is commonly recognized.

The next section reviews recent scholarship on the causes and consequences of oil dependence. Section Three describes diversification trends among the 38 largest oil producers relative to each other and the rest of the world, and Section Four shows that cross-national patterns are consistent with a Dutch Disease effect but not consistent with three other explanations. The final section concludes and suggests future research directions.

2. Previous 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. [6]

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 there is no clear explanation for this non-monotonic relationship, it has been confirmed by subsequent studies and become central to the framework for understanding the relationship between diversification and development

[3] A country's oil (and gas) income is the value of oil and gas produced in a given year, using international prices.

[4] 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.

[5] For inferences about the causes and effects of oil dependence, causal identification is 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). 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.

[6] For a summary of the broader literature on economic diversification, income, and development see Cadot et al. (2013).

(Koren and Tenreyro, 2007; Cadot et al., 2011; IMF, 2014).

It is not clear whether oil-exporting countries follow the same path as other countries: Cadot et al. (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.

In a classic Heckscher-Ohlin model, countries with a relative abundance of natural resources will specialize in their export, although whether this should eventually lead to diversification is theoretically ambiguous. Some early theories of development had competing predictions: the Prebisch-Singer hypothesis suggested that low-income countries that specialized in commodity exports were subject to declining terms of trade and unlikely to diversify (Prebisch, 1949; Singer, 1950); the staple theory of growth, however, 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 eventually 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, in which a boom in natural resource exports leads to currency appreciation and a loss of competitiveness in other tradable sectors (Corden and Neary, 1982). This implies that a large resource discovery 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 evidence of the empirical validity and substantive importance of the Dutch Disease effect: 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. Still, it is unclear whether the Dutch Disease reduces economic growth: a meta-analysis by Magud and Sosa (2013) finds little convincing evidence of a growth-reducing effect, while Matsen and Torvik (2005) argue there may be an optimal degree of Dutch Disease.

Hausmann and Rigobon (2003) suggest that even in the absence of the Dutch Disease, oil dependence could be self-perpetuating through a different mechanism. In their model, a specialization in resource exports leads to greater volatility, which in turn deters investment in other types of tradable goods and hence exacerbates the dependence on resource sector exports.

While these approaches explain why a booming natural resource sector could lead to heightened export concentration, they do not explain why some commodities might be harder to diversify from than others. The framework developed by Hidalgo et al. (2007) and Hausmann et al. (2014) offers a clue: it proposes that countries diversify by moving from products they specialize in to others that require similar capabilities and hence occupy an adjacent "product space." Of the nearly 800 products in the SITC4 classification that they evaluate, "crude oil" shares the fewest characteristics with other products and inhabits the most isolated sector of the "product space," making it the single most difficult type of good to diversify from. In other words, countries endowed with significant oil wealth might find it uniquely hard to diversify because there are few other products that require the same skills as the oil industry; hence the learning-by-doing that occurs in the oil sector may generate relatively few spillovers into other sectors.[7] This argument is consistent with the findings of both Ahmadov (2014) and Lederman and Maloney (2006) that export concentration is more strongly associated with oil than with other primary commodities.

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 enable 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. The result would be a heightened dependence on oil. 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 et al., 2015).

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 and instrumenting for potentially endogenous variables. It reports that diversification is lower in countries with autocratic institutions, weak rule of law, landlocked or mountainous terrain, and a Middle East or African location. 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.

2.1. What are the effects of oil dependence?

Research on the economic consequences of oil export dependence can be divided into two categories: those that focus on volatility and those that focus on crowding out. Either one may affect economic growth and hence lead to an economic resource curse (see e.g., Auty, 2001; Sachs, 2007; Collier and Page, 2009; Lederman and Maloney, 2006, and van der Ploeg and Venables, 2011).[8]

The most carefully-studied effect 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 (Kilian, 2008; Hamilton et al., 2009). Hence a specialization in these commodities, if left unmitigated by policies or institutions, tends to produce macroeconomic volatility (Van der Ploeg and Poelhekke, 2009).[9]

Several studies report that resource-based volatility tends to deter investment, which in turn may reduce economic growth (Ramey and

[7] 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

(*footnote continued*)
depreciation in the exchange rate and an easing of Dutch Disease effects.

[8] There is also a voluminous literature on the political resource curse, which suggests a conditional relationship between oil dependence (or possibly oil production) and outcomes like institutional quality, government accountability, and violent conflict. This literature is reviewed in Ross (2015) and Waldner and Smith (2014), but not addressed further in this paper.

[9] Jacks et al. (2011) show that commodity prices have been more volatile than the prices for services and manufactured goods since at least the 1700s.

Ramey, 1995; Blattman et al., 2007; Aghion et al., 2009). 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. (2015) 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 (2006) 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; price shocks in the resource sector hence tend to have large effects on government revenues (Ross, 2012). How these shocks influence 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 Brückner, 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 manufacturing generates more 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 et al. (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.

This crowding-out effect 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 et al., 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) 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.

Ross (2008) argues that when oil wealth crowds out export-oriented manufacturing, it also crowds women out of the labor force under some conditions. The reduced presence of women in the labor force, it suggests, also impedes the development of their economic and political rights. 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.

3. Oil and export diversification

How much progress have oil-producing nations made toward export diversification over the last four decades? How did they fare during the recent commodity price boom? And which countries were less or more successful?

Table 1
Oil and gas income per capita, 1995–2014 (mean value, 2000 dollars).
Source: Ross and Mahdavi, 2015.

1. Qatar	22696
2. Kuwait	15634
3. Brunei[b]	11518
4. Norway	11254
5. UAE	10140
6. Equatorial Guinea[a]	8037
7. Saudi Arabia	6536
8. Oman	6260
9. Trinidad	4539
10. Libya	4059
11. Gabon	3168
12. Bahrain	3106
13. Canada	2249
14. Turkmenistan[a]	2233
15. Venezuela	1863
16. Russia[a]	1662
17. Kazakhstan[a]	1548
18. Timor Leste[b]	1526
19. Azerbaijan[a]	1514
20. Angola	1438
21. Algeria	1425
22. Iraq	1377
23. Congo, Rep.	1254
24. Iran	1170
25. Denmark	1028
26. Malaysia	756
27. Netherlands	679
28. United States	666
29. Australia	644
30. Ecuador	595
31. Mexico	511
32. Argentina	454
33. Suriname[a]	443
34. Yemen[a]	438
35. Uzbekistan[a]	363
36. Syria	354
37. New Zealand	325
38. Colombia	319
39. Nigeria	315
40. United Kingdom	309

[a] New (post-1990) oil producer.
[b] No export diversification data.

To address these questions I use a dataset developed by Papageorgiou and Spatafora and released by the IMF (2014), covering almost all countries from 1962 to 2010. 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 utilizes 45.3 million observations on bilateral trade values and quantities.

