The Long-Run Effects of Oil Wealth on Development: Evidence from Petroleum Geology*

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Abstract

We estimate the long-run effects of oil wealth on development by exploiting spatial variation in sedimentary basins—areas where petroleum can potentially form. Instrumental variables estimates indicate that oil production impedes democracy and fiscal capacity development, increases corruption, and raises GDP per capita without significantly harming the non-resource sectors of the economy. We find no evidence that oil production increases internal armed conflict, coup attempts, or political purges. In several specifications failure to account for endogeneity leads to substantial underestimation of the adverse effects of oil, suggesting that countries with higher-quality political institutions and greater fiscal capacity disproportionately select into oil production. Countries that had weak executive constraints from 1950–1965 experienced the largest adverse effects of oil on democracy and fiscal capacity, yet they benefited the most in terms of GDP. Overall, the results confirm the existence of a political resource curse, while rejecting the economic resource curse hypothesis.

JEL codes: O11, O13, Q32, Q35
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1 Introduction

Does natural resource abundance promote or hinder economic and political development? Despite decades of research, the question remains largely unresolved.[1] Much of the disagreement owes to the difficulty of identifying exogenous variation in resource wealth.[2] Country-level resource exploration and extraction are endogenous to political, institutional, and economic conditions.[3] Recent contributions to the literature have exploited subnational data and short-term fluctuations in world resource prices in order to identify short-run causal effects of resource income.[4] However, several important outcomes, such as the political regime and fiscal capacity of the central government, require analysis at the national level. Furthermore, the interaction between resource wealth and economic and political variables may develop over long periods of time. Political and fiscal institutions develop and consolidate over many years—as do their effects.[5] In addition, both the "greed" and "grievance" motives for conflict (Collier and Hoeffler, 2004) can be deeply rooted in the presence of resource endowments. Therefore, the long-run effects of natural resources are of great interest. Understanding how natural resource wealth affects long-run development will inform not only domestic resource policy (e.g., royalties and drilling rights), but also federal transfer policy and foreign aid, as natural resource revenue and other forms of non-tax revenue are believed to have similar effects (e.g., Djankov, Montalvo, and Reynal-Querol, 2008; Brollo et al., 2013).

This paper examines the long-run effects of oil wealth on development using a new identifi-

[1] Early studies argued that resource wealth lowered economic growth via the Dutch Disease (Corden and Neary, 1982; Sachs and Warner, 1995, 1999, 2001), but recent studies call the Dutch Disease hypothesis into question, showing that oil discovery and production can cause positive spillovers for manufacturing and boost aggregate investment and employment (Michaels, 2011; Allcott and Keniston, 2017; Arezki, Ramey, and Sheng, 2016). Arezki et al. (2016) and Smith (2015) both present evidence that oil wealth raises GDP, using cross-country panel data. Influential early studies in the political science literature claimed that resource rents promoted authoritarianism (Ross, 2001; Jensen and Wantchekon, 2004). However, Herb (2005) and Haber and Menaldo (2011) argue that there is no robust relationship between oil rents and democracy. See, however, responses to the latter study by Andersen and Ross (2014) and Wiens, Poast, and Clark (2014). Alexeev and Conrad (2009) argue that the negative cross-sectional association between oil and the quality of institutions disappears after controlling for (instrumented) GDP. Brückner, Ciccone, and Tesei (2012) present evidence that oil exports improve democratic institutions. For recent surveys of the resource curse literature, see Ross (2015), van der Ploeg (2011), Frankel (2010), and Torvik (2009). See Cust and Poelhekke (2015) for a survey of the subnational evidence for the resource curse.

[2] See, for example, the discussions in Brunnschweiler and Bulte (2008) and van der Ploeg and Poelhekke (2010).

[3] David and Wright (1997) argue that the United States became the world's premier mineral producer from 1870–1910 not because of a fortuitous mineral endowment relative to other countries, but because its superior technology and institutions allowed it to more efficiently extract resources. Bohn and Deacon (2000) find that democratic institutions and political stability positively affect investment in oil exploration. Cust and Harding (2017) show that when oil is potentially located on a national border, 95 percent more exploratory drilling occurs in the country with relatively better institutions.

[4] Subnational studies include Vicente (2010), Michaels (2011), Litschig (2012), Monteiro and Ferraz (2012), Aragón and Rud (2013), Brollo, Nannicini, Perotti, and Tabellini (2013), Caselli and Michaels (2013), Dube and Vargas (2013), Allcott and Keniston (2017), Aragón and Rud (2016), Aragón, Rud, and Toews (2018), and Carreri and Dube (2017). For empirical strategies that exploit price shocks, see Brückner et al. (2012), Dube and Vargas (2013), Andersen, Johannesen, Lassen, and Paltseva (2017), Caselli and Tesei (2016), and Carreri and Dube (2017).

[5] See Besley and Persson (2011) for a model of fiscal capacity as a stock variable, and see Persson and Tabellini (2009) on the implications of democratic capital.

cation strategy that exploits the geological characteristics of countries. Hydrocarbons—notably crude oil and natural gas—are produced by the heating and compression of organic matter buried within sedimentary basins. Our instrumental variables approach uses new data on the spatial distribution of sedimentary basins to isolate exogenous cross-country variation in oil wealth.[6]

Addressing endogeneity is crucial in this context, because the sign of the bias of ordinary least squares is *a priori* ambiguous. If wealthier or more democratic countries attract greater private investment in resource exploration and production, perhaps due to their stronger property-rights protections, then the estimated effect of resource wealth on development will be biased upwards (Cust and Harding, 2017). On the other hand, if low-income or less democratic countries have more lax regulation of the resource sector or are governed by politicians who personally benefit from rapid extraction rates, then the estimate will be biased downwards (Robinson, Torvik, and Verdier, 2006).

Other studies have used instrumental variables (Brunnschweiler and Bulte, 2008; van der Ploeg and Poelhekke, 2010; Tsui, 2011; Borge, Parmer, and Torvik, 2015), price shocks (Brückner et al., 2012; Dube and Vargas, 2013; Andersen et al., 2017; Caselli and Tesei, 2016; Carreri and Dube, 2017), and giant oil field discoveries (Lei and Michaels, 2014; Smith, 2015; Arezki et al., 2016) to estimate the causal effects of natural resource abundance. Panel models have the advantage of controlling for unit fixed effects but potentially present two disadvantages: they typically only recover short-run effects, and they may be biased if institutions influence the timing of resource discoveries and production.

Consistent estimation of long-run effects requires a source of cross-country variation in resource wealth that is orthogonal to institutional quality and other important country characteristics. Previous cross-country studies have used initial subsoil assets as an instrument for resource wealth (e.g., van der Ploeg and Poelhekke, 2010; Tsui, 2011). However, these measures of *known* resource endowment could depend on exploration effort, which endogenously responds to economic and political conditions. We aim to improve upon this strategy by focusing on geological features that cannot respond to economic or political factors.

The instrumental variables estimates indicate that an increase in average annual oil production from 1966–2008 significantly reduces the level of democracy in 2008 as well as the average level of democracy from 1966–2008. Increasing oil production also leads to more corruption and reduces average tax revenue as a share of GDP from 2000–2008. The corresponding OLS estimates understate the negative effects of oil, suggesting that countries with better political institutions and greater state capacity disproportionately select into oil production. The evidence on internal armed conflict, coup attempts, and purges is less conclusive. Finally, we find evidence that oil production raises GDP and does not significantly harm the non-resource sectors of the economy. The results are consistent with recent research showing that oil nega-

[6] Bartik, Currie, Greenstone, and Knittel (2017) use an index of geological suitability for hydrocarbons accessible by fracking to predict the prevalence of fracking at the U.S. county level.

tively impacts political institutions without leading to noticeably worse economic outcomes on average (Ross, 2012). The results are robust to controlling for region fixed effects and a wide variety of geographic covariates.

The potential weakness of our empirical strategy is that, even after controlling for geographic confounders, predetermined correlates of development may still be correlated with our instrument, owing to the lumpy distribution of sedimentary basins around the world. We take this concern very seriously and explore the sensitivity of our estimates to controlling for other predetermined characteristics. Out of nine important predetermined characteristics considered, only one—the percentage of the population that was Muslim in 1950—is strongly correlated with the instrument. Controlling for this variable attenuates the estimated effects of oil production on institutions (which remain negative), strengthens the estimated positive effects on GDP, and has little impact on the estimated effects on conflict and tax revenue. While the instrument is not perfect, placebo tests reassuringly show no significant correlation between sedimentary basins and democracy or population density in years when world oil production was minimal.

Several studies have argued that natural resources have heterogeneous effects which depend on country-specific factors, such as institutions.[7] Following this literature, we test for heterogeneous effects, finding that the negative long-run effects of oil wealth on democracy and tax revenue are concentrated in the subsample of countries with weak institutional constraints on executive decision-making from 1950–1965. Interestingly, countries with weak executive constraints from 1950–1965 benefited the most from oil in terms of income, probably reflecting the fact that lower-income countries have the highest potential GDP gains from oil (Smith, 2015). We view the evidence on heterogeneous effects as suggestive rather than causal, because initial institutions may be correlated with unobserved country characteristics which affect modern-day outcomes.

The results on heterogeneous effects of oil on democracy are most similar to those of Tsui (2011) and Caselli and Tesei (2016), who find that resource wealth causes non-democracies to become less democratic but has no effect on the political regime in democracies. Unlike those studies, however, we condition on initial rather than contemporary political institutions to (partially) alleviate concerns about the endogeneity of political institutions. Theory predicts that natural resource wealth will have heterogeneous effects on corruption and conflict depending on the quality of institutions (Bhattacharyya and Hodler, 2010; Besley and Persson, 2011). However, our empirical results provide little support for these predictions. Our finding that oil wealth reduces fiscal capacity is related to the theoretical predictions of Besley and Persson (2009a, 2010); Besley and Persson (2011) and is consistent with previous empirical studies

[7]For the argument that the effect of natural resources on income depends on the quality of institutions, see, e.g., Lane and Tornell (1996), Tornell and Lane (1999), Mehlum, Moene, and Torvik (2006), Robinson et al. (2006), and Boschini, Pettersson, and Roine (2007). Other studies emphasize that resource rents influence politician behavior in different ways depending on preexisting political institutions; see, e.g., Aslaksen and Torvik (2006), Bhattacharyya and Hodler (2010), Tsui (2011), Andersen and Aslaksen (2013), and Caselli and Tesei (2016).

(Jensen, 2011; Cárdenas, Ramírez, and Tuzemen, 2011). To our knowledge this is the first paper to empirically test how the effect of oil on tax revenue depends on initial institutions. Recent research on fiscal capacity and natural resources emphasizes the role of the marginal value of public funds (Besley and Persson, 2011; Jensen, 2011), however our results are more consistent with a "rentier state" model (Mahdavy, 1970; Ross, 2001) which focuses on an autocrat's ability to use public finance to produce a quiescent population.

The paper proceeds as follows. Section 2 provides background information on petroleum geology and describes the construction of the instrumental variable. Section 3 describes the data, Section 4 describes the identification strategy, Section 5 presents the main results, Section 6 discusses the evidence of heterogeneous effects, and Section 7 concludes.

2 Petroleum Geology and Instrumental Variables

2.1 Formation of Hydrocarbons

This section provides a brief overview of petroleum geology and defines the instrumental variable. There are five geological prerequisites for oil reservoir formation. First, there must be a *source rock*, a sedimentary rock rich in organic material deposited by algae and zooplankton millions of years ago. Source rocks form within a sedimentary basin—a region of the Earth's crust characterized by prolonged subsidence, in which tectonic movements cause the surface area to sink and sediments from surrounding regions to fill in the depressed area (Southard, 2007). Extreme heat and pressure convert the buried organic material into hydrocarbons, notably natural gas and crude oil (Kvenvolden, 2006). Second, a *migration pathway* must connect the source rock to an area where the reservoir will form. For example, this migration pathway may be a fracture caused by seismic activity. Third, a *reservoir rock* must be located along the migration pathway. This highly porous and permeable rock, usually a sandstone or carbonate, collects and absorbs the migrating hydrocarbons (Chen, 2009). Fourth, a highly impermeable *caprock* must seal the hydrocarbons within the reservoir rock, preventing the hydrocarbons from leaking to the surface and dissipating. The final requirement is the presence of what is known as a *trap*, which concentrates the hydrocarbons in specific locations where they can be exploited (Allen and Allen, 2005).[8] See the online appendix for illustrations.

2.2 Sedimentary Basin Classification

The Fugro Robertson, Ltd. (2013) Tellus GIS database provides the name, location, description, and geological classification of every onshore and offshore sedimentary basin. See Figure 1 for a map of the basins. Geologists rely on three general techniques to collect data on sedimentary basins: (i) surface mapping, (ii) core sampling, and (iii) subsurface geophysics

[8] I am indebted to Mike Waite, a former geophysicist at Chevron, for explaining this process to me.

such as seismic profiling (Southard, 2007). Aerial photographs provide a base map of the surface, and survey work on the ground complements the photographs in the construction of surface maps (Marjoribanks, 2010, ch. 2). Core sampling involves the removal of a cylindrical piece of subsurface material using a drill. Geologists use seismic air guns to initiate seismic waves underground. They use seismic detectors to record the arrival of the waves at different points under the surface. Geologists then use the data collected by the seismic detectors to draw seismic profiles (Britannica, 2015).

Fugro Robertson, Ltd. (2013) divides sedimentary basins into 24 classification groups according to their plate-tectonic environment, primary mechanism of subsidence, and other details regarding the nature of faulting and subsidence and the relative location of the basin on the tectonic plate. Each basin forms in one of three general plate-tectonic environments. The first is a divergent environment, in which adjacent tectonic plates pull away from each other. The second is a convergent environment, in which tectonic plates collide head on, causing one plate to pass underneath the other in a process known as subduction. Convergent environments are further divided according to whether they feature continental plates, oceanic plates, or both. The third is a wrench environment, in which adjacent tectonic plates move in opposite, parallel directions, rubbing alongside each other. The mechanism of subsidence is mechanical (a.k.a., "tectonic"), thermal, or thermo-mechanical. Mechanical subsidence is caused by the movement of tectonic plates due to faulting. Thermal subsidence is caused by the thickening of the Earth's crust due to cooling of the underlying mantle, which causes the crust to become denser than its surroundings. Thermo-mechanical subsidence is caused by some combination of the aforementioned mechanical and thermal processes.

Table A.3 in the online appendix lists the name, classification code, and plate-tectonic environment ("sub-regime") of each of the 24 Fugro Robertson basin types. The classification code consists of two or three elements. The first element indicates the general plate-tectonic environment. It takes the value of "D" for "Divergent," "C" for "Convergent," and "W" for "Wrench." For codes consisting of three elements, the second element indicates the involvement of continental tectonic plates, oceanic tectonic plates, or both. A second-element value of 1 indicates the presence of two continental plates, 2 indicates the presence of one continental and one oceanic plate, and 3 indicates the presence of two oceanic plates. For example, a basin with code starting with "C.1" exists in an environment in which two continental plates are converging, while a basin with code starting with "C.2" exists in an environment in which a continental plate and an oceanic plate are converging. For codes consisting of three elements, the third element indicates the location of the basin relative to the plates and areas of faulting. For example, codes ending in "F" indicate foreland basins, which are formed adjacent to a mountain range caused by the subduction of two plates. The code "C.1.F" corresponds to a foreland basin formed in the context of two continental plates colliding, while "C.3.F" corresponds to a foreland basin formed from the collision of two oceanic plates. To give another example, codes ending in "E" indicate extensional basins, which are formed in areas characterized by the stretching of the crust or lithosphere. For codes consisting of only two elements, the second element indicates the location of the basin relative to the plates and areas of faulting. In sum, the final element of the code indicates local characteristics of the basin formation, while the preceding elements of the code indicate global characteristics of the plate-tectonic environment.

Figure A.18 in the online appendix displays diagrams for two common basin types. The first basin type, C.1.F or "peripheral foreland basin," exists in a convergent plate-tectonic environment and is characterized by a mechanical subsidence mechanism. Peripheral foreland basins are found adjacent to mountain ranges formed by the subduction of two continental plates. Large peripheral foreland basins exist in the Persian Gulf and Arabian Peninsula, adjacent to the Zagros mountains in Iran. The second basin type, D.4 or "passive margin basin," forms within a divergent plate-tectonic environment and features a thermal subsidence mechanism. Passive margins occupy areas where an oceanic plate and a continental plate have diverged, such as the eastern coastlines of the Americas and all coastlines of Africa, among other places.

2.3 Instrument Construction

The next task is to specify the candidate instrument sets. The composition of each instrument set depends on two choices. The first choice is how to aggregate the 24 Fugro Robertson basin categories into a smaller number of exhaustive and mutually exclusive basin categories. Aggregating the basin categories is reasonable *a priori* as many of the disaggregated categories account for a very small fraction of the earth's surface area and thus are unlikely to have much predictive power. The second choice is which aggregate basin categories to include in the set of instruments. Section 4 describes the instrument selection procedure.

We pursue two approaches to basin aggregation. The first is based on the global characteristics of the basin environment—the general plate-tectonic environment and primary mechanism of subsidence. Fugro Robertson, Ltd. (2013) provides a grouping that assigns each basin type to one of five plate-tectonic environments—divergent, convergent continent-continent, convergent ocean-continent, convergent ocean-ocean, and wrench—and one of three subsidence categories—mechanical, thermo-mechanical, and thermal. This method results in eight groups of basin types that actually exist, as shown in Table A.4 in the online appendix.[9]

The second approach is based on the local characteristics of the basin as indicated by the final element of the Fugro Robertson, Ltd. (2013) code. As already mentioned, the local characteristics involve the location of the basin relative to the plates and areas of faulting. This

[9]Basins with convergent ocean-ocean tectonics and thermal subsidence covered only 1,331 square kilometers of sovereign area among countries in the sample, which is several orders of magnitude less than any other basin group defined by the tectonic environment and subsidence mechanism. These basins exists in essentially just one country included in the sample. (St. Kitts and Nevis contains 1,329 square kilometers of this basin type, while Venezuela contains two square kilometers.) We therefore combine these basins with those with convergent ocean-ocean tectonics and mechanical subsidence.

approach produces ten basin groups, as shown in Table A.5 in the online appendix. The online appendix provides maps of the aggregated basin categories.

We assign values of each aggregate basin type to countries by calculating the log of the sovereign area (in square kilometers) per 1000 inhabitants in 1960 covered by the basin.[10] Sovereign territory is inclusive of maritime boundaries. Data on country land borders are from Erle and Gilles (2013), and data on maritime borders are from the Flanders Marine Institute (2013).[11]

3 Other Data Sources

This section describes the other data sources used in the empirical analysis. The sample period is 1966–2008.[12] Data on oil production, our primary measure of oil wealth, come from Ross (2013), who cleaned and compiled data from the U.S. Geological Survey, the U.S. Energy Information Administration's International Energy Statistics, the World Bank, and the BP Statistical Review. This dataset covers 172 countries, of which 96 have produced oil, from 1932–2011.[13] Oil production is measured as the log of average annual metric tons per 1000 inhabitants from 1966–2008.

To ensure that the basin instrument satisfies the exclusion restriction, we include controls for geographic features that are possibly correlated with both sedimentary basins and economic and political outcomes. The basin variable will naturally be correlated with the physical size of the country, so we include a control for total land area calculated from GIS data. Gallup, Sachs, and Mellinger (1998) show that countries with more land in the tropics and less access to waterways tended to grow more slowly over their sample period. We use their data to construct a measure of land area in the tropics. Data on country coastline are obtained from the CIA World Factbook (CIA, 2015). We also use data on the area of mountainous land from Fearon and Laitin (2003), who argue that mountainous terrain is associated with higher levels of insurgency and civil war. Finally, we control for soil quality, which could influence development directly through its effect on agricultural productivity, or indirectly through the division of labor and the evolution of gender norms (Alesina, Giuliano, and Nunn, 2013). We use the FAO's Global Agro-Ecological Zones (GAEZ) database (Fischer, van Velthuizen, Shah, and Nachtergaele, 2002) to calculate each country's land area containing "good" soil.[14]

[10] All geographic variables are normalized by population in 1960, prior to the sample period, because population may be endogenous to oil production through changes in migration (Michaels, 2011) or fertility (Ross, 2008).

[11] All geographic calculations use the Cylindrical Equal Area projected coordinate system, which preserves area measure.

[12] The sample ends in 2008 to avoid the depths of the Great Recession.

[13] An advantage of this dataset is that it also includes information on oil exports as well as natural gas production and exports. Natural gas often accumulates near crude oil reservoirs, so the sedimentary basin instrument also predicts natural gas endowment. The empirical analysis focuses on oil production to facilitate comparison to past studies, however the results are very similar when the explanatory variable is oil and gas production.

[14] The GAEZ database divides zones according to the moisture regime (dry, moist, sub-humid, or humid) and soil quality (good, moderate, or poor). We define "good soil" as soil with "good" quality falling in any of the

Soil quality depends on nutrient availability, nutrient retention capacity, rooting conditions, oxygen availability, presence of excess salts, toxicity, and workability.

As with the *Basin* variables, all geographic controls measuring surface area are expressed as the log of the surface area (in square kilometers) per 1000 inhabitants in 1960. The coastline variable is expressed as the log of the coastline (in kilometers) per 1000 inhabitants in 1960.[15] Data on population come from Maddison (2013).

We measure democracy using the standard POLITY2 index from the Polity IV database (Marshall and Gurr, 2014), which depends on qualities of executive recruitment, constraints on executive authority, and political competition. The index takes integer values from −10 to 10. POLITY2 codes cases of foreign "interruption" as missing and cases of "interregnum," or anarchy, as zero. Furthermore, the POLITY2 score is prorated starting from zero during periods of transition following interruption or interregnum. This can give the false impression that, say, a period of anarchy in an autocratic country represents a movement towards democracy. We follow the recent literature (Brückner and Ciccone, 2011; Caselli and Tesei, 2016) and code periods of interregnum as missing. Furthermore, we prorate the score during periods of transition starting from the most recent non-missing POLITY2 score. We normalize POLITY2 to take values between zero and one, with one being the most democratic. Two different democracy outcomes are used: (1) democracy in 2008 and (2) average democracy from 1966–2008 in years in which the country was independent. The measure of executive constraints is the XCONST variable from the Polity IV database, also normalized to take values between zero and one. This variable measures the "extent of institutionalized constraints on the decision-making powers of chief executives," where the constraints can be imposed by any accountability group (Marshall and Gurr, 2014).

Data on corruption and conflict come from several sources. Our corruption measure comes from the Political Risk Services (PRS) and focuses on corruption within the political system.[16] The index ranges from zero to six, with higher numbers indicating less corruption. We recode the corruption variable to be six minus the PRS index, so that the new variable ranges from zero to six, with higher numbers indicating *more* corruption. We measure corruption in 2008. Three variables capture different aspects of political conflict. First, we use the UCDP/PRIO dataset (Gleditsch, Wallensteen, Eriksson, Sollenberg, and Strand, 2002) to calculate the number of internal or internationalized internal armed conflicts per year in which the country was independent from 1966–2008. The dataset counts only conflicts in which the government is a party and which involve at least 25 battle-related deaths. Second, we use the Polity IV database (Marshall and Marshall, 2016) to count the number of (failed or successful) coup attempts per

moisture regimes. We use the most recent version of the database available, version 3.0.

[15] Due to the presence of zero values, each "log" transformation in the empirical analysis is in fact a differentiable and monotonic transformation $h(w) = \log(w)$ for $w > w_0$ and $h(w) = \log(w_0) - 1 + w/w_0$ for $w \leq w_0$. In practice w_0 is set equal to the minimum positive value of the random variable observed in the sample.

[16] According to the Political Risk Services, the measure accounts for excessive patronage, nepotism, job reservations, 'favor-for-favors,' secret party funding, and suspiciously close ties between politics and business.

year in which the country was independent from 1966–2008.[17] Finally, we use the dataset by Banks and Wilson (2016) to calculate the number of purges per year in which the country was independent from 1966–2008.[18]

Revenue data come from the ICTD Government Revenue Dataset, compiled by Prichard, Cobham, and Goodall (2014) on behalf of the International Centre for Tax and Development (ICTD). The series covers the period 1980–2013 for 204 countries, although a nontrivial amount of data are missing, particularly in earlier years. Previously available cross-country tax and revenue datasets were plagued by many missing observations, inconsistent accounting definitions, and inadequate decomposition of tax and revenue by source, among other problems. In particular, accounting treatment of natural resource revenue is notoriously variable across countries, making cross-country analysis difficult. The authors of the ICTD dataset combined and manually cleaned data from several international databases, improving data coverage and consistency. For the purposes of this paper, the ICTD dataset is particularly valuable because it is based on a standardized approach to revenue from natural resources.[19] We focus on two government revenue outcomes: total revenue and tax revenue. All revenue variables exclude social contributions. Total revenue is the sum of all tax and non-tax revenue. Crucially, total revenue includes both resource tax revenue (e.g., corporate taxes paid by private natural-resource firms) and non-tax resource revenue (e.g., royalties paid by private companies and profits from state-owned natural-resource companies). Following the ICTD classification, tax revenue is defined as the sum of all non-resource tax revenue.[20] To maximize sample size and smooth out fluctuations due to business cycles, revenue variables are measured as the log of their average share of GDP from 2000–2008.

Fiscal capacity—the state's maximum administrative ability to collect tax revenue—is unobservable. Following the empirical fiscal-capacity literature (Besley and Persson, 2011; Jensen, 2011; Cárdenas et al., 2011), we use tax revenue as a proxy for fiscal capacity. Tax revenue collection requires investment in tax administration and entails higher information and enforcement costs than other forms of revenue, such natural-resource royalties (Besley and Persson, 2011). We thus expect variation in tax revenue to largely reflect variation in the state's administrative capacity to collect taxes.

We measure the log of GDP per capita in 2008 (constant 2011 international dollars) using

[17] A coup is defined as a "forceful seizure of executive authority and office by a dissident/opposition faction within the country's ruling or political elites that results in a substantial change in the executive leadership and the policies of the prior regime (although not necessarily in the nature of regime authority or mode of governance)" (Marshall and Marshall, 2016).

[18] A purge is defined as "any systematic elimination by jailing or execution of political opposition within the ranks of the regime or the opposition" (Banks and Wilson, 2016).

[19] Despite the extensive efforts made to construct a reliable dataset, some problems remain due to the limitations of primary sources. In some cases the data appear not credible, and in other cases it is impossible to isolate natural resource revenue from other types of revenue. These problematic observations are flagged in the dataset and are excluded from the empirical analysis.

[20] This definition is conceptually appealing, as we are interested in how resource wealth affects investments in state capacity. Taxing a few large resource firms requires much less administrative capacity than, say, enforcing a personal income tax.

the World Bank's World Development Indicators. We construct sub-components of GDP per capita—non-oil GDP per capita, non-oil/gas GDP per capita, non-resource GDP per capita, and manufacturing GDP per capita—using GDP per capita and GDP share data from the World Bank's World Development Indicators. For example, non-resource GDP per capita is constructed by multiplying GDP per capita by one minus the share of natural resource rents (value of production less production costs) in GDP. Similarly, manufacturing GDP is constructed by multiplying GDP per capita by the share of manufacturing value added in GDP. Subcomponents of GDP per capita are also measured in 2008 and in log scale.

4 Identification Strategy

4.1 Estimating Equations

This section describes the identification strategy. We estimate the effect of oil wealth on country outcomes using sedimentary basin areas as instruments. The estimating equations are

$$y_{cr} = \beta Oil_{cr} + \boldsymbol{\delta}'\boldsymbol{x}_{cr} + \alpha_r + \varepsilon_{cr}$$

$$Oil_{cr} = \boldsymbol{\pi}'\boldsymbol{Basin}_{cr} + \boldsymbol{\phi}'\boldsymbol{x}_{cr} + \lambda_r + \xi_{cr},$$

where c indexes countries and r indexes regions. The variable y represents a country-level outcome, such as level of democracy or tax revenue. *Oil* is a measure of average annual oil production per capita over the period of interest.[21]

$\boldsymbol{Basin}$ is a possibly multidimensional vector of sedimentary basin measures. The main threat to identification is the possibility that some geographic features omitted from the model are correlated with elements of $\boldsymbol{Basin}$ and development outcomes. We address this concern by controlling for several geographic characteristics that have been shown to be correlated with economic and political development.[22] The vector $\boldsymbol{x}$ comprises total land area, mountainous area, tropical area, good-soil area, and length of coastline. The parameter α_r represents an unobserved region-specific determinant of development.[23] We eliminate the potential bias produced by α_r by including region indicator variables.

The first identifying assumption of the model is that, conditional on the set of geographic covariates, $\boldsymbol{Basin}$ is independent of potential development outcomes and potential selection into oil discovery. Informally, this assumption says that $\boldsymbol{Basin}$ does not have a direct effect on development outside the channel of oil discovery, and that basin prevalence is not

[21]We focus on the effect of oil production, because the results are very similar for other measures of oil abundance, such as oil discovery, oil reserves, oil endowment, and oil and gas production. These results are available upon request.

[22]See Gallup et al. (1998) for geographic correlates of economic development, and see Fearon and Laitin (2003) for the correlation between mountainous terrain and insurgency.

[23]The regions are Africa, Europe/Northern America/Oceania, Asia, and Latin America/Caribbean.

systematically related to country exploration technology or any other propensity for discovery, after controlling for geographic covariates. Given that we control for geographic features that are both plausibly correlated with $\boldsymbol{Basin}$ and may affect development outcomes, the first assumption is likely to hold. The second identifying assumption is that increasing the prevalence of sedimentary basins would never cause a country to produce less oil, for example because of lower exploration effort. This is the familiar monotonicity assumption (Imbens and Angrist, 1994; Angrist and Imbens, 1995). It is likely to hold in all but the most implausible scenarios. The final identifying assumption is that $\boldsymbol{Basin}$ and *Oil* have non-zero correlation. If these assumptions hold, then the two-stage least squares estimand identifies the average causal effect of *Oil* on y in countries where a marginal change in basin area induces a change in *Oil* (Angrist and Imbens, 1995).

Our identification strategy is related to studies which use a measure of the initial resource endowment as an instrument for resource wealth over a specific time period (van der Ploeg and Poelhekke, 2010; Tsui, 2011). The resource endowment of a country is typically measured as the sum of cumulative resource discoveries and a geological estimate of undiscovered subsoil resources. The disadvantage of this measure is that known resource endowments represent a non-random sample of true resource endowments. Resource discovery depends on exploration effort, which is likely to be correlated with country characteristics such as property rights institutions (Bohn and Deacon, 2000; Cust and Harding, 2017; Arezki, van der Ploeg, and Toscani, 2017). Hence the difference between true endowment and known endowment is a function of country characteristics that influence development. In contrast, sedimentary basins cannot respond to country-level political or economic conditions.[24] The next section will discuss robustness checks comparing estimates using the basin instrument to estimates using the oil endowment instrument from Tsui (2011).

In contrast to the empirical strategy presented here, researchers commonly use commodity price shocks, either directly (Caselli and Tesei, 2016) or interacted with a time-invariant measure of resource abundance (Brückner et al., 2012; Dube and Vargas, 2013; Andersen et al., 2017; Carreri and Dube, 2017), as a source of exogenous variation in resource wealth. The strategy appears very credible when applied to subnational data. However, in cross-country studies, the approach raises two concerns. First, the commodity price may not be exogenous to all countries. Producers with significant market share, such as members of OPEC, may adjust production to manipulate prices in response to changing global or domestic economic conditions. This concern is alleviated by dropping large producers from the sample, but at the expense of external validity. Second, the time-invariant measure of resource abundance, usually calculated in an initial period or averaged over several periods, is endogenous in cross-country regressions for reasons already mentioned. Identification issues aside, the price-shock strategy

[24] In principle, there could be some relationship between the collection of data on sedimentary basins and unobserved determinants of oil production or country outcomes. In subsection 5.5 we discuss why this is unlikely to be a source of bias. Subsection 5.5 also considers the possibility that predetermined correlates of development might be correlated with sedimentary basins.

is suited for estimating the short-run effects of natural resources, whereas this paper is focused on long-run effects.

4.2 Instrument Selection

No definitive ranking of sedimentary basin types by hydrocarbon potential exists in the petroleum geology literature.[25] Therefore, we pursue a data-driven procedure for instrument selection. In selecting a set of valid instrumental variables, the researcher generally faces a trade-off between bias and efficiency. Starting from a baseline set of valid instruments, adding additional valid instruments potentially improves asymptotic efficiency (Wooldridge, 2010, pp. 229–230). However, the finite-sample bias of 2SLS generally grows with the number of instruments used (Donald and Newey, 2001), posing a particularly severe problem when the added instruments are weak (Bound, Jaeger, and Baker, 1995). Furthermore, the presence of weak instruments can render inference based on the standard normal approximations invalid (Staiger and Stock, 1997; Stock and Yogo, 2003). In light of these concerns, we search for the (possibly singleton) set of instruments that maximizes the first-stage F statistic, rather than including all possible instruments. In this way we prioritize minimizing bias and making valid inferences over maximizing efficiency. Specifically, for each of the two basin aggregation methods described in Section 2, we estimate a first-stage regression for every possible subset of basins. For each regression, we calculate the Kleibergen and Paap (2006) robust rk Wald F statistic for the excluded instruments.

The main results will be based on the set of instruments that maximizes this F statistic, though we will also report results using the F statistic-maximizing instrument set for each set size. It is important to note that the instrument selection procedure does not invalidate second-stage inference. The reason is that model selection is performed at the service of predicting oil production, not second-stage outcomes.

5 Empirical Results

5.1 Descriptive Statistics

Table A.7 in the online appendix provides general summary statistics. Average democracy in 2008 (0.69) greatly exceeds average democracy in 1966 (0.44), reflecting a general trend toward democratization. Table 1 summarizes variables separately according to whether the country produced any oil from 1966–2008. In the sample period 96 countries had positive oil production, and 76 had zero production. In 1966 average democracy in non-oil countries was three percentage points higher than average democracy in oil countries. By 2008 this difference had increased to seven percentage points, though neither difference is statistically significant

[25] Kingston, Dishroon, and Williams (1983) admit that "there is no magic formula which can separate sedimentary basins into oil-and-gas-prone versus barren."

($p = 0.677$, $p = 0.182$). Corruption levels and the number of coup attempts were similar in the two groups, however oil countries had more internal conflict and purges ($p = 0.068$, $p = 0.067$). While oil countries had greater total revenue as a proportion of GDP from 2000–2008 compared to non-oil countries ($p < 0.001$), total non-resource tax revenue was lower in oil countries than in non-oil countries ($p = 0.179$). Oil countries tended to be richer than non-oil countries, both in 1966 ($p < 0.001$) and in 2008 ($p < 0.001$). Average executive constraints from 1950–1965 were slightly stronger in oil countries, although the difference is statistically insignificant ($p = 0.594$). Unsurprisingly, all sedimentary basin measures are higher for oil countries, with the exception of the relatively rare convergent ocean-ocean basins, though the difference in average values is statistically insignificant. Average land area, coastline, mountainous area, and good-soil area are statistically indistinguishable in the two groups, although oil countries contain less tropical area on average ($p = 0.029$). It is important to note that the categories mask considerable heterogeneity in production levels, as the distribution of oil production is highly skewed.

5.2 First-Stage Results

Table 2 presents the first-stage results for the effect of the basin variables on oil production. To conserve space, the table reports results for the three top-performing (in terms of first-stage F statistic) instrument sets for each approach to basin aggregation—global characteristics or local characteristics. Tables A.8 and A.9 in the online appendix present the first-stage results for all 18 instrument sets considered. Each column in Table 2 reports the Kleibergen and Paap (2006) robust *rk* Wald F statistic, which tests for weak identification and is robust to heteroskedasticity. In each table, column N reports the results using the instrument set of size N that maximizes the first-stage F statistic.

The first group of instruments in Table 2 are aggregate categories based on global characteristics: the general plate-tectonic environment and primary mechanism of subsidence. The singleton instrument set that maximizes this F statistic is the basin type with convergent continent-continent tectonics and mechanical subsidence, which achieves an F statistic of 25.3. The aforementioned basin type, together with the basin type with convergent ocean-continent tectonics and thermal subsidence, constitute the two-instrument set that maximizes the F statistic, achieving an F statistic of 17.6. Inspection of Table A.8 reveals that, with one exception, adding an additional instrument reduces the F statistic. When every instrument is included, the F statistic equals 9.4.

The second group of instruments in Table 2 are aggregate categories based on the final element of the Fugro Tellus code, which indicates local characteristics of the depositional environment. The singleton instrument set that maximizes the first-stage F statistic is the foreland basin type, which achieves an F statistic of 16.4. Foreland basins and intracratonic sag basins constitute the two-instrument set that maximizes the first-stage F statistic, achieving an

F statistic of 17. From column 2 to column 10 in Table A.9, the F statistic declines monotonically in the number of instruments included, equaling only 6.6 when every instrument is included.