Fig. 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 2010 IMF Article IV report (IMF, 2011) and the CIA World Factbook (Central Intelligence Agency, 2017), which

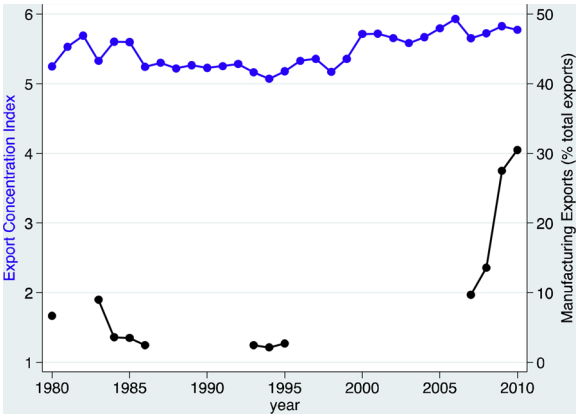

Fig. 1. Comparing data sources on Congo Brazzaville.
Note: the blue line shows the Export Concentration Index using the Papageorgiou-Spatafora data (left axis), while the black line shows manufacturing exports (right axis). The latter measure suggests an implausible surge in manufacturing exports from 2007 to 2010.
Sources: IMF, 2014; World Bank, 2016

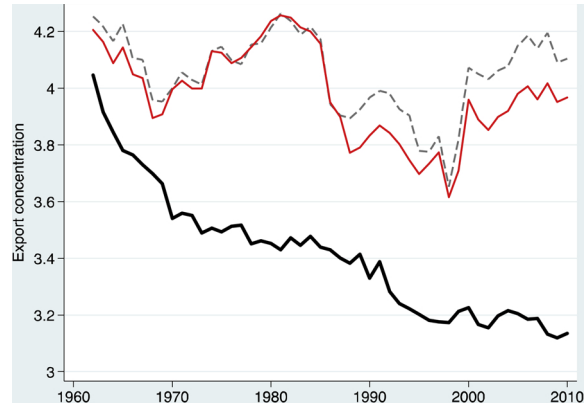

Fig. 2. Export concentration in the oil producers and the rest of the world.
Source: IMF, 2014; Ross and Mahdavi, 2015.

describe 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 reports from other sources.

Earlier studies of export concentration among the oil producers focused on *oil-dependent countries* (e.g., Ahmadov, 2014; Gelb, 2011). 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. Others fail to report their method of selecting cases, making it difficult to have confidence in their conclusions (e.g., Alsharif et al., 2017).

To identify a less-biased set of countries to examine, I rank all states by their mean per capita oil and gas income for the most recent 20 year period (1995–2014). I use a measure of production rather than exports because exports are endogenous to the size of the economy. Oil-producing countries typically consume a fraction of what they produce and export the surplus; hence an oil-producing country that successfully diversified might consume more of its oil domestically and only export a small surplus. Similarly, I normalize oil income by population rather than GDP, because strong non-oil growth will reduce the oil-to-GDP ratio but not the oil-to-population ratio. From this list I take the top forty countries. This effectively includes all countries above a threshold of $300 per capita (in constant 2000 dollars) in oil and gas income over the most recent 20 year period (Table 1).

3.1. How much have the oil producers diversified?

Collectively, the oil exporters have diversified more slowly than the rest of the world, although this pattern is sensitive to the choice of time frame. Fig. 2 shows how export concentration changed for the 38 oil producers as a group (dashed grey line) since 1962, compared to the rest of the world.[10] Since eight countries produced little or no oil before 1990 (or were not yet sovereign), the solid grey line only includes the 30 countries that were significant oil or gas producers throughout this period.[11] All subsequent figures only show trends for these 30 long-term producers. The black line includes all other countries.

If we take 1970 – the eve of the first oil shock – as the starting point, there is a sharp divergence: export concentration for the long-term oil producers rose by 2.6 percent; concentration among the non-oil producers fell 11.6 percent. The precise trajectory of each group, however, depends on when the comparison begins: if the starting year is 1980 – when concentration peaked in the oil-rich world, due to the second oil shock – the oil producers 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. Fig. 3 excludes the advanced industrialized states from both groups.[12] While both lines shift upward, they continue to diverge as before, although somewhat less sharply due to slower diversification among the non-oil countries.

The data also suggest that among states with extremely high levels of export concentration, those without oil have made more progress than those with oil. Fig. 4 shows the trajectories of the twenty countries with the highest export concentration levels in 1970. The group included eleven current or future oil producers and nine non-producers. By 2010, the eleven oil producers had become the eleven most concentrated states. This is consistent with the observation of Hausmann et al. (2014) that oil is the hardest commodity to diversify from.

Have the mineral producers faced the same problem? We should be cautious about comparisons since there are large differences in the values of their resource endowments: forty countries have at least $300 per capita in oil income, but only four have at least $300 in mineral rents.[13] Fig. 5 shows the diversification trajectories of the long-term oil producers, the mineral-rich states, and the remaining countries of the world. In both 1970 and 2010, the oil and mineral producers had almost identical levels of export concentration, although their pathways have different shapes: Interestingly, from 1962 to 1998 the long-term mineral producers diversified more quickly than the oil producers, but from 1998 to 2010 they reconcentrated more quickly.

3.2. How were the oil producers affected by the post-1998 price boom?

From 1998 to 2010, the mean annual price of oil rose more than 300 percent in real terms, from $18.47 to $86.41 in 2014 dollars (BP, 2016). How did this influence the oil producers?

[10] Although there are 40 countries above the $300 threshold, the PS data do not cover the two smallest countries (Brunei and Timor Leste).

[11] 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.

[12] 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.

[13] 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 – although its exclusion has little effect on the trend.

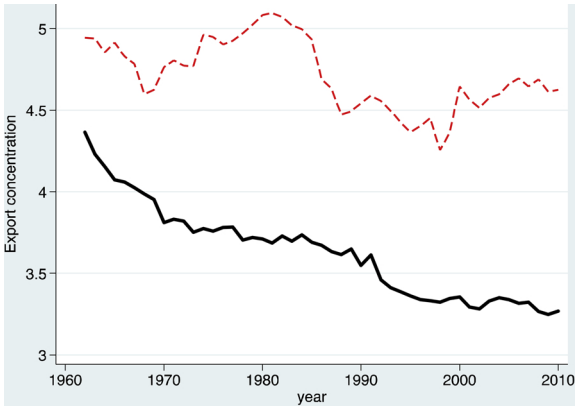

Fig. 3. Export concentration in the oil producers and the rest of the world, excluding advanced industrialized states.
Source: IMF, 2014; Ross and Mahdavi, 2015

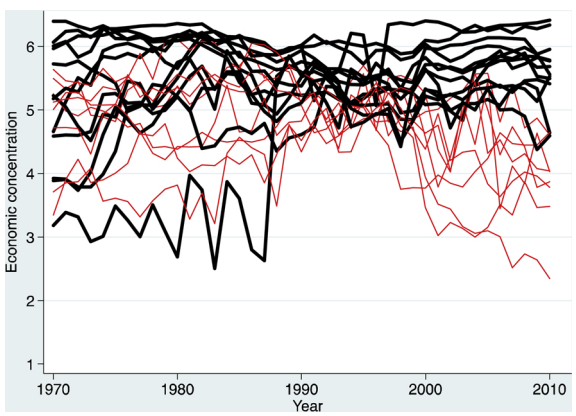

Fig. 4. Top 20 countries in export concentration in 1970.
Note: the heavy black lines indicate the country was or became a significant oil producer (generating at least $300 per capita in oil and gas income from 1995 to 2014). The thin red lines show non-oil producers.
Source: IMF, 2014; Ross and Mahdavi, 2015