Comparing the results across all instrument sets, the instrument set that maximizes the F statistic is the singleton basin type with convergent continent-continent tectonics and mechanical subsidence. The baseline second-stage results will be based on this instrument set, though we report results using the other instrument sets in the online appendix. The optimal instrument set's F statistic of 25.3 indicates that strong-instrument asymptotic theory applies. Nonetheless, to be conservative we also report 95-percent Anderson and Rubin (1949) confidence intervals for the coefficient on oil. Unlike the usual Wald test, the Anderson-Rubin test has correct size in the presence of weak instruments.

5.3 Second-Stage Results

Tables 3 and 4 present the main second-stage results. In each table, Panel A presents the OLS estimates, and Panel B presents the IV estimates. Below the IV estimates in Panel B, we report the p-value to a test of whether oil production is endogenous. The endogeneity test is the Hansen (1982) overidentification test of the null hypothesis that oil production is exogenous. The test is valid under the assumption that *Basin* is exogenous.[26]

5.3.1 Political Resource Curse

Table 3 presents tests of the political resource curse hypothesis. The regressions presented in the first two columns provide strong evidence that oil wealth impedes democracy. The IV estimates indicate that a one-percent increase in average annual oil production per capita from 1966–2008 reduces the level of democracy in 2008 by 0.038. The same increase in oil production reduces average democracy during 1966–2008 by 0.039. The effects are statistically significant at the five- and one-percent levels, respectively, and appear to be large in political-economic terms. An increase in oil production by one standard deviation (4.24 log points) reduces the 2008 democracy score by 0.16, or half a standard deviation. This is roughly equal to the difference between the scores of Colombia or Kenya (0.85) and the United States (1.0). In both democracy specifications, the OLS estimates are smaller in absolute magnitude than the IV estimates; in the second specification we can statistically reject the exogeneity of oil production ($p = 0.063$), although in the first we cannot.

The results in column 3 suggest that oil wealth increases corruption, consistent with conventional wisdom and previous empirical evidence (e.g., Bhattacharyya and Hodler, 2010). An increase in oil production by one standard deviation increases corruption by 0.58 points, or half a standard deviation. The OLS estimates are much smaller in absolute magnitude and are statistically insignificant. The discrepancy between the OLS and IV results is consistent

[26] The test is essentially a heteroskedasticity-robust version of the usual Durbin-Wu-Hausman test of the difference between OLS and IV.

with more corrupt countries attracting less oil exploration and production, perhaps due to a poor business environment. In this specification we can statistically reject the exogeneity of oil production ($p = 0.053$).

The results in columns 4 through 6 provide little evidence that oil wealth increases conflict—contrary to conventional wisdom, though consistent with previous research (Cotet and Tsui, 2013). The OLS results suggest that oil wealth has a positive and significant effect on internal armed conflict, though the corresponding IV estimate is half the size of OLS and is statistically insignificant. Both the OLS and IV regressions find that the effect of oil wealth on coup attempts and purges is statistically insignificant.

Columns 7 and 8 examine the effect of oil production on government revenue. The IV estimate of the effect of oil production on total government revenue is positive but statistically insignificant. In contrast, the IV estimate of the effect of oil production on tax revenue is negative and statistically significant. A one-percent increase in oil production causes a 0.16-percent reduction in tax revenue as a share of GDP from 2000–2008. The effect on tax revenue is significant at the one-percent level. An increase in oil production by one standard deviation causes a decline in tax revenue by 0.69 log points, or one standard deviations. This is roughly the difference between Burundi (−2.01) and France (−1.32). The corresponding OLS estimates are much smaller in absolute magnitude. The Hansen (1982) test decisively rejects the exogeneity of oil production in the tax revenue specification ($p < 0.001$) but not the total revenue specification.

5.3.2 Economic Resource Curse

Table 4 presents tests of the economic resource curse hypothesis. Column 1 presents results for (log) GDP per capita, while columns 2 through 5 present results for disaggregated measures of (log) GDP per capita. Both the OLS and IV estimates indicate that oil wealth raises GDP. According to the IV estimate, a one-percent increase in average oil production per capita raises GDP per capita in 2008 by 0.07 percent. The effect is statistically significant at the ten-percent level. Raising oil production by one standard deviation causes an increase in GDP by 0.31 log points, or 0.25 standard deviations. This is roughly the difference between Norway (11.09) and Ireland (10.78) or between Algeria (9.45) and Ecuador (9.14).

The results in column 1 could be consistent with oil wealth harming the non-resource sectors of the economy, as long as the positive effects on the resource sector outweigh the negative effects on the non-resource sectors. The OLS results in columns 2 through 5 indicate that oil wealth actually raises non-resource GDP and manufacturing GDP. The IV estimates for non-resource GDP are similar to the OLS estimates, though less precise. Together they suggest that a one-percent increase on oil production raises non-resource GDP by 0.05 to 0.07 percent. The OLS and IV estimates of the effect of oil wealth on manufacturing significantly diverge. The OLS estimate indicates that a one-percent increase on oil production raises manufacturing

GDP by almost 0.08 percent, and this estimate is significant at the one-percent level. On the other hand, the IV estimate is negative and statistically insignificant. We reject the exogeneity of oil production in the manufacturing GDP equation ($p = 0.079$).

In four of the 13 specifications, the Hansen (1982) test rejects the exogeneity of oil production at the 10-percent level. This outcome is unlikely to be due simply to chance or multiple hypothesis testing. For example, if oil production were in fact exogenous in each of the 13 regressions, the probability of rejecting the null hypothesis of exogeneity at the 10-percent level in four or more of the specifications is 0.034 (assuming the tests are independent).[27] Furthermore, whenever the OLS and IV estimates diverge considerably, OLS understates the negative effects of oil relative to IV. Thus the results are consistent with the possibility that countries with stronger political and fiscal institutions disproportionately select into oil discovery and production.

5.4 Varying the Instrument Set

The results discussed so far are based on the optimal (singleton) instrument set which maximizes the first-stage F statistic. We now consider how the results change when the instrument set changes. Figures A.4 and A.5 in the online appendix plot the second-stage results for the political and economic outcomes, respectively, using instrument sets categorized according to the general plate-tectonic environment and primary mechanism of subsidence. The results based on N instruments use the instrument set of size N that achieves the highest first-stage F statistic. For each outcome, the gray, dashed line indicates the value of the corresponding OLS estimate. As Table A.8 shows, each of the eight instrument sets is at least moderately strong, however the first (singleton) instrument set is significantly stronger than the others, with a first-stage F statistic of 25.3. Because of this, along with the fact that the bias of 2SLS generally increases with the number of instruments (Donald and Newey, 2001), we would expect results based on the first instrument set to have lower bias, but also lower precision, compared to results based on the other instrument sets. Consistent with this prediction, the estimated effects of oil production on democracy, average democracy, corruption index, and tax revenue are further from the OLS results and less precise when using one instrument—or even two instruments—compared to estimates based on larger instrument sets. Adding additional, weaker instruments pushes the 2SLS estimates toward the OLS estimate, which we expect to be biased upwards for democracy and tax revenue and downwards for corruption. The estimates of the effect of oil production on internal conflict and purges show a somewhat different pattern: estimates based on small instrument sets imply effects roughly equal to zero, while estimates based on larger instrument sets imply positive and marginally significant effects. The point estimates for coup attempts and total revenue do not change much as the instrument

[27] Under the stated assumptions, the number of rejections, W, has a binomial distribution with $n = 13$ and $p = 0.1$. Therefore, $\mathrm{P}(W \geq 4) = 0.034$.

set varies. For every measure of GDP, the point estimates based on smaller instrument sets are smaller than the point estimates based on larger instrument sets. This pattern is especially apparent for non-resource GDP and manufacturing GDP. Similar to the results for democracy, corruption, and tax revenue, the GDP results are consistent with the fact that richer countries with stronger institutions engage in more resource exploration and production.

Figures A.6 and A.7 in the online appendix plot the second-stage results for the political and economic outcomes, respectively, using instrument sets categorized according to the local properties of the depositional environment. Once again, results based on N instruments use the instrument set of size N that achieves the highest first-stage F statistic. The coefficient patterns are qualitatively similar to those in Figures A.4 and A.5 in the online appendix. The main difference is that the estimates based on different instrument sets diverge less from each other, perhaps because the smaller instrument sets are weaker than in the case of the tectonic-subsidence grouping. Another difference is that the sign and statistical significance of the estimated effect of oil production is less sensitive to the instrument set—at least for the political outcomes—than when instrument sets based on the tectonic-subsidence grouping are used. In fact, nearly every instrument set implies that oil production has a negative and significant effect on democracy, average democracy, and tax revenue; a positive and significant effect on corruption, internal conflict, purges, and total revenue; and an insignificant effect on coup attempts. The preponderance of the evidence suggests that OLS understates the adverse political effects of oil production, though the OLS and 2SLS estimates often are not statistically different from one another. In the GDP equations, by contrast, the OLS and 2SLS results are similar for most instrument sets and do not suggest that OLS is systematically biased in one direction or another.

5.5 Validity of the Instrument

5.5.1 Measurement

We now consider several potential objections to the validity of the *Basin* instrument. The first relates to measurement. Two of the three methods used to map sedimentary basins—core sampling and seismic profiling—require the use of advanced technology and physical access to the area under investigation. One might therefore worry that the precision or reliability of the basin data is increasing in "good" institutions like property rights protections. In that case the *variance* of the basin measurement error would be decreasing in the quality of institutions. However, it does not follow that the measurement error is *correlated* with the quality of institutions, so the above form of measurement error need not produce asymptotic bias.

Another version of the measurement argument supposes that basin area is systematically underestimated in countries with poor institutions, invalidating the instrument. This argument is unconvincing for two reasons. First, it is inconsistent with the pattern of basin coverage by region. Table A.6 in the online appendix summarizes the portion of sovereign area covered by sedimentary basins separately for seven regions defined by common geographical location and history. Basin coverage is actually higher on average in Eastern Europe and Central Asia (0.67) and the Middle East and North Africa (0.86)—areas associated with relatively weak property-rights protections—than in the extensively prospected areas of Northern, Central, Western, and Southern Europe and Neo-Europes (0.57).[28] This pattern is visually confirmed in Figure 1. Second, even if basin area were underestimated in countries with poor institutions, the vast majority of the conclusions drawn in this paper would hold up. This type of non-classical measurement error would cause the IV estimates to understate the effects of oil on democracy, corruption, conflict, and fiscal capacity, so that the estimated coefficients would often provide informative (absolute) lower bounds on the true effect.[29]

5.5.2 Reverse-Engineering of the Basin Classification

The next potential objection is that sedimentary basin classification could be reverse-engineered: the known presence or absence of hydrocarbons may influence how geologists categorize a basin, based on their knowledge of other hydrocarbon-rich or hydrocarbon-poor basins. Therefore, some of the correlation between hydrocarbons and particular basin types may be spurious rather than based on true geological features.

This issue is unlikely to invalid our results, for two reasons. First, reverse-engineering of basin categories would bias the 2SLS estimates towards the OLS estimates. The intuition is simple: in the most extreme case of reverse-engineering, a few basin types would have 100-percent hydrocarbon success rates and would jointly predict oil production perfectly, causing the 2SLS estimates to equal the OLS estimates. To the extent that the 2SLS and OLS estimates differ, the 2SLS estimates still provide useful bounds on the true effects of oil production.

Second, as already discussed, Figures A.4, A.5, A.6, and A.7 in the online appendix show that the results are broadly similar whether instruments are constructed based on global characteristics of basins or local characteristics. It is unlikely that both the global and local categorizations of basins could be reverse-engineered.

5.5.3 Predetermined Confounders

Another potential objection is that *Basin* could be correlated with omitted determinants of development, causing an asymptotic bias of unknown sign. To explore this possibility, Table 5 reports the results from regressing several predetermined variables on the basin instrument, controls, and region effects. The first outcome is the urbanization rate in 1850, which is the

[28] The "Neo-Europes" are Australia, Canada, New Zealand, and the United States.

[29] Let Z, Z^*, and X be the measured *Basin*, the true *Basin*, and *Oil*, respectively, after netting out the control variables using population projections. If the measurement error in *Basin*, e, is uncorrelated with the control variables, then $Z = Z^* + e$ (Wooldridge, 2010, p. 29). Then the probability limit of $\hat{\beta}_{IV}$ is $\beta + \mathrm{Cov}(\varepsilon, e)/\mathrm{Cov}(X, Z)$. Because $\mathrm{Cov}(X, Z)$ is positive, the sign of the bias depends on the sign of $\mathrm{Cov}(\varepsilon, e)$. For "good" outcome variables like democracy, the example in the text implies that the bias is positive, whereas for "bad" outcome variables like conflict, the bias is negative.

last year in the series provided by Chandler (1987). The next outcome is an indicator for have a British legal origin, taken from William Easterly's Global Development Network Growth Database (Easterly, 2001). The third outcome is an indicator for having a legacy as a communist country, taken from the list of communist countries in Kornai (1992). The next three outcomes measure the percentage of the population that was Christian, Muslim, or Hindu in 1950. These data come from the World Religion Database (Johnson and Grim, 2017). The final three outcomes are measures of ethnic, religious, and linguistic fractionalization produced by Alesina, Devleeschauwer, Easterly, Kurlat, and Wacziarg (2003). Seven of the nine estimated coefficients on *Basin* are statistically insignificant, suggesting that the instrument is uncorrelated with historical determinants of long-run economic development, legal origin, communist legacy, the presence of Christians or Hindus, or religious or linguistic fractionalization. The basin instrument has a strong, positive correlation with the percentage of the population that was Muslim in 1950. A large portion of this correlation is driven by the religious composition and presence of basins in the Middle East and North Africa; adding a dummy variable for this region causes the coefficient on *Basin* to fall by half.[30] The basin instrument also has a positive correlation with ethnic fractionalization that is significant at the ten-percent level. It is therefore important to examine how the main results change when we control for these two variables.

Table 6 reports the main results for the political outcomes using the optimal instrument while controlling for the percentage of the population that was Muslim in 1950. The OLS estimates of the effect of oil production on the political outcomes generally move slightly closer to zero while maintaining the same pattern of signs and similar levels of statistical significance: oil production still has a negative and significant effect on democracy, average democracy, and tax revenue, while having a positive and significant effect on internal conflict and total revenue. Controlling for the Muslim population causes the 2SLS estimates to become more imprecise, due to a weakened first stage. The 2SLS estimates for the effect of oil production on democracy, average democracy, and corruption all move towards zero while remaining greater than the OLS point estimates in absolute value, once again suggesting that OLS may understate the adverse effects of oil wealth on institutions. These three point estimates are now statistically insignificant. Given that OLS likely provides an upper bound on the effect of oil production on democracy, we are still able to conclude that oil impedes democracy. Controlling for Muslim population pushes the 2SLS estimate of the effect of oil production on tax revenue slightly closer to zero, however this estimate remains sizable and highly significant.

Table 7 reports the main results for the economic outcomes using the optimal instrument while controlling for the percentage of the population that was Muslim in 1950. Both the OLS and 2SLS estimates are broadly similar to those in the baseline specification, in terms of both magnitude and significance. Controlling for Muslim population leads to slightly larger positive estimated effects of oil production on GDP.

[30] Result not shown but available upon request.

Overall, Tables 6 and 7 suggest that the baseline 2SLS estimates may have slightly overstated the adverse effects of oil wealth on democracy and taxation while still providing strong evidence that such adverse effects exist. The results weaken the original claim that the OLS results for average democracy and corruption were substantially biased, while confirming the claim that the OLS results for taxation were substantially biased. The robustness check confirms the baseline OLS and 2SLS estimates for the GDP regressions.

Are the above results limited to the optimal instrument, or do they apply to all instrument sets? Figures A.8, A.9, A.10, and A.11 in the online appendix replicate the main results using optimal instrument sets of different sizes while controlling for the percentage of the population that was Muslim in 1950. The pattern of coefficient estimates based on different instrument sets is very similar to the pattern in the original figures. The two main differences are that some point estimates move slightly closer to zero, and the confidence intervals of all point estimates grow.

Tables A.10 and A.11 in the online appendix report the main results using the optimal instrument while controlling for ethnic fractionalization. The results are remarkably similar to the baseline results, which is perhaps unsurprising given that the partial correlation between *Basin* and ethnic fractionalization is weak. Figures A.12, A.13, A.14, and A.15 in the online appendix confirm that the results using different instrument sets hardly change when we control for ethnic fractionalization.

5.5.4 Placebo Tests

While it is reassuring that our conclusions do not change significantly when accounting for the influence of potential confounders described above, there may be other determinants of political and economic development that are correlated with the basin instrument. We address this possibility with two placebo tests. If *Basin* impacts development only through the channel of oil wealth, then it should have no impact on economic and political outcomes in years when oil was not a commercially valuable commodity or when world oil production was minimal. Before 1859 the value of oil was modest. The year 1859 saw both the first modern oil well (by Edwin Drake) and the first commercially successful internal-combustion engine (by Étienne Lenoir) (Britannica, 2015). Prior to 1920 no country produced a significant amount of oil, defined as \$100 per capita (in constant 2007 USD) (Andersen and Ross, 2014). In 1940 there were three significant oil producers, and by 1950 there were 10. For context, 56 countries were significant oil producers in 2008 (Ross, 2013).

Figure 2 plots estimates of the reduced-form effect of *Basin* on political and economic development in different years, controlling for geography and climate. Panel (a) presents the effect of *Basin* on the polity index. To examine the changing influence of the basin instrument over time, we fix the sample of countries. The four graphs are based on fixed country samples starting in 1900, 1910, 1920, and 1930. All four graphs tell the same story: prior to 1940, the effect of *Basin* on democracy was statistically indistinguishable from zero. Starting in 1940, *Basin* had a negative and statistically significant effect, and this negative effect persisted to 2008.

Panel (b) is similar, presenting four graphs of the reduced-form effect of *Basin* on log population density over time. We focus on population density, because GDP data prior to 1950 are available only for a small number of countries. Prior to 1950, the availability of population data from Maddison (2013) varies considerably from year to year. We choose to measure log population density in the years 1820, 1870, and 1913, because these are the only years prior to 1950 for which population data are available for more than 65 countries. The graphs suggest that *Basin* had no influence on log population density prior to 1970; the effect of *Basin* on log population density becomes positive and statistically significant starting in 1990.

Together, the results in Figure 2 suggest that *Basin* did not influence political and economic development in periods in which the value of oil production was insignificant. These results strengthen the claim that the baseline results are not simply driven by omitted variables that are correlated with both *Basin* and long-run development.

5.5.5 Predetermined Borders

The validity of the basin instrument rests on the assumption that national borders were drawn without consideration for the locations of sedimentary basins. The most plausible violation of this assumption would occur in geographic regions where modern borders were established after the discovery of oil. If oil-field acquisition (hence basin acquisition) via border changes were systematically related to potential outcomes—e.g., if more economically or militarily powerful countries acquired more oil fields through territorial conquest or delimiting colonial dependencies—then the IV estimator would be inconsistent for the treatment effect of interest.

To address this concern we replicate the main analysis on the subsample that excludes any country whose land borders could have plausibly been influenced by the location of oil fields.[31] We first record the year of the earliest known oil discovery for each country, according to Thieme, Lujala, and Rød (2007); Lujala, Rød, and Thieme (2007). We then record the year of the earliest establishment of modern borders, using the information in Strang (1991), Britannica (2015), and CIA (2015). It is important to note that the modern borders of most former colonies and former satellite states were drawn decades before independence. Finally, we record the dates of all changes to homeland territory (as opposed to dependency territory) since 1816, according to Tir, Schafer, Diehl, and Goertz (1998). Using data on country contiguity from Correlates of War Project (2007) (described in Stinnett, Tir, Schafer, Diehl, and Gochman (2002)) to identify neighboring countries, we implement the following procedure:

1. Exclude country *A* if country *A* first discovered oil before its modern borders were set.

[31] We focus this robustness check on land borders for tractability, as maritime borders are often ambiguous or disputed.

2. Exclude country *A* if country *A*'s neighbor, country *B*, first discovered oil before country *A*'s modern borders were set, *and* country *B*'s modern borders were not set prior to the discovery.

3. To minimize unnecessary exclusions, include countries that were to be excluded according to Rule 1 or Rule 2 if either (a) there are no known onshore oil fields within 200 kilometers of the border in question, or (b) there are no land basins within 200 kilometers of the border in question.

4. Include countries with borders set prior to 1859, even if they qualify for exclusion according to Rule 1 or Rule 2.[32]

The procedure results in the exclusion of 61 countries from the baseline sample of 157 countries. Tables 8 and 9 report regression results based on the sample of countries with borders that were not plausibly influenced by the location of oil fields or basins. The results are remarkably similar to the results from the full sample, both qualitatively and quantitatively. The broad similarity of the results to the main results suggests that countries with borders drawn after the discovery of oil are not systematically different than countries with borders drawn before the discovery of oil.

5.6 Comparison to Endowment Instrument

The closest predecessor to the identification strategy in this paper is Tsui (2011), who uses oil endowment as an instrument for oil discovery. To facilitate comparison between Tsui (2011) and the current paper, we normalize the oil endowment variable in the same manner that we normalize the basin variables: *Endowment* is the (log of) total oil endowment in millions of barrels divided by 1960 population.[33] As mentioned in the introduction, there are *a priori* reasons to worry that known oil endowment is endogenous. We find suggestive statistical evidence that this is indeed the case. Tables A.12 and A.13 in the online appendix compare the OLS results, 2SLS results based on *Endowment*, and 2SLS results based on *Basin*. The first-stage *F* statistic on *Endowment* is extremely large—410 in the full sample—and IV estimates using *Endowment* are almost always closer than IV estimates using *Basin* to the OLS estimates. In addition, the Hansen (1982) overidentification test rejects the exogeneity of *Endowment* in the average democracy, corruption, tax revenue, and manufacturing GDP specifications, though it fails to reject exogeneity in the other specifications.[34] Nonetheless, the *Endowment* and *Basin* instruments produce the same qualitative conclusions, providing support for the political resource curse hypothesis and rejecting the economic resource curse hypothesis.

[32] Before 1859 petroleum was arguably not a very valuable commodity and thus would not have influenced border formation. The year 1859 saw both the first modern oil well (by Edwin Drake) and the first commercially successful internal-combustion engine (by Étienne Lenoir) (Britannica, 2015).

[33] The data on oil endowment is shared online by Cotet and Tsui (2013).

[34] This overidentification test evaluates the exogeneity of *Endowment* under the assumption that *Basin* is exogenous.

5.7 Discussion

The estimated negative effects of oil production on democracy and tax revenue indicate that oil wealth has a tendency to degrade—or retard the development of—democratic institutions and fiscal capacity over the long run. Oil wealth increases the value of holding political power, which in theory could make a coups d'état more attractive in the eyes of potential usurpers. However, the resource revenue also strengthens the government's hand, potentially funding investment in defense.[35] The results of this section suggest that oil wealth increases government repression in the form of purges.[36] However, in equilibrium oil wealth does not lead to more coup attempts. This result is consistent with the model of Tsui (2010), which predicts that the number of political insurgents will be independent of the size of resource wealth.[37] The reason is that an increase in resource wealth induces the ruler to invest in political entry barriers which deter potential insurgents.

The fact that OLS underestimates the pernicious effects of oil on democracy and tax revenue suggests that countries with better political institutions and greater state capacity have a greater propensity to select into oil production.[38] The results are consistent with recent evidence that the drilling decisions of international oil companies are highly sensitive to the quality of national institutions (Cust and Harding, 2017).

6 Heterogeneous Effects by Executive Constraints

6.1 Theory

Several political economy models predict that the political and economic effects of natural resource wealth will depend on the quality of institutions. In some models institutions determine the extent to which incumbents can spend resources to increase their likelihood of staying in power. The degree to which resource booms promote autocracy or resource misallocation within the economy thus depends on institutions (Robinson et al., 2006; Caselli and Tesei, 2016). In a similar vein, democratic institutions determine the degree to which popular support (or lack thereof) affects the incumbent's chances of staying in power. While resource booms increase the scope of corruption, incumbents are less likely to embezzle state funds when democratic institutions are strong (Bhattacharyya and Hodler, 2010). In addition, resource rents are more likely to promote repression and civil war when political checks and balances are weak (Besley and Persson, 2009b, 2011). Finally, resource abundance can reduce economic

[35] Cotet and Tsui (2013) find that oil discoveries increase military spending in nondemocratic countries.

[36] Note that we find a positive, significant effect of oil production on purges using many instrument sets of size greater than one. The evidence on internal armed conflict is inconclusive.

[37] This result depends on the counterinsurgent technology having constant returns to scale.

[38] Prospecting intensity probably accounts for most of the differential selection into oil production. While known subsoil assets in the OECD countries are valued at around US$265,000 per square kilometer, in sub-Saharan Africa known subsoil assets are valued at only US$45,000 per square kilometer (Collier and Laroche, 2015).

growth when institutions favor rent-seeking over productive activities (Mehlum et al., 2006).[39]

In the online appendix we present a theoretical model that predicts that institutions will determine the effect of resource revenue on the incumbent's *joint* decision over the political regime and tax policy. An autocrat faces the threat of a popular uprising and must decide whether to allow a transition to democracy or suppress the movement using bribes. Under democracy the median voter, who is poor, chooses a positive tax rate. When the autocrat chooses to suppress democracy, his optimal strategy involves bribing the rich citizens and setting taxes equal to zero. Both the autocrat's ability and willingness to suppress democracy increase in the amount of resource rents accruing to the autocrat. However, executive constraints create transaction costs associated with stealing resource rents from government coffers and making bribes. As a result, a resource boom increases the likelihood that autocracy and low taxation persist *if and only if* executive constraints are sufficiently weak. See the online appendix for details.

6.2 Evidence

To test the implications of the theoretical models described above, we estimate the effects of oil production, allowing for heterogeneity in the response according to the strength of executive constraints. We construct a measure of initial executive constraints by averaging each country's XCONST score (Polity IV) from 1950–1965.[40] The variable XCONST is measured on a scale of one to seven, with one indicating "unlimited authority," three indicating "slight to moderate limitation on executive authority," five indicating "substantial limitations on executive authority," and seven indicating "executive parity or subordination." Numbers two, four, and six denote intermediate categories. We construct an indicator variable, *weak constraints*, which equals one for countries that averaged a score of three or lower from 1950–1965. In our sample the median score for average XCONST over this period is three.

We split the sample into two subsamples—countries with relatively strong executive constraints and those with relatively weak constraints—and estimate the structural equation separately for each subsample. We then compare the IV estimates obtained in each subsample. While we have data on democracy in 2008 for 157 countries, we observe *weak constraints* for only 116 countries. This is because countries that gained independence after 1965 have missing values for XCONST for all years from 1950–1965.

Tables A.14 and A.15 in the online appendix present the results of the heterogeneity analysis. The validity of the exercise relies on the assumption that *weak constraints* is uncorrelated with unobserved determinants of development. In the online appendix we show that *weak constraints* is, for the most part, uncorrelated with the different sedimentary basin measures.

[39]See Tsui (2010) for a model that combines the economic and political dimensions of the resource curse while modeling institutions as the deadweight costs associated with rent appropriate and political entry deterrence.

[40]Naturally, the sample is restricted to countries with at least one observation of XCONST from 1950–1965. We use a 16-year average to reduce noise and maximize sample size.

Nonetheless, exogeneity is a strong assumption, and the results in this section should be interpreted with caution. The optimal basin instrument in the full-sample analysis leads to excessively small first-stage F statistics in the subsample analysis. We therefore report results based on the instrument set {Foreland, Intracratonic Sag}, which produces modestly sized first-stage F statistics in the subsamples. We checked the results using the seven strongest instrument sets according to Tables A.8 and A.9, and the pattern of second-stage coefficients is very similar using different instrument sets.

6.2.1 Political Resource Curse

Table A.14 in the online appendix presents the results of the heterogeneity analysis for the political outcomes. As shown in Panel A, in the sample of strong-constraints countries, oil production has a statistically insignificant effect on each political variable, with the exception of total revenue. In contrast, Panel B shows that, in the sample of weak-constraints countries, oil production has a statistically significant effect on six of the eight outcomes, reducing democracy in 2008, average democracy from 1966–2008, and tax revenue; and increasing internal conflict, purges, and total revenue. The effects of oil production on corruption and coup attempts are statistically insignificant in the sample of weak-constraints countries.

A one-percent increase in oil production reduces the level of democracy in 2008 by 0.044. The effect is significant at the five-percent level. In the weak-constraints sample, an increase in oil production of one standard deviation (4.24 log points) reduces 2008 democracy by 0.19, or 0.59 standard deviations.[41] This is roughly equal to the difference between the scores of Algeria (0.6) and Malawi (0.8).[42] The negative effect of oil on democracy in 2008 is smaller in magnitude (−0.027) and statistically insignificant in the strong-constraints sample.

Oil production also has a large effect on tax revenue in the sample of weak-constraints countries. A one-percent increase in oil production reduces the tax-revenue-to-GDP ratio by 0.108 percent in the sample of countries with weak constraints. The estimate is significant at the five-percent level. Among countries with weak constraints, increasing oil production by one standard deviation (4.24 log points) reduces the tax revenue share of GDP by 0.46, or 0.67 standard deviations, which is roughly equal to the difference in tax revenue between Nicaragua (−1.83) and Mexico (−2.33).[43] The negative effect of oil on tax revenue is smaller in magnitude (−0.012) and statistically insignificant in the strong-constraints sample.

Overall, the results suggest that the adverse political consequences of oil wealth are concentrated in the sample of countries with weak initial constraints on the executive. While the point estimates in the two subsamples often differ substantially, Panel C shows that we are unable to reject the hypothesis that the point estimates are equation in any of the equations,

[41] The standard deviation of 2008 democracy in the weak-constraints sample is 0.31.

[42] While both Algeria and Malawi had weak executive constraints from 1950–1965, Algeria produced a significant amount of oil from 1966–2008, and Malawi produced no oil.

[43] Both Nicaragua and Mexico had weak executive constraints from 1950–1965. From 1966–2008 oil production was substantial in Mexico and nil in Nicaragua.

perhaps owing to the small sample sizes.

6.2.2 Economic Resource Curse

Table A.15 in the online appendix presents the results of the heterogeneity analysis for the economic outcomes. As shown in Panel A, in the sample of strong-constraints countries, oil production has a positive effect on each economic variable, though each coefficient is statistically insignificant. The point estimates for the sample of weak-constraints countries, reported in Panel B, are slightly larger than those in Panel A, and they are all significant at least at the ten-percent level. In the weak-constraints sample, a one-percent increase in oil production raises GDP per capita by 0.15 percent, and the effect is almost identical for manufacturing GDP—contrary to the Dutch Disease hypothesis.

6.2.3 Weak Constraints

The heterogeneity analysis would be invalid if, for example, pre-1966 oil production affected both *weak constraints* and post-1966 democracy and tax revenue. However, the *Basin* measures have virtually no statistical association with *weak constraints*, as shown in the online appendix. The only basin types that have a statistically significant association with *weak constraints* are convergent ocean-ocean basins, convergent wrench basins, and fore-arc basins. In all three cases, the association with *weak constraints* is negative, which contradicts the claim that pre-1966 oil production adversely affected pre-1966 institutions.

6.3 Discussion

We find evidence that the long-run effects of oil wealth on development may be heterogeneous. In particular, the adverse effects of oil on democracy and fiscal capacity are concentrated in the subsample of countries that had weak executive constraints from 1950–1965. This result is consistent with other recent findings. Tsui (2011) finds that the discovery of oil impeded democratization only in countries that were non-democratic at the time of discovery. Similarly, Caselli and Tesei (2016) show that resource windfalls cause autocratic countries to become even more autocratic, whereas they have no effect on the regime in democratic countries or in deeply entrenched autocracies. Finally, Andersen and Aslaksen (2013) show that oil wealth positively affects political survival (measured as the leader's duration in office) in intermediate and autocratic regimes, but not in democracies. In contrast to the results of Bhattacharyya and Hodler (2010), we do not observe heterogeneous effects of oil on corruption. Neither does the effect of oil on conflict seem to differ according to institutional quality. The finding that oil has a larger positive effect on GDP in weak-constraints countries is consistent with other evidence that less developed countries have the largest GDP gains from oil production (Alexeev and Conrad, 2009; Smith, 2015).

In order to identify a heterogeneous effect of oil, the dimension of heterogeneity (e.g., political institutions) must be uncorrelated with unobserved determinants of future political outcomes and oil wealth. Of course, this assumption is unlikely to hold. However, unlike the studies mentioned above, we condition on initial rather than contemporaneous political institutions to (partially) alleviate concerns about the simultaneity of political institutions and resource production.

The heterogeneity results are interesting in light of the recent literature on the determinants of fiscal capacity. Previous empirical studies find that resource wealth tends to negatively impact tax revenue (Cárdenas et al., 2011; Jensen, 2011; Crivelli and Gupta, 2014). However, these studies do not test for heterogeneous effects. The fiscal capacity model of Besley and Persson (2009a, 2010); Besley and Persson (2011) predicts that a "common-interest" state emerges when institutions are "cohesive" enough. In their model institutional cohesion depends on the ability of the group in power to redistribute resources away from the group not in power. In a common-interest state, politicians invest in fiscal capacity, because they know that future capacity to tax will be used to raise funds for common-interest public goods rather than for redistributing income away from the group not in power. Because the marginal utility from public goods is assumed to be declining, a relaxation of the government's budget constraint due to a resource windfall causes the group in power to invest less in fiscal capacity. When institutions are not cohesive, no group invests in fiscal capacity, regardless of the level of resource revenue. Therefore, the model predicts that resource rents lower future tax revenue only in countries with cohesive institutions. In contrast, we find that the negative effect of oil production on future tax revenue is strongest in countries that lack cohesive institutions. Our results are not wholly inconsistent with the fiscal capacity model, however they do underscore the importance of low taxation as a means of political survival.

7 Conclusion

Using a new instrumental variables approach, we find that oil wealth impedes democracy, increases corruption, reduces taxation, and raises GDP without significantly harming the non-resource sectors of the economy. We find no evidence that oil wealth increases internal armed conflict, coup attempts, or political purges. In several specifications OLS substantially underestimates the detrimental effects of oil, suggesting that countries with better institutions disproportionately select into oil discovery and production. Controlling for the percentage of the population that was Muslim in 1950 attenuates the estimates for democracy and corruption, though oil production still appears to adversely affect these outcomes. For outcomes such as democracy and fiscal capacity, the initial strength of executive constraints appears to determine whether subsequent oil production is a curse or a blessing. However, initial institutions seem to matter less for how oil affects corruption, conflict, and purges. Despite suffering a political resource curse, countries with weak initial institutions saw the greatest economic gains from oil wealth, at least in aggregate terms.

This paper's identification strategy is useful to researchers studying the long-run impact of oil wealth on any outcome in cross-country data. The strategy can also be applied to subnational analyses—granted that the geographic units of analysis are large—because the spatial distribution of sedimentary basins generates exogenous within-country variation in oil endowment. Furthermore, the general idea of the strategy—that geophysical processes provide useful identifying variation in resource wealth—may prove useful for studying the effects of mineral resources in other contexts. Recent examples in this vein include Fernihough and O'Rourke (2014) and Bartik et al. (2017), who exploit geological information to study the economic effects of coal and fracking, respectively.

One limitation of this study is that it does not cleanly identify how the potential economic benefit of resource extraction varies with institutional quality. The fact that countries starting with weak institutions experienced the largest economic gains from oil wealth probably owes more to the initial poverty of these countries than to the pure mediating effect of institutions. Future work should examine this mediating effect by using variation in institutions that is orthogonal to both resource wealth and economic conditions. Such an analysis may be possible at the country level using "exogenous" democratic transitions (Pozuelo, Slipowitz, and Vuletin, 2016) or at the subnational level in countries that experienced regional variation in the timing of democratic reforms, such as Indonesia (Skoufias, Narayan, Dasgupta, and Kaiser, 2014).