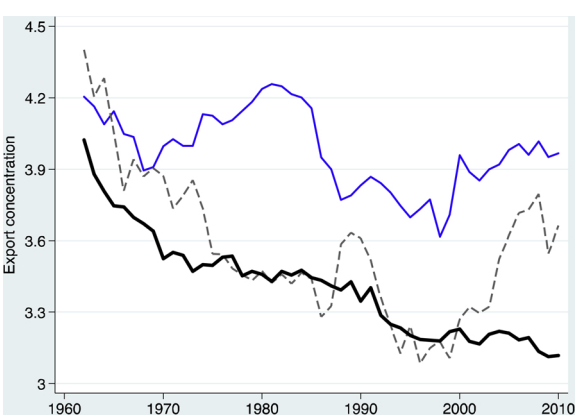

Fig. 5. Export concentration among the oil producers, minerals producers, and the rest of the world.
Source: IMF, 2014; Ross and Mahdavi, 2015; World Bank, 2016.

As Fig. 2 shows, the impact was dramatic: the oil producers became much more concentrated after 1998 while the rest of the world became 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 (Fig. 6).

It is striking how few oil-producing states were able to resist this trend. Fig. 7 compares export concentration levels in 1998 and 2010 for

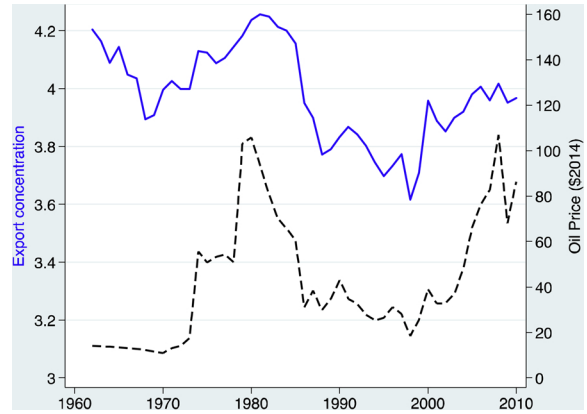

Fig. 6. Export concentration in the oil producers and the real oil price.
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

both the oil producers (dots) to the rest of the world (circles). The 45° line shows where countries would lie if their concentration levels were identical in 1998 and 2010. Eight oil producers are below the line (meaning they grew more diverse) and 28 above it (meaning they grew more concentrated), while two were unchanged.

Fig. 8 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. Eight states diversified: Oman, United Arab Emirates, Syria, Iran, Bahrain, Colombia, Malaysia, New Zealand. Four of them, however, were effectively forced to diversify by circumstances beyond their control: Iran's exports were subject to economic sanctions, while reserves were depleted in United Arab Emirates, Syria, and Bahrain.

3.3. How did the paths of the oil producers vary?

For oil producers, movement toward lower concentration is often an artifact of falling oil prices (Fig. 6) or resource depletion, and may not reflect real growth in non-oil exports. To distinguish between artifactual and genuine diversification, I plot country-level changes in export concentration alongside country-level changes in per capita oil income for all 38 countries (Appendix 1). I classify countries as "successful diversifiers" if a) their export concentration scores declined at least 10 percent between 1980 and 2010 – two years when the real price of oil was almost identical – and b) the value of their oil and gas production was either steady or rising. For convenience I have separated the new producers from the long-term producers, and grouped the long-term producers into "high concentration" (above 5), "moderate concentration" (between 3 and 5), and

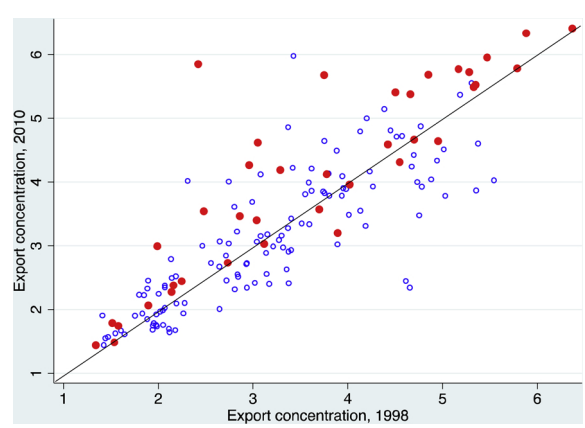

Fig. 7. Export concentration in 1998 and 2010.
From 1998–2010, most oil producers became less diverse. Source: IMF, 2014; Ross and Mahdavi, 2015.

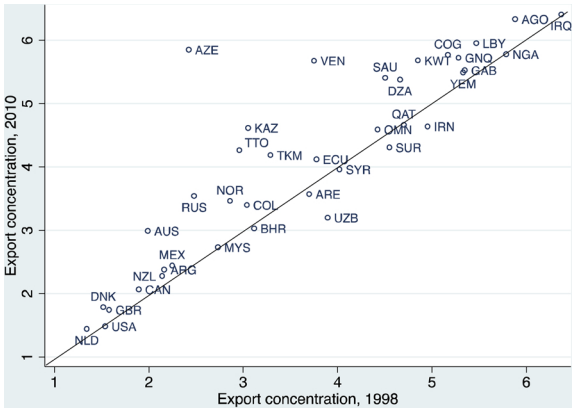

Fig. 8. Export concentration in 1998 and 2010 (oil producers only).
Source: IMF, 2014; Ross and Mahdavi, 2015.

Table 2
Diversification pathways of the oil exporting countries.1980–2010.

	Not diversified since 1980	Diversified since 1980
High-concentration oil states (10)	Nigeria Angola Gabon Congo-Brazzaville Algeria Libya Kuwait Iraq Venezuela	Saudi Arabia
Moderate concentration states (9)	Norway Qatar Trinidad Ecuador	Oman Colombia Iran[a] Syria[b] United Arab Emirates[b]
Low concentration states (11)	Argentina Mexico Australia Canada Denmark Great Britain Netherlands United States	Malaysia New Zealand Bahrain[b]
New producers (8)	Azerbaijan Kazakhstan Turkmenistan Russia Equatorial Guinea Yemen	Suriname Uzbekistan

[a] Diversified due to sanctions.
[b] Diversified due to depletion.

"low concentration" (below 3) groups. Their status is shown in Table 2.

The ten high-concentration countries are, by definition, the least diversified and hence those with the least success. They include all four of the long-term producers in sub-Saharan Africa (Nigeria, Angola, Gabon, and Congo Republic), and both of the long-term producers in North Africa (Algeria and Libya). They are joined by three of the major producers in the Gulf region (Saudi Arabia, Kuwait, and Iraq) and one from Latin America (Venezuela).

One country in this group saw a significant decline in concentration: Saudi Arabia, where it fell by 11.6 percent. But the value of oil production per capita declined even more rapidly, suggesting that this may have simply been a mechanical effect.