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8 Tables

Table 1: Summary Statistics by Oil Presence

	Oil Countries	Non-Oil Countries	Difference	p-value
Democracy, 2008	0.66	0.73	−0.07	0.182
Democracy, 1966	0.43	0.46	−0.03	0.677
Avg. democracy, 1966–2008	0.52	0.54	−0.02	0.683
Corruption, 2008	3.38	3.52	−0.14	0.508
Internal conflicts per year, 1966–2008	0.27	0.13	0.13*	0.068
Coup attempts per year, 1966–2008	0.05	0.07	−0.01	0.330
Purges per year, 1966–2008	0.08	0.04	0.04*	0.067
Total revenue, 2000–2008 (log avg.)	−1.41	−1.68	0.27***	0.000
Tax revenue, 2000–2008 (log avg.)	−2.04	−1.89	−0.14	0.179
GDP, 2008 (log p.c.)	9.46	8.58	0.88***	0.000
GDP, 1966 (log p.c.)	8.01	7.24	0.77***	0.000
Non-Oil GDP, 2008 (log p.c.)	9.34	9.11	0.23	0.300
Non-Oil/Gas GDP, 2008 (log p.c.)	9.36	9.11	0.25	0.256
Non-Resource GDP, 2008 (log p.c.)	9.27	8.51	0.76***	0.000
Manufacturing GDP, 2008 (log p.c.)	7.39	6.51	0.88***	0.000
Executive constraints, 1950–1965	0.48	0.45	0.04	0.594
Oil production, 1966–2008 (log avg. p.c.)	−1.60	−9.03	7.42***	0.000
Oil endowment (log p.c.)	−8.78	−11.93	3.15***	0.000
Convergent C-C mechanical area (log p.c.)	−7.37	−9.61	2.23***	0.000
Convergent O-C thermal area (log p.c.)	−8.74	−8.99	0.25**	0.021
Convergent O-C mechanical area (log p.c.)	−8.81	−10.64	1.83***	0.001
Convergent O-O area (log p.c.)	−9.92	−9.63	−0.29	0.428
Divergent thermal area (log p.c.)	−5.90	−7.29	1.38*	0.066
Wrench mechanical area (log p.c.)	−12.82	−13.80	0.97*	0.084
Divergent mechanical area (log p.c.)	−10.43	−10.89	0.46	0.264
Convergent C-C thermo-mechanical area (log p.c.)	−8.40	−8.68	0.28**	0.047
Foreland area (log p.c.)	−5.96	−8.47	2.51***	0.000
Intracratonic sag area (log p.c.)	−10.05	−12.21	2.16***	0.007
Passive margin area (log p.c.)	−8.26	−9.45	1.19	0.136
Convergent sag area (log p.c.)	−14.39	−15.98	1.59***	0.001
Post-rift sag area (log p.c.)	−9.57	−10.97	1.40**	0.010
Wrench area (log p.c.)	−12.82	−13.80	0.97*	0.084
Extensional area (log p.c.)	−9.82	−9.99	0.17	0.589
Convergent wrench area (log p.c.)	−11.47	−11.93	0.46	0.355
Fore-arc area (log p.c.)	−10.03	−10.75	0.72	0.141
Rift area (log p.c.)	−10.43	−10.89	0.46	0.264
Land area (log p.c.)	−3.09	−3.41	0.32	0.185
Coastline (log p.c.)	−9.22	−9.51	0.29	0.528
Mountainous area (log p.c.)	−6.23	−6.92	0.69	0.132
Tropical area (log p.c.)	−6.77	−5.49	−1.28**	0.030
Good soil area (log p.c.)	−6.70	−6.91	0.21	0.599
Observations	96	76		

Notes. See Table A.1 in the online appendix for variable definitions. This table defines oil countries as those countries that had positive oil production at any time from 1966–2008. Averages are reported in the first two columns. The third column reports the difference of the averages, and the fourth column reports the p-value corresponding to the two-sided test of equality of the averages. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: First-Stage Estimates for Optimal Sets of Basin Instruments

	Log Avg. Oil Production per capita, 1966–2008					
	(1)	(2)	(3)	(4)	(5)	(6)
Global Characteristics:						
Convergent C-C mechanical	0.599***	0.592***	0.589***			
	(0.119)	(0.119)	(0.124)			
Convergent O-C thermal		0.589***				
		(0.175)				
Convergent O-C mechanical			0.359***			
			(0.084)			
Convergent O-O			−0.362**			
			(0.139)			
Local Characteristics:						
Foreland				0.576***	0.608***	0.613***
				(0.142)	(0.143)	(0.139)
Intracratonic sag					0.213***	0.209***
					(0.069)	(0.068)
Passive margin						0.091
						(0.076)
Observations	157	157	157	157	157	157
R^2	0.318	0.327	0.394	0.315	0.357	0.364
F statistic	25.3	17.6	18.9	16.4	17.0	14.4

Notes. See Tables A.3 and A.4 in the online appendix for basin variable definitions. See Table A.1 in the online appendix for other variable definitions. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Testing for a Political Resource Curse

	Democracy, 2008	Avg. Democracy, 1966–2008	Corruption, 2008	Internal Conflict, 1966–2008	Coup Attempts, 1966–2008	Purges, 1966–2008	Total Revenue, 2000–2008	Tax Revenue, 2000–2008
	Panel A: Ordinary Least Squares							
Oil production	−0.019***	−0.014***	0.032	0.012**	0.001	0.003	0.032***	−0.044***
	(0.005)	(0.004)	(0.023)	(0.006)	(0.002)	(0.002)	(0.007)	(0.012)
Observations	157	160	136	172	160	172	165	167
R^2	0.441	0.536	0.334	0.204	0.203	0.093	0.463	0.471
	Panel B: Two-Stage Least Squares							
Oil production	−0.038**	−0.039***	0.136**	0.007	0.002	−0.001	0.021	−0.163***
	(0.017)	(0.015)	(0.060)	(0.018)	(0.003)	(0.005)	(0.016)	(0.039)
Observations	157	160	136	172	160	172	165	167
F statistic	25.3	26.7	23.2	31.4	26.7	31.4	29.3	27.3
A-R 95% CI	[−0.081, −0.008]	[−0.077, −0.014]	[0.027, 0.280]	[−0.030, 0.045]	[−0.004, 0.009]	[−0.011, 0.010]	[−0.015, 0.053]	[−0.268, −0.100]
Oil exog.	0.209	0.063	0.053	0.780	0.578	0.445	0.446	0.000

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The A-R 95% confidence interval is based on the Anderson and Rubin (1949) χ^2 test of the null hypothesis that the coefficients on the endogenous variables in the structural equation are jointly equal to zero. The A-R test is robust to the presence of weak instruments. The p-value of the test of the endogeneity of oil wealth is from the Hansen (1982) overidentification test of the null hypothesis that oil wealth is exogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Testing for an Economic Resource Course

	GDP, 2008	Non-Oil GDP, 2008	Non-Oil/Gas GDP, 2008	Non-Resource GDP, 2008	Manufacturing GDP, 2008
	Panel A: Ordinary Least Squares				
Oil production	0.092^{***}	0.043^{**}	0.040^{**}	0.071^{***}	0.076^{***}
	(0.015)	(0.017)	(0.017)	(0.016)	(0.021)
Observations	166	132	129	166	145
R^2	0.661	0.623	0.608	0.657	0.599
	Panel B: Two-Stage Least Squares				
Oil production	0.074^{*}	0.045	0.039	0.054	−0.037
	(0.040)	(0.044)	(0.044)	(0.041)	(0.075)
Observations	166	132	129	166	145
F statistic	29.3	20.4	20.1	29.3	14.3
A-R 95% CI	[−0.010, 0.157]	[−0.047, 0.139]	[−0.055, 0.132]	[−0.033, 0.137]	[−0.246, 0.097]
Oil exog.	0.632	0.963	0.967	0.646	0.079

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The A-R 95% confidence interval is based on the Anderson and Rubin (1949) χ^2 test of the null hypothesis that the coefficients on the endogenous variables in the structural equation are jointly equal to zero. The A-R test is robust to the presence of weak instruments. The p-value of the test of the endogeneity of oil wealth is from the Hansen (1982) overidentification test of the null hypothesis that oil wealth is exogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Partial Correlation between *Basin* and Predetermined Variables

	Urbanization, 1850	British Legal Origin	Communist Legacy	Percentage Christian, 1950	Percentage Muslim, 1950	Percentage Hindu, 1950	Fractionalization: Ethnic	Fractionalization: Religious	Fractionalization: Linguistic
Convergent C-C mechanical	−0.050	0.003	−0.014	−0.357	5.759***	0.015	0.015*	0.002	0.008
	(0.277)	(0.015)	(0.012)	(0.597)	(0.865)	(0.214)	(0.008)	(0.008)	(0.007)
Observations	84	163	172	172	172	172	171	172	165
R^2	0.449	0.086	0.060	0.800	0.495	0.078	0.407	0.093	0.402

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Testing for a Political Resource Curse (Controlling for Percentage Muslim in 1950)

	Democracy, 2008	Avg. Democracy, 1966–2008	Corruption, 2008	Internal Conflict, 1966–2008	Coup Attempts, 1966–2008	Purges, 1966–2008	Total Revenue, 2000–2008	Tax Revenue, 2000–2008
	Panel A: Ordinary Least Squares							
Oil production	-0.014^{***}	-0.011^{**}	0.018	0.012^{*}	−0.000	0.003	0.034^{***}	-0.033^{***}
	(0.005)	(0.004)	(0.022)	(0.006)	(0.002)	(0.002)	(0.007)	(0.010)
Observations	157	160	136	172	160	172	165	167
R^2	0.477	0.567	0.359	0.204	0.231	0.093	0.464	0.530
	Panel B: Two-Stage Least Squares							
Oil production	−0.016	−0.025	0.093	0.003	−0.003	−0.001	0.023	-0.138^{***}
	(0.019)	(0.015)	(0.077)	(0.022)	(0.005)	(0.006)	(0.020)	(0.044)
Observations	157	160	136	172	160	172	165	167
F statistic	12.4	15.3	10.6	18.9	15.3	18.9	16.3	14.8
A-R 95% CI	[−0.062, 0.025]	[−0.067, 0.004]	[−0.073, 0.298]	[−0.047, 0.048]	[−0.014, 0.006]	[−0.015, 0.012]	[−0.025, 0.064]	[−0.274, −0.068]
Oil exog.	0.893	0.339	0.318	0.675	0.470	0.488	0.585	0.006

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The A-R 95% confidence interval is based on the Anderson and Rubin (1949) χ^2 test of the null hypothesis that the coefficients on the endogenous variables in the structural equation are jointly equal to zero. The A-R test is robust to the presence of weak instruments. The p-value of the test of the endogeneity of oil wealth is from the Hansen (1982) overidentification test of the null hypothesis that oil wealth is exogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Testing for an Economic Resource Course (Controlling for Percentage Muslim in 1950)

	GDP, 2008	Non-Oil GDP, 2008	Non-Oil/Gas GDP, 2008	Non-Resource GDP, 2008	Manufacturing GDP, 2008
	Panel A: Ordinary Least Squares				
Oil production	0.099***	0.049***	0.045**	0.078***	0.090***
	(0.015)	(0.017)	(0.017)	(0.015)	(0.021)
Observations	166	132	129	166	145
R^2	0.668	0.628	0.611	0.665	0.616
	Panel B: Two-Stage Least Squares				
Oil production	0.112**	0.087	0.074	0.096*	0.011
	(0.051)	(0.060)	(0.061)	(0.052)	(0.097)
Observations	166	132	129	166	145
F statistic	17.1	11.7	10.8	17.1	6.8
A-R 95% CI	[0.005, 0.228]	[−0.033, 0.245]	[−0.058, 0.234]	[−0.012, 0.216]	[−0.344, 0.224]
Oil exog.	0.793	0.499	0.631	0.735	0.401

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The A-R 95% confidence interval is based on the Anderson and Rubin (1949) χ^2 test of the null hypothesis that the coefficients on the endogenous variables in the structural equation are jointly equal to zero. The A-R test is robust to the presence of weak instruments. The p-value of the test of the endogeneity of oil wealth is from the Hansen (1982) overidentification test of the null hypothesis that oil wealth is exogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Testing for a Political Resource Curse: Subsample with Predetermined Borders

	Democracy, 2008	Avg. Democracy, 1966–2008	Corruption, 2008	Internal Conflict, 1966–2008	Coup Attempts, 1966–2008	Purges, 1966–2008	Total Revenue, 2000–2008	Tax Revenue, 2000–2008
	Panel A: Ordinary Least Squares							
Oil production	-0.017^{***}	-0.018^{***}	0.044	0.014^{**}	0.002	0.002	0.020^{**}	-0.043^{***}
	(0.006)	(0.006)	(0.030)	(0.006)	(0.002)	(0.002)	(0.009)	(0.014)
Observations	96	97	80	108	97	108	104	105
R^2	0.395	0.580	0.376	0.219	0.201	0.119	0.441	0.467
	Panel B: Two-Stage Least Squares							
Oil production	-0.035^{**}	-0.042^{***}	0.151^{**}	0.009	0.001	−0.000	0.006	-0.138^{***}
	(0.014)	(0.012)	(0.068)	(0.012)	(0.003)	(0.008)	(0.019)	(0.047)
Observations	96	97	80	108	97	108	104	105
F statistic	21.7	21.7	20.4	27.8	21.7	27.8	30.3	25.4
A-R 95% CI	[−0.067, −0.008]	[−0.071, −0.021]	[0.018, 0.311]	[−0.016, 0.035]	[−0.006, 0.009]	[−0.017, 0.017]	[−0.035, 0.044]	[−0.260, −0.058]
Oil exog.	0.157	0.038	0.086	0.637	0.698	0.809	0.387	0.033

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The A-R 95% confidence interval is based on the Anderson and Rubin (1949) χ^2 test of the null hypothesis that the coefficients on the endogenous variables in the structural equation are jointly equal to zero. The A-R test is robust to the presence of weak instruments. The p-value of the test of the endogeneity of oil wealth is from the Hansen (1982) overidentification test of the null hypothesis that oil wealth is exogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

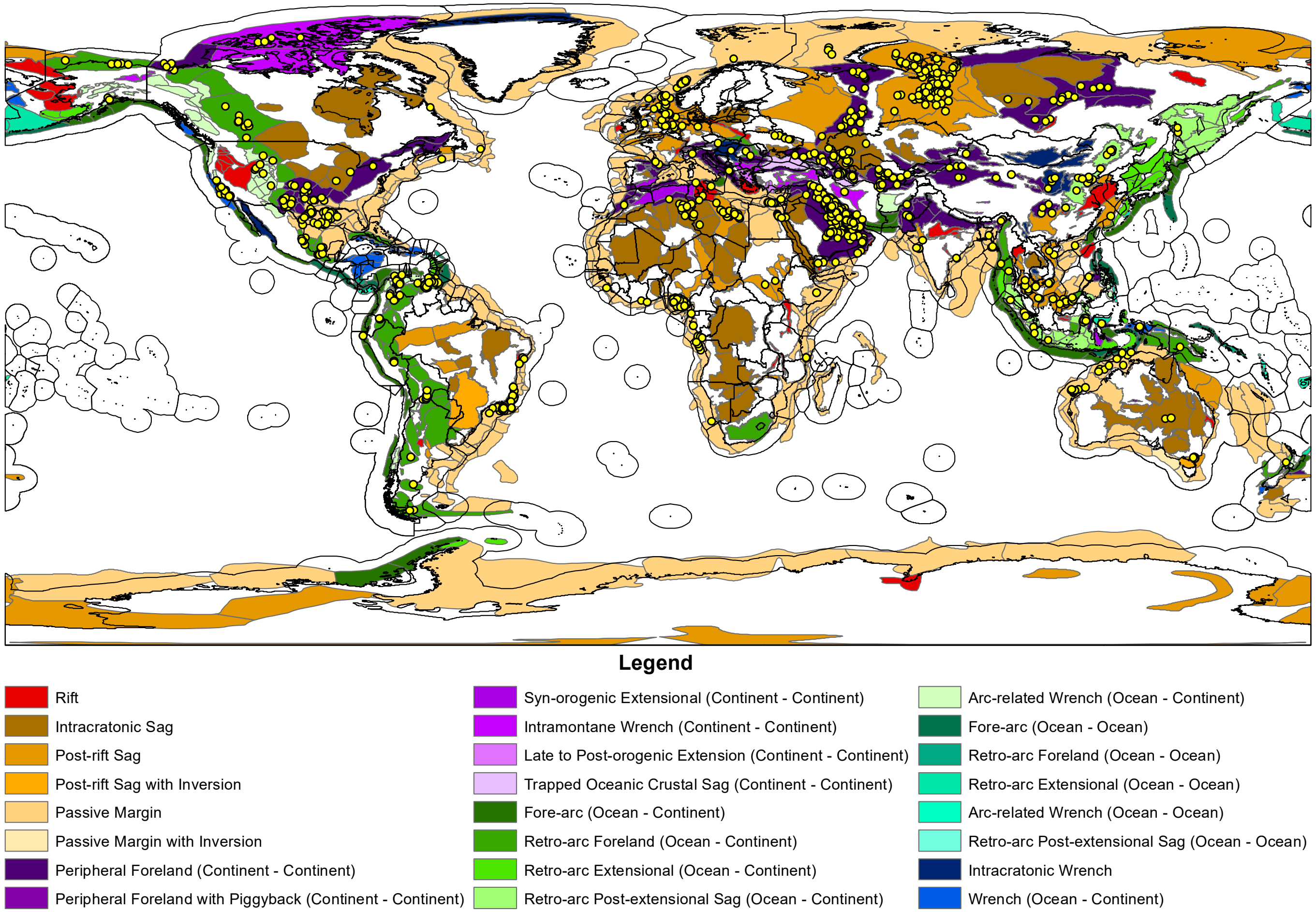
Table 9: Testing for an Economic Resource Course: Subsample with Predetermined Borders

	GDP, 2008	Non-Oil GDP, 2008	Non-Oil/Gas GDP, 2008	Non-Resource GDP, 2008	Manufacturing GDP, 2008
	Panel A: Ordinary Least Squares				
Oil production	0.081***	0.036	0.036	0.062***	0.049
	(0.020)	(0.023)	(0.023)	(0.021)	(0.031)
Observations	105	73	70	105	89
R^2	0.686	0.647	0.632	0.678	0.596
	Panel B: Two-Stage Least Squares				
Oil production	0.112**	0.099*	0.096	0.107**	0.006
	(0.050)	(0.059)	(0.060)	(0.051)	(0.084)
Observations	105	73	70	105	89
F statistic	30.4	19.4	18.5	30.4	13.9
A-R 95% CI	[0.020, 0.229]	[−0.005, 0.254]	[−0.008, 0.252]	[0.013, 0.227]	[−0.181, 0.196]
Oil exog.	0.484	0.225	0.239	0.331	0.577

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The A-R 95% confidence interval is based on the Anderson and Rubin (1949) χ^2 test of the null hypothesis that the coefficients on the endogenous variables in the structural equation are jointly equal to zero. The A-R test is robust to the presence of weak instruments. The p-value of the test of the endogeneity of oil wealth is from the Hansen (1982) overidentification test of the null hypothesis that oil wealth is exogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

9 Figures

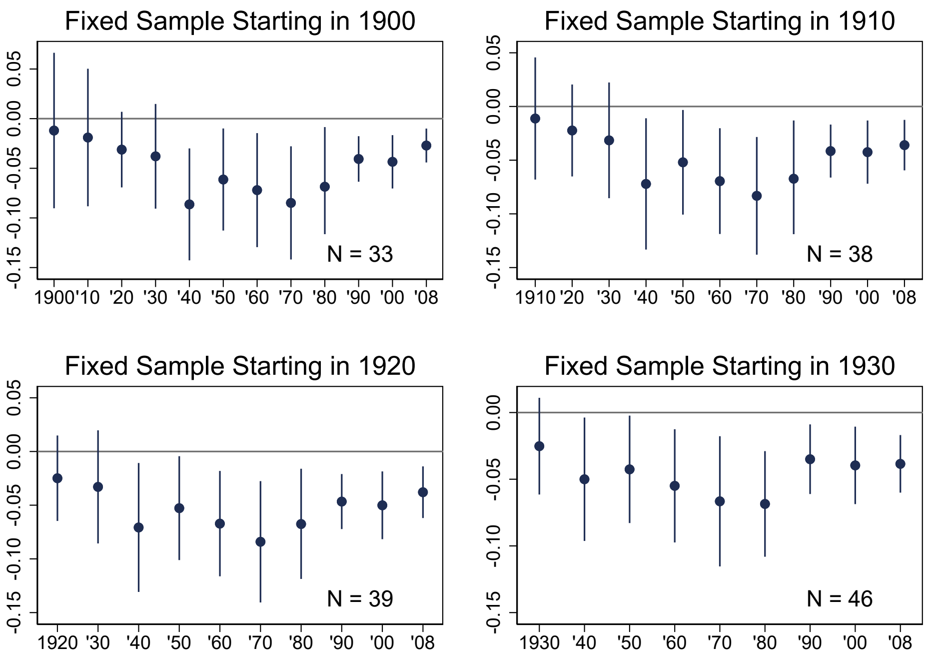
Figure 1: Sedimentary Basins and Giant Oil and Gas Fields



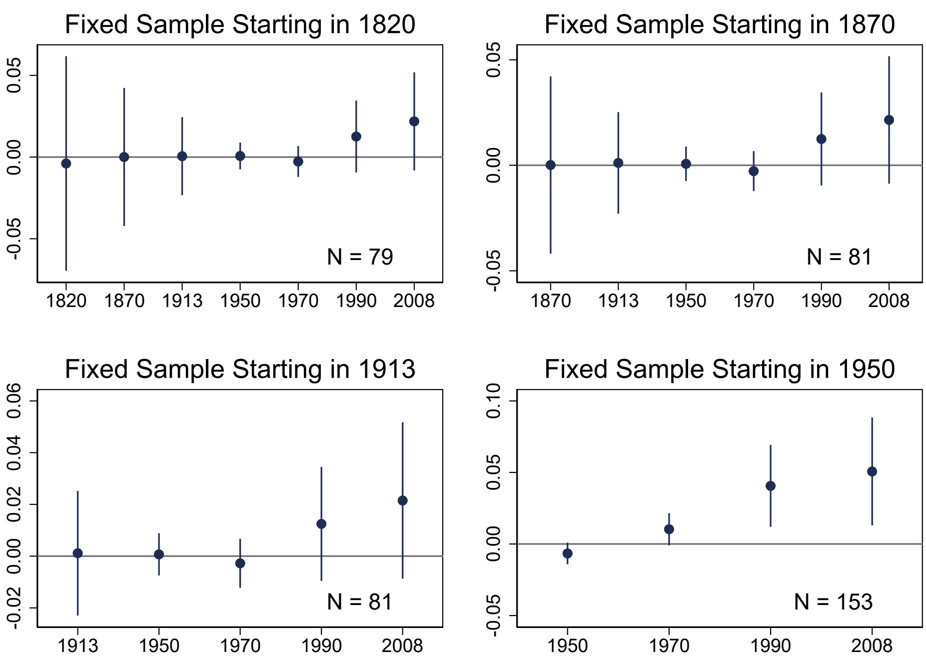
Notes. Colored areas represent sedimentary basins, and yellow dots represent giant oil and gas fields. The GIS data on sedimentary basins come from Fugro Robertson, Ltd. (2013), and the GIS data on giant oil and gas fields come from Horn (2004).

Figure 2: Placebo Tests

(a) Effect of *Basin* on Democracy by Year



(b) Effect of *Basin* on Log Population Density by Year



Notes. This figure plots point estimates and 95-percent confidence intervals for the reduced-form effect of the optimally chosen *Basin* variable over time, controlling for geography and climate. In each graph, the sample of countries is fixed. The outcome variable in Panel (a) is democracy, and the outcome variable in Panel (b) is log population density.

A Appendix (For Online Publication)

A.1 Heterogeneous Effects: Theory

A.1.1 The Environment

Suppose the economy is populated by an autocrat and a continuum of citizens. There are two time periods, indexed by $t \in \{1, 2\}$. In period one the state of the world is autocracy, and in period two the state is either autocracy or democracy and is denoted by $S \in \{A, D\}$. There are two types of (exogenous) income in the economy: private income and natural resource rents. Each period citizens receive state-dependent private income, and the government receives natural resource rents in the amount of $R_t \geq 0$.[44] Following Acemoglu and Robinson (2006), we assume that there are two groups of citizens, the rich and the poor.[45] The individual private incomes of the rich and the poor in state S are y_S^r and y_S^p, respectively. The total population of citizens is normalized to unity, and a fraction δ are rich, where $\delta < 1/2$. Total private income coincides with average private income and is equal to $\bar{y}_S = \delta y_S^r + (1-\delta) y_S^p$. Letting φ denote the fraction of total income held by the rich, the per capita incomes of the rich and poor can be written as

$$y_S^r = \frac{\varphi \bar{y}_S}{\delta} \qquad \text{and} \qquad y_S^p = \frac{(1-\varphi)\bar{y}_S}{1-\delta}, \tag{A.1}$$

where $\varphi > \delta$. All citizens are risk neutral.

Private income is potentially taxed under both autocracy and democracy. Under autocracy citizens receive group-specific transfers, or "bribes," from the autocrat, whereas under democracy all citizens receive a lump-sum transfer of equal size. Thus the indirect utilities of citizen i in states A and D, respectively, are

$$V_A^i = (1-\tau_A) y_A^i + b^i \quad \text{and} \quad V_D^i = (1-\tau_D) y_D^i + T,$$

where τ_S is the tax rate, b^i is the group-specific bribe, and T is the lump-sum transfer. There is an aggregate cost of taxation that is proportional to total income, $C(\tau_S)\bar{y}_S$. We assume that costs are low at low levels of taxation and are increasing and convex for strictly positive tax rates: $C(0) = 0$, $C'(\cdot) > 0$, and $C''(\cdot) > 0$. We also assume $C'(0) = 0$ and $C'(1) = 1$ to ensure an interior solution to the problem that follows. The capacity to tax is nil in period one, but τ_S may be positive in period two.

Under democracy tax revenue and resource rents are shared equally among the citizens.

[44] For example, natural resource rents could arrive in the form of profits from state-owned resource firms or royalties paid by international resource firms.

[45] In contrast to Acemoglu and Robinson (2006), here the rich group is separate from the ruling elite and can potentially challenge the power of the elite.

Thus period-two transfers satisfy the budget constraint,

$$T \leq (\tau_D - C(\tau_D))\bar{y}_D + R_2.$$

The (deposed) autocrat receives income normalized to zero.

Under autocracy the autocrat confiscates the tax revenue and resource rents.[46] However, there are transaction costs associated with stealing government revenue, so the autocrat receives only a fraction $(1-\theta)$ of government revenue, where $\theta \in [0,1]$. Transaction costs may stem from transparency of the budget or administrative procedures (Persson and Tabellini, 2000). More generally, transaction costs depend on the strength of accountability groups which constrain executive power.[47] The greater is the capacity of accountability groups to constrain the executive's ability to act unilaterally, the higher is θ. Let aggregate bribes be denoted by $b = \delta b^r + (1-\delta)b^p$. When the autocrat makes aggregate bribes in the amount of b, he incurs a cost of $(1+\gamma)b$ in period one and group i enjoys the benefits of b^i in period two.[48] Similar to θ, the parameter $\gamma > 0$ captures the marginal transaction cost of making bribes and depends on executive constraints. Assume that the autocrat is risk neutral and discounts future utility by the factor $\beta \in (0,1)$, where $\beta > \varphi$. The autocrat's indirect utility in period t under autocracy is equal to consumption, c_t, where

$$\begin{aligned} & 0 \leq c_1 \leq (1-\theta)R_1 - (1+\gamma)b \\ \text{and} \qquad & 0 \leq c_2 \leq (1-\theta)\left[R_2 + (\tau_A - C(\tau_A))\bar{y}_A\right]. \end{aligned}$$

Note that we have assumed that the autocrat is credit-constrained. This is a reasonable assumption to a first approximation: the more unilateral authority the ruler has, the less likely he is to be compelled to repay a loan, making him a risky borrower.[49]

[46]Using data on deposits to offshore bank accounts, Andersen et al. (2017) show that political elites appropriate oil rents in oil-rich autocracies but not in oil-rich democracies.

[47]A powerful legislature and an independent judiciary are archetypal accountability groups, but in nondemocracies executive accountability may derive from other sources. In a one-party government the executive may be constrained by senior officials in the ruling party. In a monarchy a council of nobles may provide a check on the king's power. The military may even provide a counterbalance in coup-prone polities (Marshall and Gurr, 2014). Finally, powerful producer groups, such as the cattle ranchers in Botswana, can restrain executive power (Acemoglu, Johnson, and Robinson, 2003). Strong accountability groups force the autocrat to use convoluted, opaque methods of stealing the rents, costing the autocrat θR_t. Alternatively, one can think of θ as the fraction of rents the autocrat must pay to accountability groups as bribes in exchange for keeping a fraction $1-\theta$ of the rents. Interpreting the allocation of rents as the result of a Nash bargaining game, θ represents the bargaining power of accountability groups relative to the ruler.

[48]This timing assumption could capture the fact that many potential group-specific transfers—public employment, targeted public goods, or exclusive production rights—are enjoyed with a time lag. The autocrat's period-one cost of providing b could reflect an upfront investment cost or an opportunity cost of guaranteeing liquidity in period two.

[49]See, for example, North and Weingast (1989).

A.1.2 The Political Game

Timing. The timing of events is as follows. In the beginning of the first period, the autocrat receives $(1-\theta)R_1$ and announces period-two policies (τ_A, b^r, b^p). We assume that the autocrat can fully commit to period-two policies in period one.[50] Tax policy is set with a one-period delay, so the autocrat can only choose period-two taxes.[51] At the end of the first period, the citizens decide whether to stage a revolution to depose the autocrat. We assume that the revolution succeeds if and only if both groups of citizens participate. A group of citizens participate in the revolution if and only if their period-two payoff under democracy strictly exceeds their period-two payoff under autocracy, given the (binding) promises of the autocrat. We assume that citizens can commit to their period-two rebellion decision in period one. If the revolution succeeds, then the state transitions to democracy, the autocrat receives zero income, and rich and poor citizens vote on the tax rate and transfers and receive payoffs V_D^r and V_D^p. If the revolution fails, then the autocrat stays in power, implements policies (τ_A, b^r, b^p), and receives $(1-\theta)\left[R_2 + (\tau_A - C(\tau_A))\bar{y}_A\right]$; and rich and poor citizens receive payoffs V_A^r and V_A^p.

Period-two equilibrium. To characterize the subgame perfect Nash equilibrium, we work backwards and first consider the Nash equilibrium starting in period two. If the state is autocracy in the second period, then each player's strategy and payoff is determined by policy commitments made in the first period. Citizen i receives $(1-\tau_A)y_A^i + b^i$ and the autocrat receives $(1-\theta)\left[R_2 + (\tau_A - C(\tau_A))\bar{y}_A\right]$.

If the state is democracy in the second period, then citizens vote on the tax rate, τ_D, and the level of lump-sum transfers, T. Because utility is strictly increasing in transfers (all else equal), the budget constraint will always bind: $T = (\tau_D - C(\tau_D))\bar{y}_D + R_2$. For a given value of τ_D, the payoff of citizen i under democracy is

$$(1-\tau_D)y_D^i + (\tau_D - C(\tau_D))\bar{y}_D + R_2. \tag{A.2}$$

Let τ_D^i denote the most preferred tax rate of citizen i. Because there are no public goods in this economy, the sole function of the tax is redistribution. Therefore, $\tau_D^r = 0$. Substituting (A.1) into (A.2), it is straightforward to show that the most preferred tax rate of a poor citizen satisfies

$$C'(\tau_D^p) = \frac{\varphi - \delta}{1-\delta}.$$

It follows from our assumptions that $\tau_D^p \in (0,1)$ and τ_D^p is increasing in the amount of inequality, φ. It is possible to show that both poor and rich citizens have single-peaked preferences over

[50]Thus we abstract from the possibility that democratization could result from the elite's inability to commit to future policy (Acemoglu and Robinson, 2006).

[51]Taxation requires significant investments in the government's ability to monitor citizens and enforce the tax code (Besley and Persson, 2011). For simplicity we capture this fact by assuming that tax policy is implemented with a delay, abstracting from investment costs.

τ_D.[52] Suppose that under democracy τ_D is chosen by pairwise majority voting in an environment with no uncertainty. Then by the median-voter theorem, the most preferred policy of the median voter, τ_D^p, is selected (Black, 1948; Downs, 1957). The equilibrium payoff to citizen i under democracy is then

$$V_D^i = (1 - \tau_D^p)y_D^i + (\tau_D^p - C(\tau_D^p))\bar{y}_D + R_2.$$

Period-one equilibrium. At the end of period one, each citizen chooses whether to participate in the revolution, given the period-two equilibrium policies under autocracy, (τ_A, b^r, b^p), and under democracy, (τ_D^p, T). Citizen i participates in the revolution if and only if $V_D^i > V_A^i$. Equivalently, for each value of τ_A, citizen i participates in the revolution if and only if $b^i < \tilde{b}^i(\tau_A)$, where

$$\tilde{b}^i(\tau_A) = (1 - \tau_D^p)y_D^i + (\tau_D^p - C(\tau_D^p))\bar{y}_D + R_2 - (1 - \tau_A)y_A^i.$$

Note that $\tilde{b}^i(\tau_A)$ is strictly increasing in τ_A: increasing the tax rate under autocracy causes citizen i to demand a larger reservation bribe in exchange for not rebelling. The following assumption ensures that democracy is sufficiently appealing relative to autocracy that $\tilde{b}^i(\tau_A) > 0$ for any R_2 and τ_A.

Assumption A.1. *$G^i \equiv (1 - \tau_D^p)y_D^i + (\tau_D^p - C(\tau_D^p))\bar{y}_D - y_A^i > 0$ for $i \in \{r, p\}$.*

In the beginning of period one, the autocrat chooses period-two policies, (τ_A, b^r, b^p), to maximize his lifetime discounted utility, taking the strategies of citizens as given. Letting $(\tau_A, b^r, b^p) \in \mathcal{P}$, the function $\rho : \mathcal{P} \mapsto \{0, 1\}$ indicates whether the revolution is prevented, where $\rho(\tau_A, b^r, b^p) = 1$ indicates prevention. The autocrat's problem is

$$\max_{\tau_A, b^r, b^p} (1 - \theta)R_1 - (1 + \gamma)b + \rho(\tau_A, b^r, b^p)\beta(1 - \theta)\left[R_2 + (\tau_A - C(\tau_A))\bar{y}_A\right]$$

$$\begin{aligned} \text{subject to} \qquad & b = \delta b^r + (1 - \delta)b^p \\ & (1 + \gamma)b \leq (1 - \theta)R_1 \\ & \rho(\tau_A, b^r, b^p) = \begin{cases} 1 & \text{if } b^r \geq \tilde{b}^r(\tau_A) \text{ or } b^p \geq \tilde{b}^p(\tau_A) \\ 0 & \text{otherwise.} \end{cases} \end{aligned}$$

Strictly speaking, R_2 denotes expected period-two resource rents from the perspective of period one.

For each τ_A it is optimal for the autocrat to pay bribes (b^r, b^p), with $b^i > 0$ for some $i \in \{r, p\}$, if and only if three conditions are satisfied:

[52] The strict convexity of $C(\cdot)$ guarantees that the indirect utility function is strictly concave in τ. This is a sufficient condition for preferences to be single-peaked.

(i) Sufficiency: $\rho(\tau_A, b^r, b^p) = 1$

(ii) Feasibility: $(1+\gamma)b \le (1-\theta)R_1$

(iii) Desirability: $(1+\gamma)b \le \beta(1-\theta)\left[R_2 + (\tau_A - C(\tau_A))\bar{y}_A\right]$.

The bribes are sufficient if they prevent the revolution, they are feasible if the autocrat has enough income in period one to cover the cost of the bribes, and they are desirable if the autocrat's expected benefit from staying in power exceeds the cost of the bribes. If no set of bribes satisfy all three conditions, the autocrat sets $b^r = b^p = 0$ and the state transitions to democracy in period two.

If the autocrat chooses to pay bribes to avert a revolution, it is optimal to bribe only one group of citizens. To simplify the analysis, we assume that the rich are cheaper to bribe than the poor.

Assumption A.2. $\delta\tilde{b}^r(\tau_A) \le (1-\delta)\tilde{b}^p(\tau_A)$ *for all* $\tau_A \in [0,1]$.

This assumption is reasonable because the rich are less numerous and have more to lose from democracy than the poor.[53] Assumption A.2 is more likely to hold the smaller is δ and the larger are τ_D^p, R_2, and $\bar{y}_A$. When the autocrat chooses to pay bribes, he will pay each rich citizen exactly $\tilde{b}^r(\tau_A)$ so that $b = \delta\tilde{b}^r(\tau_A)$.

We make the following parametric assumptions for γ.

Assumption A.3. $\beta/\varphi - 1 < \gamma < \beta/\delta - 1$.

The first inequality rules out the situation in which the autocrat both taxes and bribes the rich citizens in order to prevent a revolution. To see this, note that when $b = \delta\tilde{b}^r(\tau_A)$, the autocrat's marginal cost of increasing τ_A is $(1+\gamma)\varphi\bar{y}_A$, while his marginal benefit is $\beta(1-\theta)(1-C'(\tau_A))\bar{y}_A$. Assumption A.3 guarantees that the marginal cost of increasing τ_A exceeds the marginal benefit for all values of τ_A and θ. Thus the autocrat will set $\tau_A = 0$ whenever $b = \delta\tilde{b}^r(\tau_A)$. The second inequality guarantees that a threshold value $\theta^*(\gamma)$, which will be described below, is strictly positive.

Noting that $\rho(0, \tilde{b}^r(0), 0) = 1$ and $\tilde{b}^r(0) = G^r + R_2$, where G^r is defined in Assumption A.1, the autocrat will set $\tau_A = 0$ and $b = \delta\tilde{b}^r(0)$ if and only if the following conditions are satisfied:

(i) Feasibility: $\delta(1+\gamma)(G^r + R_2) \le (1-\theta)R_1$

(ii) Desirability: $\delta(1+\gamma)(G^r + R_2) \le \beta(1-\theta)R_2$.

The following definitions are useful for studying the comparative statics of the model.

Definition A.4. *A **resource boom** is an increase in both* R_1 *and* R_2.