For the nine moderately-concentrated producers, the trends are more mixed. Export concentration fell for eight of the nine states – all but Norway, where new oil finds boosted production. But in four of the eight states (Qatar, Trinidad, Syria and United Arab Emirates) the value of oil production dropped more-or-less in tandem with the drop in export concentration. Two countries met the definition of success: Oman, where concentration fell by 26.4 percent while oil and gas income per capita rose by 22.4 percent, and Colombia, where concentration fell by 11.1 percent while production rose by almost 200 percent (albeit from a low initial level). Ecuador was a near-success, with a 5.2 percent drop in concentration. The remaining country – Iran – technically meets the definition of success, as its concentration fell by 21.9 percent while production rose. Yet Iran's diversification occurred partly due to international sanctions, rendering it hard to make judgments about the success or failure of its diversification efforts.

Among the eleven low-concentration producers there are two additional cases of diversification success: Malaysia and New Zealand. Bahrain grew more diversified by necessity, as its oil and gas reserves were depleted. In the remaining eight states, export concentration rose in six and fell in two (Argentina and Mexico), both of which also saw declining production.

There are eight remaining countries, all of 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 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 (from other commodities) before they were oil producers, and produce only modest amounts of oil (Uzbekistan, Suriname).

Overall, nine of the 30 long-term producers saw their export concentrations decline from 1980 to 2010. In four cases the decline appears to have been "mechanical," caused by external sanctions (Iran) or resource depletion (Bahrain, UAE, and Syria). Hence just five states meet the definition of "success": Oman, Colombia, Malaysia, New Zealand, and Saudi Arabia. The reasons for their success are beyond the scope of this analysis, but merit careful attention in future research.

The consistently high concentration levels of the African oil producers is also striking. One possible explanation is that their failure to diversify merely reflects the diversification failures of the region as a whole, including both oil and non-oil states. This is not the case: Fig. 9 compares the 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 did not suffer the same fate: Zambia, South Africa, and Mauritania have all become more diversified.[14]

3.4. Correlates of change

Countries might find it easier to diversify if they have less oil (and hence a smaller Dutch Disease effect), larger populations (with bigger domestic markets and more human capital), more effective governments (generating a better supply of public goods that can encourage private sector growth (Ahmadov, 2014)), and more accountable governments (making their interventions in the market less arbitrary (Wiig and Kolstad, 2012; Malik, 2016)). Can these factors help explain why diversification trends vary so much across the oil-producing world?

Of these four factors, only the first – oil wealth – is clearly associated with a country's export concentration level. Fig. 10 shows the cross-national pattern for 2010. The fitted line suggests there is a strong association between a country's oil and gas income per capita and its export

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

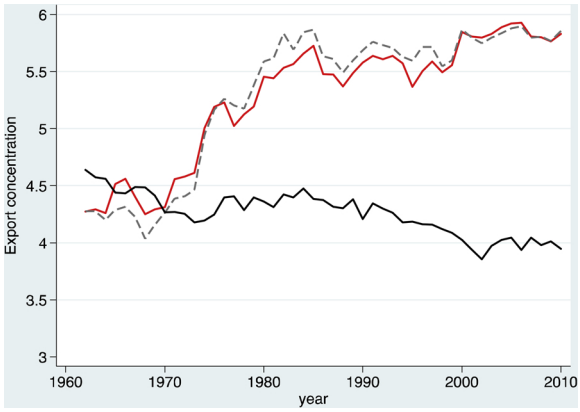

Fig. 9. Export concentration in sub-Saharan Africa.
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

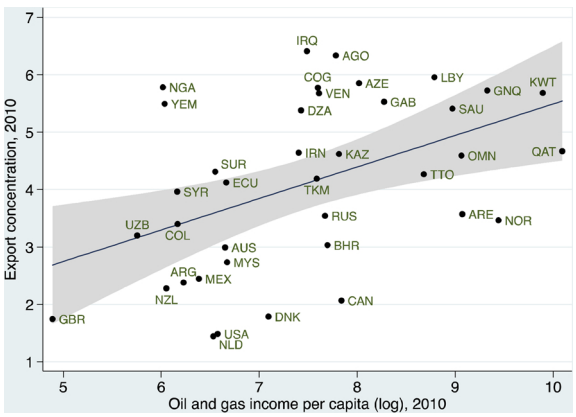

Fig. 10. Export concentration & oil income per capita (oil producers only).
Source: IMF, 2014; Ross and Mahdavi, 2015.

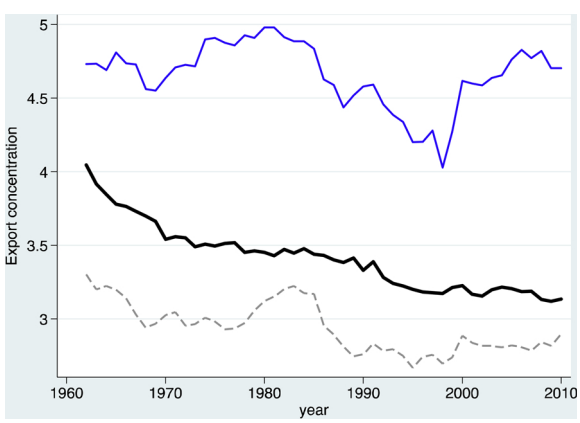

Fig. 11. Export concentration in oil-rich states, oil-moderate states, and the rest of the world.

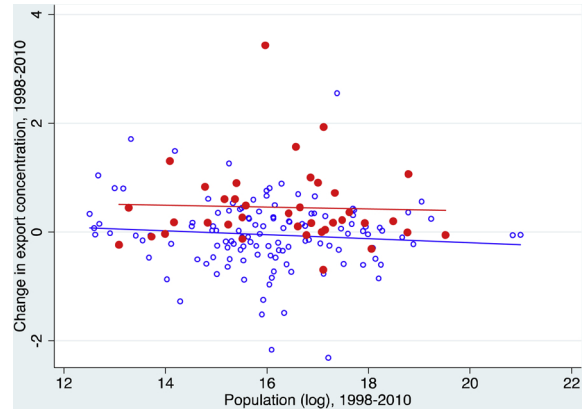

Fig. 12. Changes in export concentration and population.
Source: IMF, 2014; World Bank, 2016.

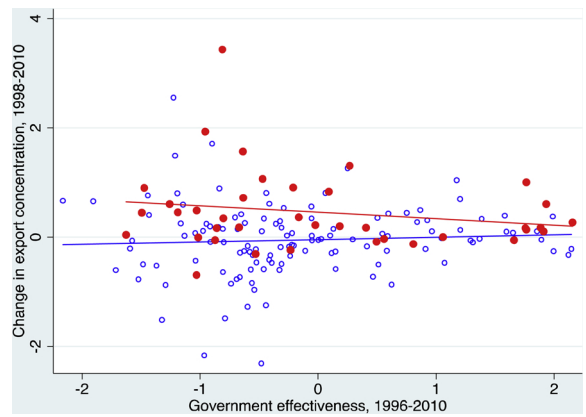

Fig. 13. Changes in export concentration and mean government effectiveness.
Source: IMF, 2014; World Bank, 2016.