[53] Note that the assumption is weaker than assuming that $\tilde{b}^r(\tau_A) \le \tilde{b}^p(\tau_A)$ for all $\tau_A \in [0,1]$, because $\delta < 1/2$.

Definition A.5. *In an economy with parameter values* (δ, γ, θ)*, a* ***balanced resource boom*** *is a resource boom that satisfies*

$$\frac{\Delta R_2}{\Delta R_1} < \frac{1-\theta}{\delta(1+\gamma)}.$$

Because an increase in R_2 increases the attractiveness of democracy to the citizens, if the increase in R_2 far exceeds the increase in R_1, the autocrat will be unable to pay the reservation bribe of the rich. In contrast, a balanced resource boom increases the likelihood that the feasibility constraint is satisfied, because the increase in R_2 is not "too large" relative to the increase in R_1. Because Assumption A.3 implies that $\delta(1+\gamma) < \beta$, a balanced resource boom could involve $\Delta R_2 > \Delta R_1$. Note that a resource boom is more likely to be balanced the smaller are γ and θ.

A.1.3 Results

We are now ready to state the main results.

Proposition A.6. *For each* γ *there exists a threshold value* $\theta^*(\gamma) \in (0, 1)$ *such that for* $\theta < \theta^*(\gamma)$*, a balanced resource boom makes the transition to democracy less likely, the lower is* θ*. For* $\theta \geq \theta^*(\gamma)$ *the state transitions to democracy for any* $(R_1, R_2) \geq 0$*.*

Proof. First note that the feasibility constraint is satisfied because the resource boom is balanced. Let $\theta^*(\gamma) = 1 - \delta(1+\gamma)/\beta$, which is in $(0, 1)$ by Assumption A.3. When $\theta < \theta^*(\gamma)$, we have that $\beta(1-\theta) - \delta(1+\gamma)$ is positive and decreasing in θ. This means that an increase in R_2 increases the likelihood that the desirability constraint is satisfied, and the marginal effect of R_2 on desirability is decreasing in θ. When $\theta \geq \theta^*(\gamma)$, the desirability constraint is always violated. $\square$

Proposition A.6 states that a balanced increase in resource rents will lower the chances of democratization when constraints on the ruler are sufficiently weak. However, when constraints are strong, no resource boom can impede democratization. The assumption that the autocrat is credit-constrained necessitates that the resource boom be balanced. Note that both types of marginal transaction costs induced by executive constraints, γ and θ, matter for the outcome. For example, lowering γ (subject to Assumption A.3 holding) increases $\theta^*(\gamma)$, raising the likelihood that a balanced resource boom impedes democratization for a given value of θ.

Corollary A.7. *There exists a threshold value* $\theta^* \in (0, 1)$ *such that for* $\theta < \theta^*$*, a balanced resource boom is more likely to result in zero tax revenue, the lower is* θ*. For* $\theta \geq \theta^*$ *taxes are positive for any* $(R_1, R_2) \geq 0$*.*

Proof. The result follows immediately from Proposition A.6 by noting that under autocracy, $\tau_A = 0$, while under democracy, $\tau_D = \tau_D^p > 0$. $\square$

The prediction of Corollary A.7 contrasts with that of the fiscal capacity model of Besley and Persson (2011). In their model political transitions are exogenous and taxation is used either to fund a public good or to redistribute income to the group in power. An increase in resource wealth leads to lower taxes only when institutions are "cohesive," i.e., θ is large. This is because in their model tax revenue is spent on the public good when institutions are cohesive, and the diminishing marginal utility of the public good implies that tax revenue is less valuable after a resource windfall that relaxes the budget constraint. For small values of θ, resource wealth does not affect equilibrium taxation in their model. In our model the mechanism determining the tax rate is quite different: the political transition is endogenous, and equilibrium taxation depends on the incumbent's ability and willingness to use patronage to remain in power. Figure A.16 graphically demonstrates how the effect of a resource boom on the suppression decision depends on the strength of executive constraints.

A.2 Tables

Table A.1: Variable Descriptions and Sources

Variable	Definition	Source
Democracy, 2008	POLITY2 index in 2008, normalized to take values between zero and one	Polity IV
Avg. Democracy, 1966–2008	Average normalized POLITY2 index from 1966–2008 in years in which the country was independent	Polity IV
Corruption, 2008	Recoded corruption index in 2008 ranging from 0 to 6, with higher numbers indicating more corruption	PRS
Internal Conflict, 1966–2008	Internal or internationalized internal armed conflicts per year in which country was independent from 1966–2008	UCDP/PRIO
Coup Attempts, 1966–2008	(Failed or successful) coup attempts per year in which country was independent from 1966–2008	Polity IV
Purges, 1966–2008	Political purges per year in which country was independent from 1966–2008	CNTS
Total Revenue, 2000–2008	Log of average government revenue share of GDP from 2000–2008	ICTD
Tax Revenue, 2000–2008	Log of average tax revenue share of GDP from 2000–2008	ICTD
GDP, 2008	Log of GDP per capita in 2008 in constant 2011 international dollars	WDI
Non-Oil GDP, 2008	Log of non-oil GDP per capita in 2008 in constant 2011 international dollars	WDI
Non-Oil/Gas GDP, 2008	Log of non-oil/gas GDP per capita in 2008 in constant 2011 international dollars	WDI
Non-Resource GDP, 2008	Log of non-resource GDP per capita in 2008 in constant 2011 international dollars	WDI
Manufacturing GDP, 2008	Log of manufacturing value added per capita in 2008 in constant 2011 international dollars	WDI
Population Density, 2008	Log of population in 2008 divided by land area	Maddison, GIS
Executive Constraints, 1950–1966	Average XCONST index from 1950–1965 after normalizing XCONST to take values between zero and one	Polity IV
Weak Constraints, 1950–1966	Indicates having averaged three points or fewer out of seven on XCONST from 1950–1965	Polity IV
Oil Production, 1966–2008	Log of average annual metric tons of oil produced per 1000 inhabitants from 1966–2008	Ross
Oil Endowment	Log of total oil endowment in millions of barrels per 1000 inhabitants in 1960	ASPO
Basin Type Area	Log of sovereign area covered by a type of basin in square km per 1000 inhabitants in 1960 (see Tables A.3, A.4, A.5)	Tellus
Land Area	Log of land area in square km per 1000 inhabitants in 1960	GIS
Coastline	Log of length of coastline in km per 1000 inhabitants in 1960	CIA
Mountainous Area	Log of mountainous land area in square km per 1000 inhabitants in 1960	FL
Tropical Area	Log of land area falling within tropics in square km per 1000 inhabitants in 1960	GSM
Good Soil Area	Log of land area containing "good" soil in square km per 1000 inhabitants in 1960	GAEZ

Notes. Polity IV stands for the Polity IV Project (Marshall and Gurr, 2014; Marshall and Marshall, 2016). PRS stands for Political Risk Services. UCDP/PRIO stands for the UCDP/PRIO Armed Conflict Dataset (Gleditsch et al., 2002). CNTS stands for Cross-National Time-Series Data Archive (Banks and Wilson, 2016). ICTD stands for International Centre for Tax and Development (Prichard et al., 2014). WDI stands for the World Bank World Development Indicators. Maddison stands for the Maddison Project (Maddison, 2013). Ross stands for Ross (2013). ASPO stands for Association for the Study of Peak Oil. WOGR stands for the World Oil and Gas Review published by ENI (ENI, 2015). Tellus stands for the Fugro Robertson, Ltd. (2013) Tellus GIS database. GIS stands for author's calculation using ArcGIS. CIA stands for CIA World Factbook (CIA, 2015). FL stands for Fearon and Laitin (2003). GSM stands for Gallup et al. (1998). GAEZ stands for the FAO's Global Agro-Ecological Zones database (version 3.0) (Fischer et al., 2002).

Table A.2: Variable Descriptions and Sources (Continued)

Variable	Definition	Source
Urbanization, 1850	Urbanization rate in 1850	Chandler
British Legal Origin	Equals one if the country has a British legal origin, and zero otherwise	Easterly
Communist Legacy	Equals one if the country has a legacy of communism, and zero otherwise	Kornai
Percentage Christian, 1950	Percentage of the population that was Christian in 1950	WRD
Percentage Muslim, 1950	Percentage of the population that was Muslim in 1950	WRD
Percentage Hindu, 1950	Percentage of the population that was Hindu in 1950	WRD
Ethnic Fractionalization	$1 - \sum_{i=1}^{N} s_{ij}^2$, where s_{ij} is the share of ethnic group $i \in \{1, \ldots, N\}$ in country j	Alesina et al.
Religious Fractionalization	$1 - \sum_{i=1}^{N} s_{ij}^2$, where s_{ij} is the share of religious group $i \in \{1, \ldots, N\}$ in country j	Alesina et al.
Linguistic Fractionalization	$1 - \sum_{i=1}^{N} s_{ij}^2$, where s_{ij} is the share of linguistic group $i \in \{1, \ldots, N\}$ in country j	Alesina et al.

Notes. Chandler stands for Chandler (1987). Easterly stands for William Easterly's Global Development Network Growth Database (Easterly, 2001). Kornai stands for Kornai (1992). WRD stands for the World Religion Database (Johnson and Grim, 2017). Alesina et al. stands for Alesina et al. (2003).

Table A.3: Fugro Robertson Global Basin Classification Codes

Sub-Regime Group	Code	Sub-Regime Name
Convergent (Continent-Continent)	C.1.F	Peripheral Foreland (Continent-Continent)
	C.1.F(p)	Peripheral Foreland with Piggyback (Continent-Continent)
	C.1.POE	Late to Post-Orogenic Extension (Continent-Continent)
	C.1.SOE	Syn-Orogenic Extensional (Continent-Continent)
	C.1.TOC	Trapped Oceanic Crustal Sag (Continent-Continent)
	C.1.W	Intramontane Wrench (Continent-Continent)
Convergent (Ocean-Continent)	C.2.E	Retro-Arc Extensional (Ocean-Continent)
	C.2.F	Retro-Arc Foreland (Ocean-Continent)
	C.2.FA	Fore-Arc (Ocean-Continent)
	C.2.S	Retro-Arc Post-Extensional Sag (Ocean-Continent)
	C.2.W	Arc-Related Wrench (Ocean-Continent)
Convergent (Ocean-Ocean)	C.3.E	Retro-Arc Extensional (Ocean-Ocean)
	C.3.F	Retro-Arc Foreland (Ocean-Ocean)
	C.3.FA	Fore-Arc (Ocean-Ocean)
	C.3.S	Retro-Arc Post-Extensional Sag (Ocean-Ocean)
	C.3.W	Arc-Related Wrench (Ocean-Ocean)
Divergent	D.1	Rift
	D.2	Intracratonic Sag
	D.3	Post-Rift Sag
	D.3(i)	Post-Rift Sag with Inversion
	D.4	Passive Margin
	D.4(i)	Passive Margin with Inversion
Wrench	W.1	Intracratonic Wrench
	W.2	Wrench (Ocean-Continent)

Source. Fugro Robertson, Ltd. (2013).

Table A.4: Grouping by Plate-Tectonic Environment and Primary Subsidence Mechanism

Number	Tectonics	Subsidence	Basin Aggregation in Group
1	Convergent C-C	Mechanical	C.1.F + C.1.F(p) + C.1.SOE + C.1.W
2	Convergent C-C	Thermo-Mechanical	C.1.POE + C.1.TOC
3	Convergent O-C	Mechanical	C.2.E + C.2.F + C.2.FA + C.2.W
4	Convergent O-C	Thermal	C.2.S
5	Convergent O-O	Mechanical or Thermal	C.3.E + C.3.F + C.3.FA + C.3.S + C.3.W
6	Divergent	Mechanical	D.1
7	Divergent	Thermal	D.2 + D.3 + D.3(i) + D.4 + D.4(i)
8	Wrench	Mechanical	W.1 + W.2

Notes. The categorization is from Fugro Robertson, Ltd. (2013). See Table A.3 for the basin types associated with each code. In "C-C," "O-C," and "O-O," "C" stands for continent, and "O" stands for "Ocean."

Table A.5: Grouping by Final Component of Fugro Tellus Code

Number	Group Name	Basin Aggregation in Group
1	Foreland	C.1.F + C.1.F(p) + C.2.F + C.3.F
2	Fore-Arc	C.2.FA + C.3.FA
3	Extensional	C.1.POE + C.1.SOE + C.2.E + C.3.E
4	Convergent Sag	C.1.TOC + C.2.S + C.3.S
5	Convergent Wrench	C.1.W + C.2.W + C.3.W
6	Rift	D.1
7	Intracratonic Sag	D.2
8	Post-Rift Sag	D.3 + D.3(i)
9	Passive Margin	D.4 + D.4(i)
10	Wrench	W.1 + W.2

Notes. The categorization is from Fugro Robertson, Ltd. (2013). See Table A.3 for the basin types associated with each code.

Table A.6: Total Basin Coverage of Sovereign Area by Region

	Mean	Std. Dev.	Min.	Max.	Obs.
East Asia and the Pacific	0.39	0.25	0.00	0.75	20
Eastern Europe and Central Asia	0.67	0.28	0.13	1.00	23
Rest of Europe and Neo-Europes	0.57	0.32	0.00	1.00	26
Latin America and the Caribbean	0.56	0.22	0.12	0.99	30
Middle East and North Africa	0.86	0.20	0.35	1.00	21
Sub-Saharan Africa	0.44	0.28	0.00	0.90	45
South Asia	0.55	0.32	0.03	1.00	7
Total	0.56	0.30	0.00	1.00	172

Notes. This table summarizes the portion of country sovereign area containing any type of sedimentary basin.

Table A.7: Summary Statistics

	Mean	Std. Dev.	Min.	Max.	Obs.
Democracy, 2008	0.69	0.32	0.00	1.00	157
Democracy, 1966	0.44	0.38	0.00	1.00	117
Avg. democracy, 1966–2008	0.53	0.31	0.00	1.00	160
Corruption, 2008	3.44	1.18	0.00	6.00	136
Internal conflicts per year, 1966–2008	0.21	0.48	0.00	3.86	172
Coup attempts per year, 1966–2008	0.06	0.08	0.00	0.35	160
Purges per year, 1966–2008	0.06	0.13	0.00	1.12	172
Total revenue, 2000–2008 (log avg.)	−1.53	0.45	−3.05	−0.54	165
Tax revenue, 2000–2008 (log avg.)	−1.97	0.69	−5.03	−0.77	167
GDP, 2008 (log p.c.)	9.06	1.26	6.36	11.71	166
GDP, 1966 (log p.c.)	7.69	1.00	6.05	10.37	136
Non-Oil GDP, 2008 (log p.c.)	9.27	1.16	6.33	11.46	132
Non-Oil/Gas GDP, 2008 (log p.c.)	9.28	1.15	6.33	11.45	129
Non-Resource GDP, 2008 (log p.c.)	8.93	1.30	5.92	11.45	166
Manufacturing GDP, 2008 (log p.c.)	6.99	1.51	2.61	9.54	145
Population density, 2008 (log)	−2.77	1.34	−6.25	1.91	153
Executive constraints, 1950–1965	0.47	0.37	0.00	1.00	116
Oil production, 1966–2008 (log avg. p.c.)	−4.88	4.24	−9.03	4.45	172
Oil discovery, 1966–2003 (log avg. p.c.)	−9.03	3.24	−11.14	1.73	172
Oil reserves, 1966–2003 (log avg. p.c.)	−5.26	3.14	−7.30	4.69	172
Oil endowment (log p.c.)	−10.17	2.76	−11.93	−0.31	172
Oil quality	3.44	3.28	1.00	10.44	127
Convergent C-C mechanical area (log p.c.)	−8.36	2.97	−10.34	0.20	172
Convergent O-C thermal area (log p.c.)	−8.85	0.70	−8.99	−4.22	172
Convergent O-C mechanical area (log p.c.)	−9.62	3.69	−11.92	−1.06	172
Convergent O-O area (log p.c.)	−9.80	2.38	−10.66	−0.31	172
Divergent thermal area (log p.c.)	−6.51	4.91	−13.75	1.27	172
Wrench mechanical area (log p.c.)	−13.25	3.66	−14.94	−0.73	172
Divergent mechanical area (log p.c.)	−10.64	2.68	−12.10	−2.02	172
Convergent C-C thermo-mechanical area (log p.c.)	−8.52	0.92	−8.75	−2.91	172
Foreland area (log p.c.)	−7.07	2.93	−9.60	0.20	172
Intracratonic sag area (log p.c.)	−11.00	5.21	−14.70	−0.03	172
Passive margin area (log p.c.)	−8.78	5.19	−13.75	1.27	172
Convergent sag area (log p.c.)	−15.09	3.20	−16.14	−2.91	172
Post-rift sag area (log p.c.)	−10.18	3.56	−12.52	−0.73	172
Wrench area (log p.c.)	−13.25	3.66	−14.94	−0.73	172
Extensional area (log p.c.)	−9.90	2.07	−10.68	−1.60	172
Convergent wrench area (log p.c.)	−11.67	3.20	−13.12	−0.32	172
Fore-arc area (log p.c.)	−10.35	3.16	−11.92	−0.80	172
Rift area (log p.c.)	−10.64	2.68	−12.10	−2.02	172
Land area (log p.c.)	−3.23	1.58	−7.79	0.49	172
Coastline (log p.c.)	−9.35	2.99	−14.01	−3.17	172
Mountainous area (log p.c.)	−6.54	2.99	−11.21	−0.53	172
Tropical area (log p.c.)	−6.21	3.85	−10.47	−0.08	172
Good soil area (log p.c.)	−6.79	2.64	−11.49	−0.37	172

Notes. See Table A.1 in the online appendix for variable definitions. Due to the presence of zero values, the "log" transformation of the oil and geographic variables is actually a differentiable and monotonic transformation $h(w) = \log(w)$ for $w > w_0$ and $h(w) = \log(w_0) - 1 + w/w_0$ for $w \leq w_0$. This function was suggested by James Hamilton of UC San Diego. In practice w_0 is chosen for each variable as the minimum positive value observed in the sample.