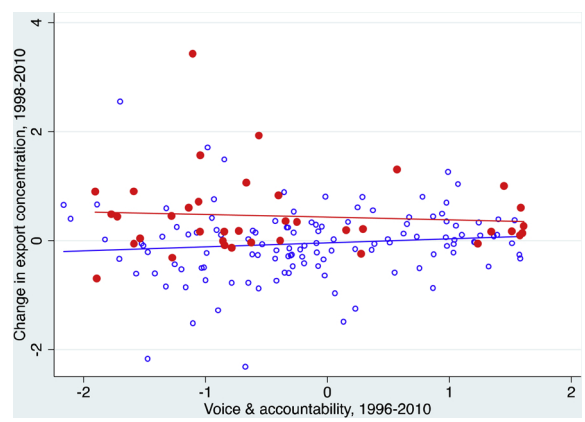

Fig. 14. Changes in export concentration and mean government accountability.
Source: IMF, 2014; World Bank, 2016.

concentration. There is also considerable deviation around the trend.

Fig. 11 shows the pattern over time, dividing all countries into three categories: the 18″oil rich" states (where oil income per capita averaged over $1000 per capita from 1970 to 2010), the 12 states with moderate oil incomes (between $300 and $1000 per capita), and all other countries. The high-oil group has higher levels of export concentration, while the moderate oil countries have far less concentration – even less than the non-oil countries.

The other three factors have little or no straightforward correlation with export concentration. Fig. 12 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.

In Fig. 13, 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 less concentration. Similarly, there is a slight negative correlation between government accountability and less concentration, for the oil producers only

(Fig. 14).[15] In simple cross-country OLS regressions, each of these factors is associated with reductions in export concentration among the oil producers, but none of the correlations are statistically significant.

4. Conclusion

Over the last half century, the oil producing states have diverged from the rest of the world, diversifying more slowly or in some cases not at all. 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. Today they have become the most highly-specialized states in the global economy, and hence the most vulnerable to large price shocks.

Not all of the oil producers have followed the same path. Four of the 38 major oil producers (Oman, Malaysia, Colombia, and New Zealand) have successfully grown more diversified since the oil shocks of the 1970s, even though their oil revenues were flat or rising. A fifth country, Saudi Arabia, also grew more diversified but this was partly attributable to falling per capita oil revenues. At the other extreme, the oil producers of both North and sub-Saharan Africa have uniformly failed to diversify and warrant special concern.

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 as new discoveries caused their oil and gas exports to soar. Some well-governed long-term producers – like Malaysia, Norway, and Canada – also experienced high concentration levels during the 1998–2010 price boom. Still, the number of successful diversifiers is surprisingly small.

These findings can inform the growing policy literature about the challenges of diversification in the oil-exporting world. They also underscore the importance of further improvements to the data. Five areas should receive special attention: collecting better data on diversification in the domestic economy, including employment diversification and the size of the non-extractive private sector; correcting the misclassification of processed petroleum products, a practice that creates the false appearance of diversification into non-oil sectors; the generation of price-corrected measures of diversification that allow us to distinguish between nominal and genuine diversification; and improved data on service sector performance, including the trade in services.

Better data will give scholars and policymakers a more reliable picture of the diversification landscape and help them understand the factors associated with success and failure. It could also attract new scholars to a topic whose real-world importance dwarfs the attention it receives from social scientists.

Declaration of Competing Interest

None.

Appendix A

See Figs. A1–A11

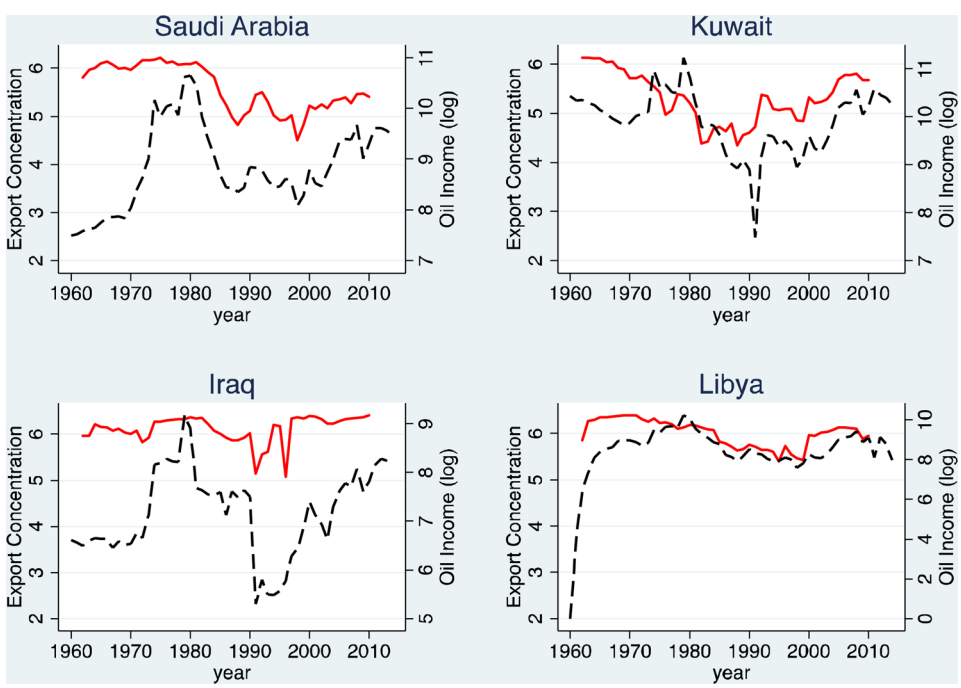

Fig. A1. Export concentration and oil income trends for high-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

[15] Since export concentration levels are not problematically high for 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.

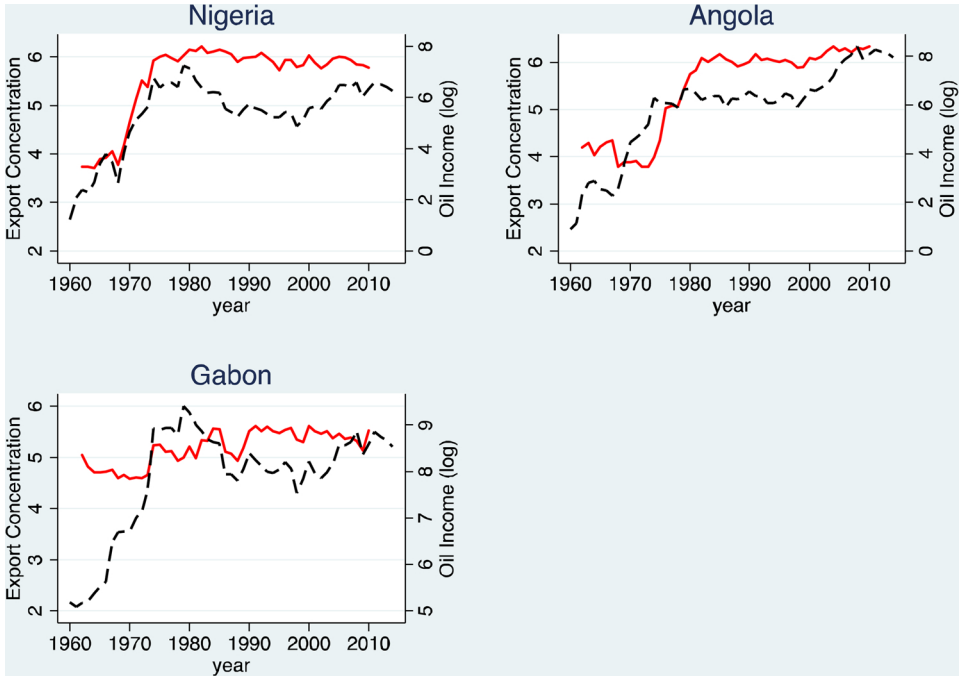

Fig. A2. Export concentration and oil income trends for high-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

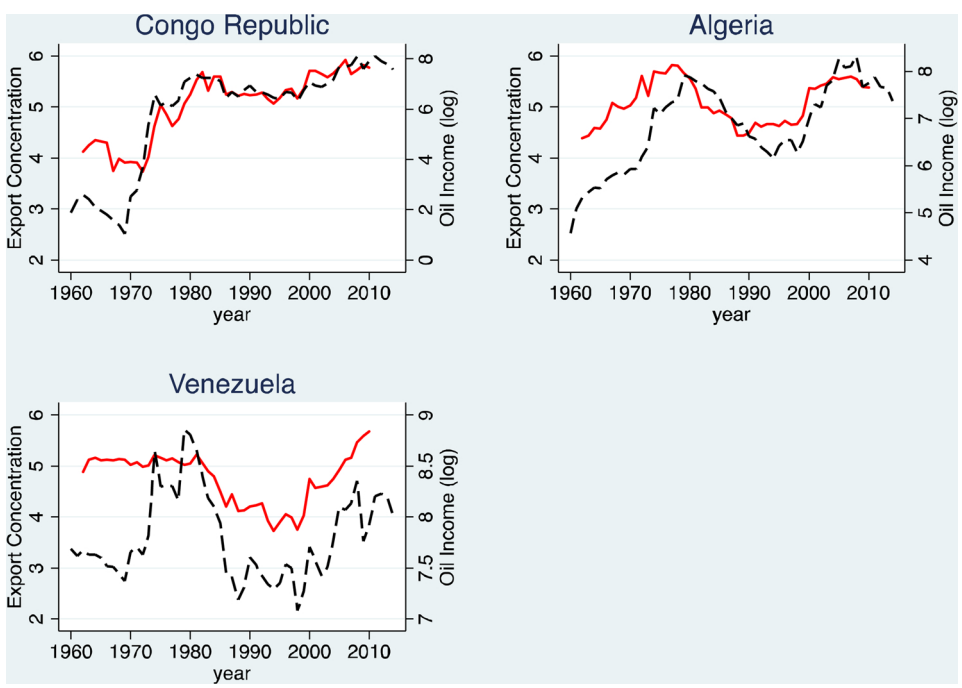

Fig. A3. Export concentration and oil income trends for high-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

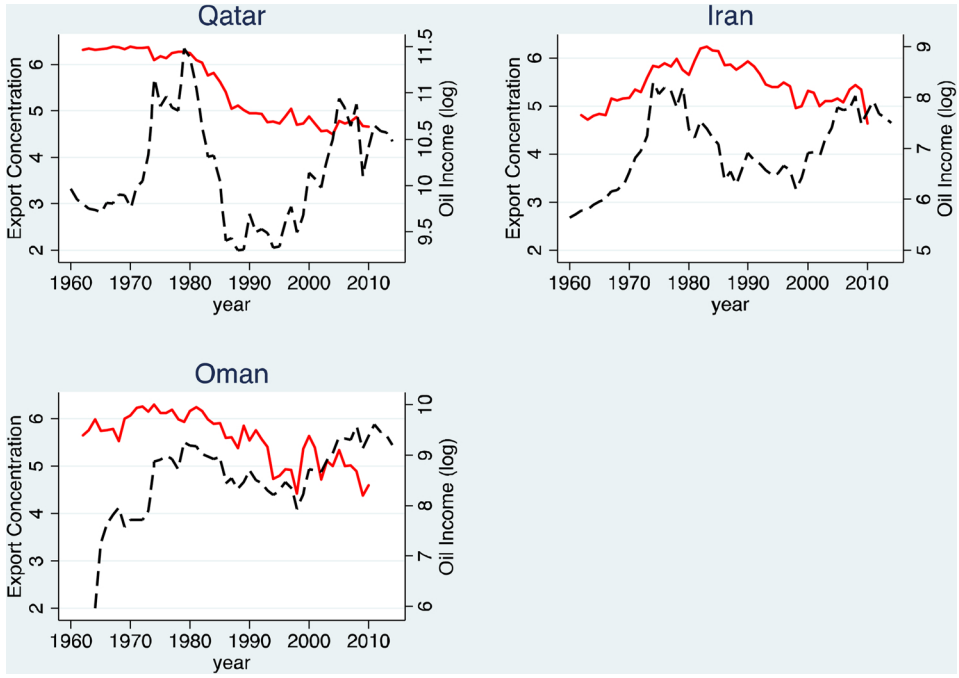

Fig. A4. Export concentration and oil income trends for moderate-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

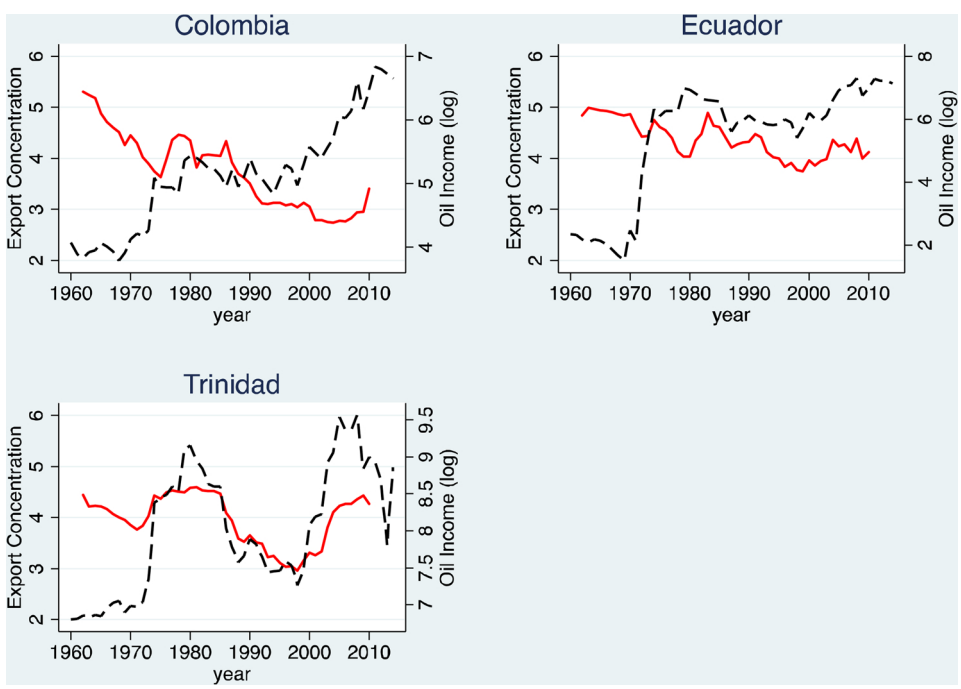

Fig. A5. Export concentration and oil income trends for moderate-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

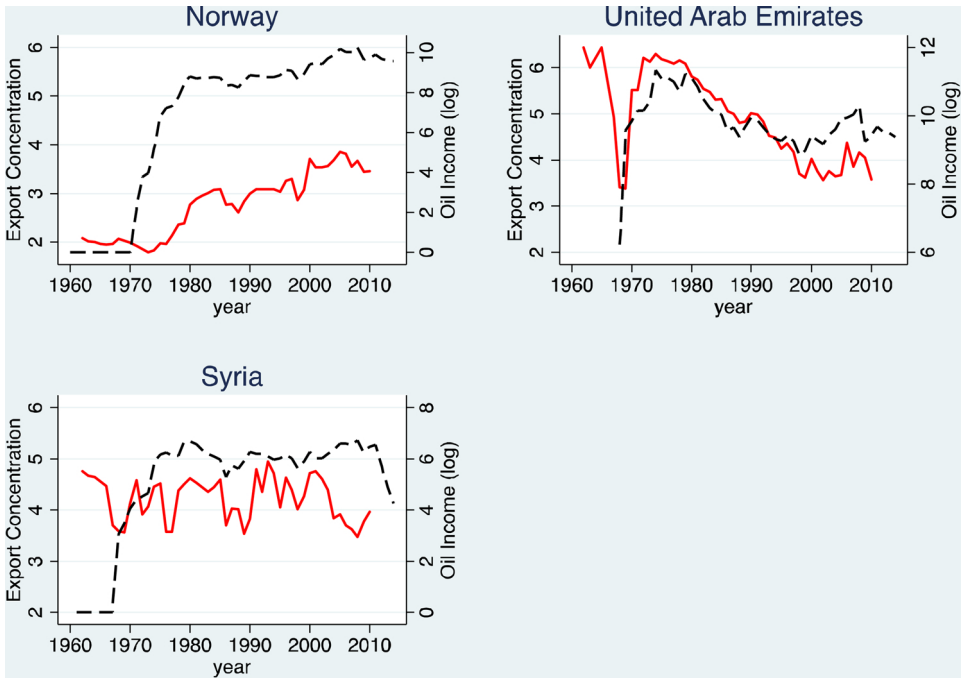

Fig. A6. Export concentration and oil income trends for moderate-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

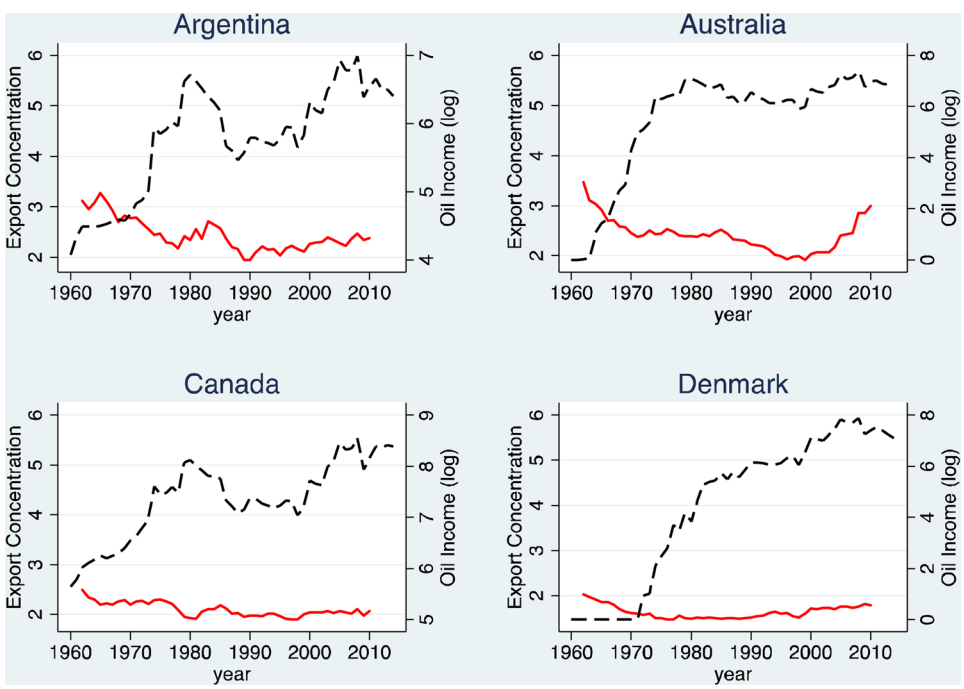

Fig. A7. Export concentration and oil income trends for low-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF 2014, Ross and Mahdavi, 2015; BP, 2016.

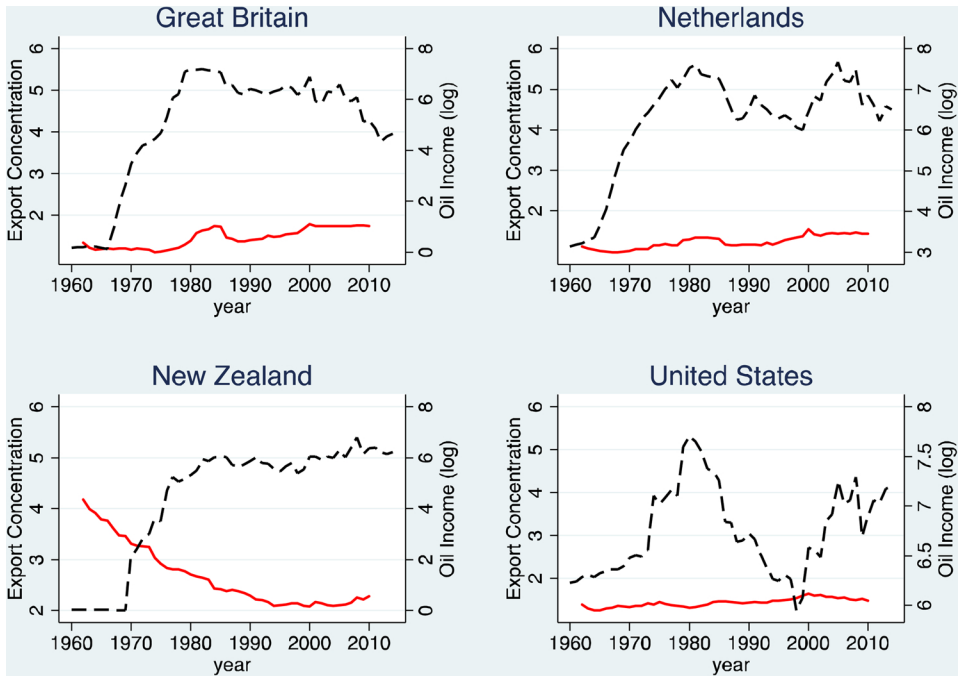

Fig. A8. Export concentration and oil income trends for low-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

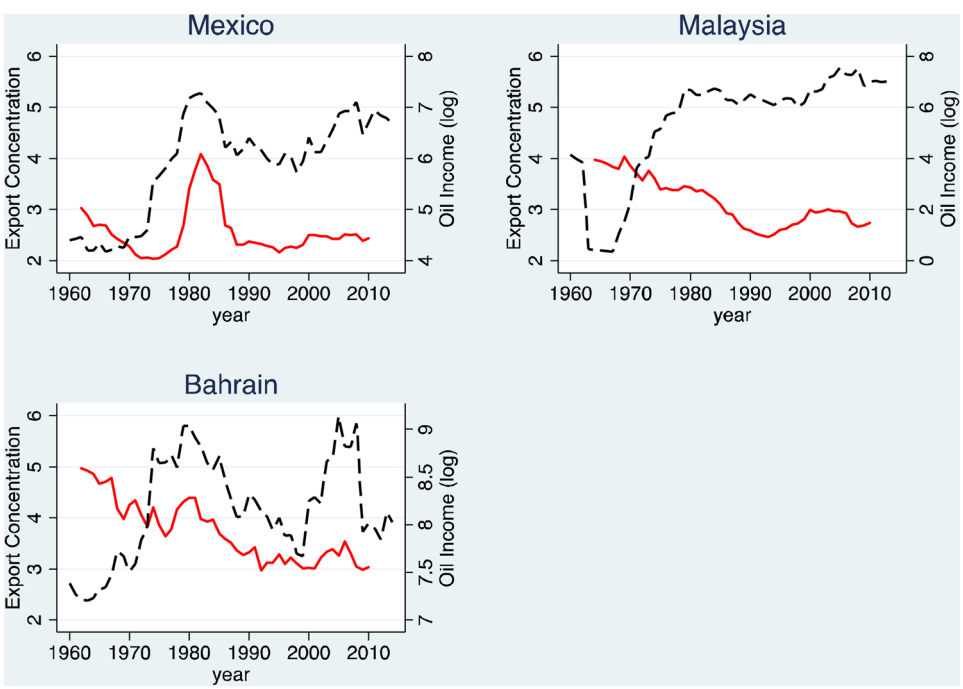

Fig. A9. Export concentration and oil income trends for low-concentration countries. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

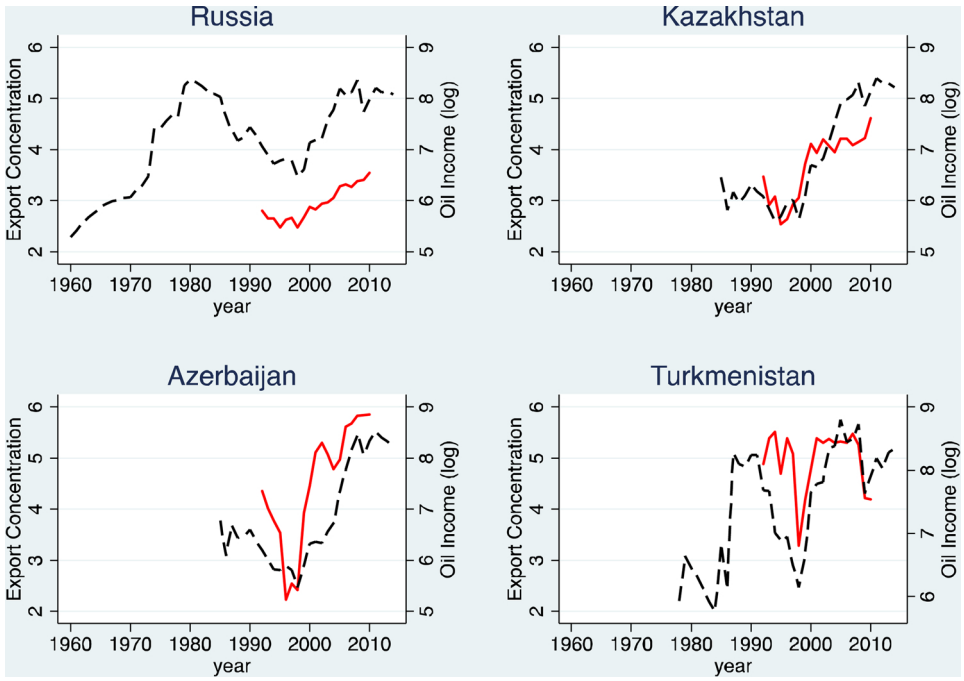

Fig. A10. Export concentration and oil income trends for newer oil producers. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

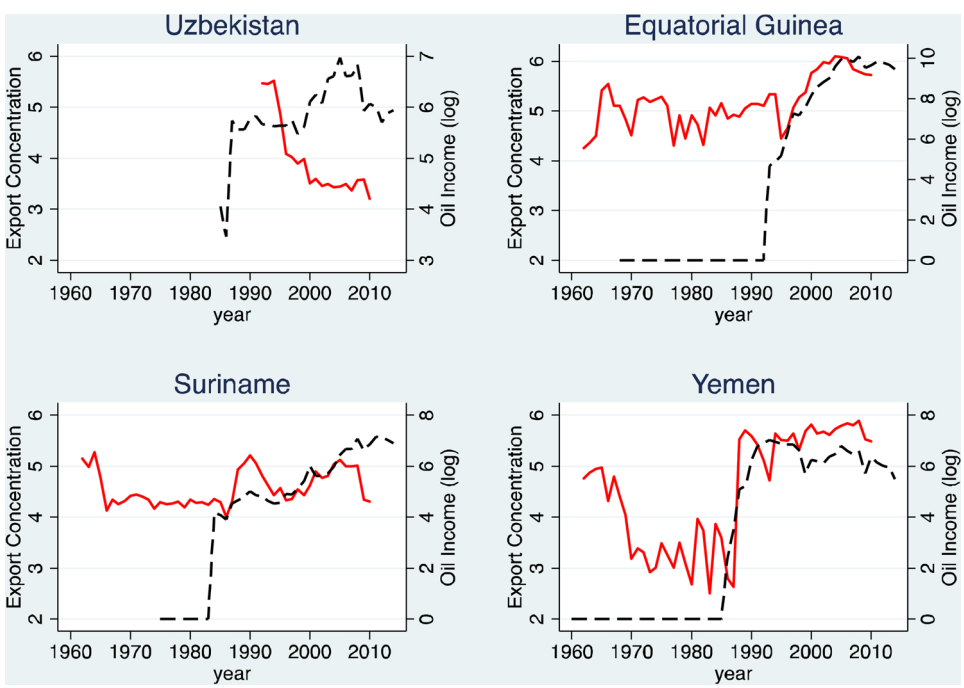

Fig. A11. Export concentration and oil income trends for newer oil producers. In each figure the solid red line shows export concentration (left axis) and the dashed black line shows oil income per capita (right axis).
Source: IMF, 2014; Ross and Mahdavi, 2015; BP, 2016.

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