Table A.8: First-Stage Estimates for Optimal Sets of Basin Measures by Plate-Tectonic Environment and Primary Mechanism of Subsidence

	Log Avg. Oil Production per capita, 1966–2008							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Convergent C-C mechanical	0.599***	0.592***	0.589***	0.584***	0.607***	0.610***	0.609***	0.604***
	(0.119)	(0.119)	(0.124)	(0.124)	(0.125)	(0.124)	(0.126)	(0.127)
Convergent O-C thermal		0.589***		0.371**	0.340*	0.285	0.267	0.271
		(0.175)		(0.168)	(0.176)	(0.185)	(0.194)	(0.194)
Convergent O-C mechanical			0.359***	0.337***	0.320***	0.329***	0.327***	0.329***
			(0.084)	(0.087)	(0.088)	(0.091)	(0.091)	(0.091)
Convergent O-O			−0.362**	−0.377***	−0.344**	−0.345**	−0.341**	−0.341**
			(0.139)	(0.142)	(0.149)	(0.151)	(0.152)	(0.153)
Divergent thermal					0.058	0.062	0.060	0.059
					(0.069)	(0.069)	(0.071)	(0.071)
Wrench mechanical						0.070	0.073	0.075
						(0.072)	(0.074)	(0.075)
Divergent mechanical							0.026	0.026
							(0.116)	(0.117)
Convergent C-C thermo-mechanical								0.059
								(0.327)
Observations	157	157	157	157	157	157	157	157
R^2	0.318	0.327	0.394	0.398	0.400	0.403	0.404	0.404
F statistic	25.3	17.6	18.9	16.5	14.0	12.6	10.8	9.4

Notes. See Tables A.3 and A.4 in the online appendix for basin variable definitions. See Table A.1 in the online appendix for other variable definitions. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9: First-Stage Estimates for Optimal Sets of Basin Measures by Final Component of Fugro Tellus Code

	Log Avg. Oil Production per capita, 1966–2008									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Foreland	0.576***	0.608***	0.613***	0.585***	0.677***	0.677***	0.701***	0.710***	0.700***	0.701***
	(0.142)	(0.143)	(0.139)	(0.140)	(0.144)	(0.142)	(0.141)	(0.139)	(0.142)	(0.142)
Intracratonic sag		0.213***	0.209***	0.201***	0.155**	0.153**	0.164**	0.159**	0.159**	0.164**
		(0.069)	(0.068)	(0.068)	(0.073)	(0.073)	(0.074)	(0.075)	(0.075)	(0.077)
Passive margin			0.091	0.102		0.080	0.086	0.085	0.086	0.080
			(0.076)	(0.076)		(0.076)	(0.077)	(0.076)	(0.077)	(0.077)
Convergent sag				0.199***	0.164***	0.174***	0.183***	0.190***	0.189***	0.184***
				(0.063)	(0.061)	(0.064)	(0.063)	(0.066)	(0.066)	(0.066)
Post-rift sag					0.231**	0.218**	0.233**	0.227**	0.228**	0.213**
					(0.101)	(0.100)	(0.101)	(0.102)	(0.103)	(0.106)
Wrench					0.119	0.119	0.122	0.122	0.122	0.129
					(0.079)	(0.078)	(0.078)	(0.078)	(0.079)	(0.079)
Extensional							−0.196	−0.182	−0.199	−0.224
							(0.173)	(0.172)	(0.180)	(0.188)
Convergent wrench								−0.049	−0.069	−0.061
								(0.118)	(0.110)	(0.109)
Fore-arc									0.077	0.077
									(0.107)	(0.105)
Rift										0.084
										(0.107)
Observations	157	157	157	157	157	157	157	157	157	157
R^2	0.315	0.357	0.364	0.383	0.409	0.415	0.420	0.421	0.422	0.424
F statistic	16.4	17.0	14.4	12.6	11.7	10.3	9.5	8.4	7.4	6.6

Notes. See Tables A.3 and A.5 in the online appendix for basin variable definitions. See Table A.1 in the online appendix for other variable definitions. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.10: Testing for a Political Resource Curse (Controlling for Ethnic Fractionalization)

	Democracy, 2008	Avg. Democracy, 1966–2008	Corruption, 2008	Internal Conflict, 1966–2008	Coup Attempts, 1966–2008	Purges, 1966–2008	Total Revenue, 2000–2008	Tax Revenue, 2000–2008
	Panel A: Ordinary Least Squares							
Oil production	−0.019***	−0.014***	0.030	0.011*	0.001	0.003	0.035***	−0.042***
	(0.005)	(0.004)	(0.023)	(0.006)	(0.002)	(0.002)	(0.007)	(0.012)
Observations	156	159	135	171	159	171	164	166
R^2	0.439	0.537	0.336	0.216	0.207	0.093	0.510	0.479
	Panel B: Two-Stage Least Squares							
Oil production	−0.040**	−0.041***	0.133**	0.003	0.002	−0.000	0.027	−0.165***
	(0.018)	(0.015)	(0.060)	(0.019)	(0.003)	(0.005)	(0.017)	(0.041)
Observations	156	159	135	171	159	171	164	166
F statistic	22.4	24.6	21.3	28.0	24.6	28.0	26.2	24.4
A-R 95% CI	[−0.086, −0.009]	[−0.080, −0.014]	[0.023, 0.282]	[−0.038, 0.041]	[−0.004, 0.010]	[−0.011, 0.011]	[−0.009, 0.061]	[−0.279, −0.099]
Oil exog.	0.181	0.059	0.058	0.664	0.579	0.476	0.613	0.001

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The A-R 95% confidence interval is based on the Anderson and Rubin (1949) χ^2 test of the null hypothesis that the coefficients on the endogenous variables in the structural equation are jointly equal to zero. The A-R test is robust to the presence of weak instruments. The p-value of the test of the endogeneity of oil wealth is from the Hansen (1982) overidentification test of the null hypothesis that oil wealth is exogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.11: Testing for an Economic Resource Course (Controlling for Ethnic Fractionalization)

	GDP, 2008	Non-Oil GDP, 2008	Non-Oil/Gas GDP, 2008	Non-Resource GDP, 2008	Manufacturing GDP, 2008
	Panel A: Ordinary Least Squares				
Oil production	0.097***	0.047***	0.044***	0.076***	0.083***
	(0.015)	(0.017)	(0.017)	(0.015)	(0.021)
Observations	165	131	128	165	144
R^2	0.674	0.637	0.621	0.667	0.618
	Panel B: Two-Stage Least Squares				
Oil production	0.091**	0.059	0.052	0.070*	−0.005
	(0.040)	(0.043)	(0.043)	(0.041)	(0.075)
Observations	165	131	128	165	144
F statistic	26.1	18.8	18.4	26.1	11.9
A-R 95% CI	[0.008, 0.177]	[−0.030, 0.156]	[−0.038, 0.148]	[−0.015, 0.157]	[−0.220, 0.139]
Oil exog.	0.878	0.773	0.846	0.883	0.186

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The A-R 95% confidence interval is based on the Anderson and Rubin (1949) χ^2 test of the null hypothesis that the coefficients on the endogenous variables in the structural equation are jointly equal to zero. The A-R test is robust to the presence of weak instruments. The p-value of the test of the endogeneity of oil wealth is from the Hansen (1982) overidentification test of the null hypothesis that oil wealth is exogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.12: Testing for a Political Resource Curse: Basin vs. Endowment

	Democracy, 2008	Avg. Democracy, 1966–2008	Corruption, 2008	Internal Conflict, 1966–2008	Coup Attempts, 1966–2008	Purges, 1966–2008	Total Revenue, 2000–2008	Tax Revenue, 2000–2008
	Panel A: Ordinary Least Squares							
Oil production	−0.019***	−0.014***	0.032	0.012**	0.001	0.003	0.032***	−0.044***
	(0.005)	(0.004)	(0.023)	(0.006)	(0.002)	(0.002)	(0.007)	(0.012)
Observations	157	160	136	172	160	172	165	167
R^2	0.441	0.536	0.334	0.204	0.203	0.093	0.463	0.471
	Panel B: 2SLS using Endowment							
Oil production	−0.026***	−0.018***	0.034	0.003	0.001	0.001	0.043***	−0.080***
	(0.005)	(0.005)	(0.024)	(0.009)	(0.002)	(0.002)	(0.008)	(0.017)
Observations	157	160	136	172	160	172	165	167
F statistic	326.8	350.4	286.1	409.6	350.4	409.6	401.2	395.2
	Panel C: 2SLS using Basin							
Oil production	−0.038**	−0.039***	0.136**	0.007	0.002	−0.001	0.021	−0.163***
	(0.017)	(0.015)	(0.060)	(0.018)	(0.003)	(0.005)	(0.016)	(0.039)
Observations	157	160	136	172	160	172	165	167
F statistic	25.3	26.7	23.2	31.4	26.7	31.4	29.3	27.3
Overident. p-value	0.418	0.084	0.063	0.752	0.547	0.708	0.129	0.003

Notes. See Table A.1 in the online appendix for variable definitions. Panel A presents OLS estimates for comparison. Panel B presents IV estimates using initial oil endowment as an instrument for oil production. Panel C presents IV estimates using *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) *rk* statistic, which tests for weak identification and is robust to heteroskedasticity. The Hansen (1982) overidentification test p-value corresponds to the null hypothesis that both Endowment and *Basin* are valid instruments. Assuming that *Basin* is a valid instrument, rejection implies that Endowment is endogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.13: Testing for an Economic Resource Course: Basin vs. Endowment

	GDP, 2008	Non-Oil GDP, 2008	Non-Oil/Gas GDP, 2008	Non-Resource GDP, 2008	Manufacturing GDP, 2008
	Panel A: Ordinary Least Squares				
Oil production	0.092^{***}	0.043^{**}	0.040^{**}	0.071^{***}	0.076^{***}
	(0.015)	(0.017)	(0.017)	(0.016)	(0.021)
Observations	166	132	129	166	145
R^2	0.661	0.623	0.608	0.657	0.599
	Panel B: 2SLS using Endowment				
Oil production	0.114^{***}	0.066^{***}	0.061^{***}	0.085^{***}	0.070^{***}
	(0.016)	(0.017)	(0.017)	(0.016)	(0.024)
Observations	166	132	129	166	145
F statistic	407.9	224.3	424.4	407.9	322.3
	Panel C: 2SLS using Basin				
Oil production	0.074^{*}	0.045	0.039	0.054	−0.037
	(0.040)	(0.044)	(0.044)	(0.041)	(0.075)
Observations	166	132	129	166	145
F statistic	29.3	20.4	20.1	29.3	14.3
Overident. p-value	0.273	0.587	0.563	0.373	0.093

Notes. See Table A.1 in the online appendix for variable definitions. Panel A presents OLS estimates for comparison. Panel B presents IV estimates using initial oil endowment as an instrument for oil production. Panel C presents IV estimates using *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) rk statistic, which tests for weak identification and is robust to heteroskedasticity. The Hansen (1982) overidentification test p-value corresponds to the null hypothesis that both Endowment and *Basin* are valid instruments. Assuming that *Basin* is a valid instrument, rejection implies that Endowment is endogenous. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.14: Political Resource Curse: Heterogeneous Effects by Initial Institutional Quality

	Democracy, 2008	Avg. Democracy, 1966–2008	Corruption, 2008	Internal Conflict, 1966–2008	Coup Attempts, 1966–2008	Purges, 1966–2008	Total Revenue, 2000–2008	Tax Revenue, 2000–2008
	Panel A: Countries with Relatively Strong Executive Constraints from 1950–1965							
Oil production	−0.027	−0.009	−0.054	0.010	−0.000	0.018	0.057**	−0.012
	(0.019)	(0.018)	(0.070)	(0.037)	(0.005)	(0.012)	(0.025)	(0.030)
Observations	53	54	51	54	54	54	52	53
F statistic	4.2	5.5	6.0	5.5	5.5	5.5	4.1	4.2
	Panel B: Countries with Relatively Weak Executive Constraints from 1950–1965							
Oil production	−0.044**	−0.022**	0.033	0.035**	0.007	0.013*	0.071***	−0.108**
	(0.017)	(0.010)	(0.045)	(0.017)	(0.006)	(0.007)	(0.022)	(0.047)
Observations	60	62	54	62	62	62	58	60
F statistic	10.2	12.7	10.6	12.7	12.7	12.7	11.1	12.4
	Panel C: Difference between Estimates							
Difference	0.017	0.013	−0.087	−0.025	−0.007	0.005	−0.014	0.096
	(0.054)	(0.029)	(0.134)	(0.063)	(0.010)	(0.025)	(0.072)	(0.079)
p-value	0.754	0.658	0.518	0.689	0.491	0.836	0.846	0.227

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The F statistic is the Kleibergen and Paap (2006) *rk* statistic, which tests for weak identification and is robust to heteroskedasticity. Column titles refer to the sample of countries used in the regression. Countries in the "Strong" subsample averaged strictly greater than three points out of seven on the executive constraints index, XCONST (Polity IV), from 1950–1965. Countries in the "Weak" subsample averaged three points or fewer out of seven on XCONST from 1950–1965. A score of three points for XCONST indicates "slight to moderate limitation on executive authority" (Polity IV). In practice "Weak" indicates having an average XCONST score equal to or below the median average XCONST score from 1950–1965. The standard errors and p-values in Panel C are calculated by a bootstrap procedure based on 200 repetitions. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.15: Economic Resource Curse: Heterogeneous Effects by Initial Institutional Quality

	GDP, 2008	Non-Oil GDP, 2008	Non-Oil/Gas GDP, 2008	Non-Resource GDP, 2008	Manufacturing GDP, 2008
	Panel A: Countries with Relatively Strong Executive Constraints from 1950–1965				
Oil production	0.117	0.061	0.059	0.104	0.122
	(0.075)	(0.066)	(0.068)	(0.078)	(0.118)
Observations	51	46	45	51	50
F statistic	3.4	2.2	2.1	3.4	3.3
	Panel B: Countries with Relatively Weak Executive Constraints from 1950–1965				
Oil production	0.152^{***}	0.109^{**}	0.104^{*}	0.132^{***}	0.149^{***}
	(0.040)	(0.055)	(0.053)	(0.045)	(0.057)
Observations	59	48	47	59	50
F statistic	12.0	6.9	7.0	12.0	6.8
	Panel C: Difference between Estimates				
Difference	−0.035	−0.048	−0.045	−0.029	−0.027
	(0.112)	(0.168)	(0.137)	(0.114)	(0.284)
p-value	0.753	0.774	0.745	0.800	0.925

Notes. See Table A.1 in the online appendix for variable definitions. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. The IV specifications use *Basin* as an instrument for oil production. The *F* statistic is the Kleibergen and Paap (2006) *rk* statistic, which tests for weak identification and is robust to heteroskedasticity. Column titles refer to the sample of countries used in the regression. Countries in the "Strong" subsample averaged strictly greater than three points out of seven on the executive constraints index, XCONST (Polity IV), from 1950–1965. Countries in the "Weak" subsample averaged three points or fewer out of seven on XCONST from 1950–1965. A score of three points for XCONST indicates "slight to moderate limitation on executive authority" (Polity IV). In practice "Weak" indicates having an average XCONST score equal to or below the median average XCONST score from 1950–1965. The standard errors and p-values in Panel C are calculated by a bootstrap procedure based on 200 repetitions. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.16: Weak Executive Constraints and Basins: Tectonic-Subsidence Grouping

	Weak Executive Constraints, 1950–1965							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Convergent C-C mechanical	0.028							
	(0.019)							
Convergent O-C thermal		−0.047						
		(0.062)						
Convergent O-C mechanical			−0.018					
			(0.015)					
Convergent O-O				−0.036*				
				(0.022)				
Divergent thermal					−0.003			
					(0.014)			
Wrench mechanical						0.016		
						(0.012)		
Divergent mechanical							−0.003	
							(0.017)	
Convergent C-C thermo-mechanical								−0.020
								(0.052)
Observations	116	116	116	116	116	116	116	116
R^2	0.184	0.175	0.183	0.187	0.172	0.184	0.172	0.172

Notes. See Table A.1 for variable definitions. The variable "weak constraints" is an indicator for having averaged three points or fewer out of seven on XCONST from 1950–1965. A score of three points for XCONST indicates "slight to moderate limitation on executive authority" (Polity IV). In practice "weak constraints" indicates having an average XCONST score equal to or below the median average XCONST score from 1950–1965. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

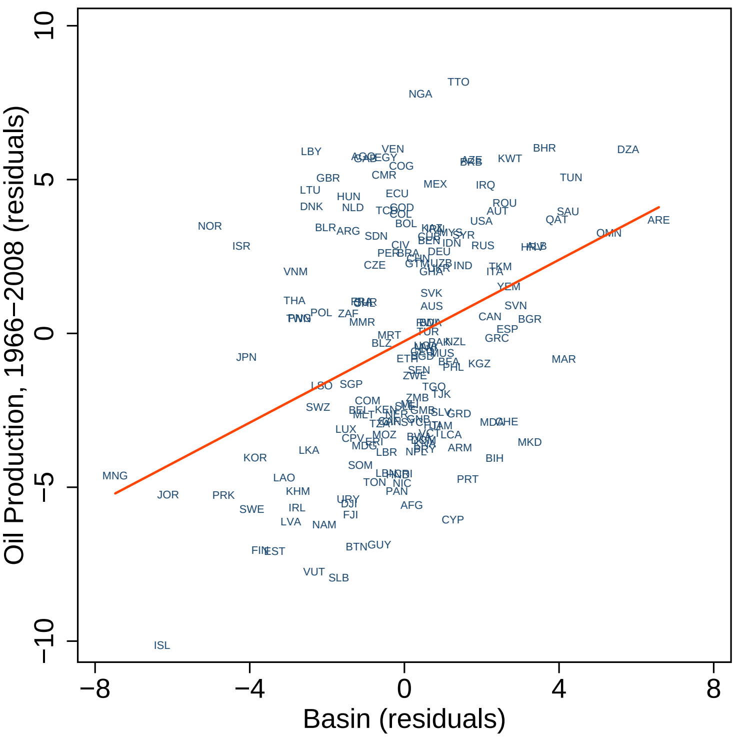
Table A.17: Weak Executive Constraints and Basins: Final Component of Code Grouping

	Weak Executive Constraints, 1950–1965									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Foreland	0.001									
	(0.020)									
Intracratonic sag		0.003								
		(0.011)								
Passive margin			−0.013							
			(0.012)							
Convergent sag				0.000						
				(0.019)						
Post-rift sag					−0.004					
					(0.013)					
Wrench						0.016				
						(0.012)				
Extensional							−0.010			
							(0.024)			
Convergent wrench								−0.032**		
								(0.014)		
Fore-arc									−0.035**	
									(0.017)	
Rift										−0.003
										(0.017)
Observations	116	116	116	116	116	116	116	116	116	116
R^2	0.171	0.172	0.180	0.171	0.172	0.184	0.172	0.205	0.201	0.172

Notes. See Table A.1 for variable definitions. The variable “weak constraints” is an indicator for having averaged three points or fewer out of seven on XCONST from 1950–1965. A score of three points for XCONST indicates “slight to moderate limitation on executive authority” (Polity IV). In practice “weak constraints” indicates having an average XCONST score equal to or below the median average XCONST score from 1950–1965. All specifications include geographic controls (land area, coastline, and mountainous area), climatic controls (tropical area and good soil area), and region fixed effects. Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

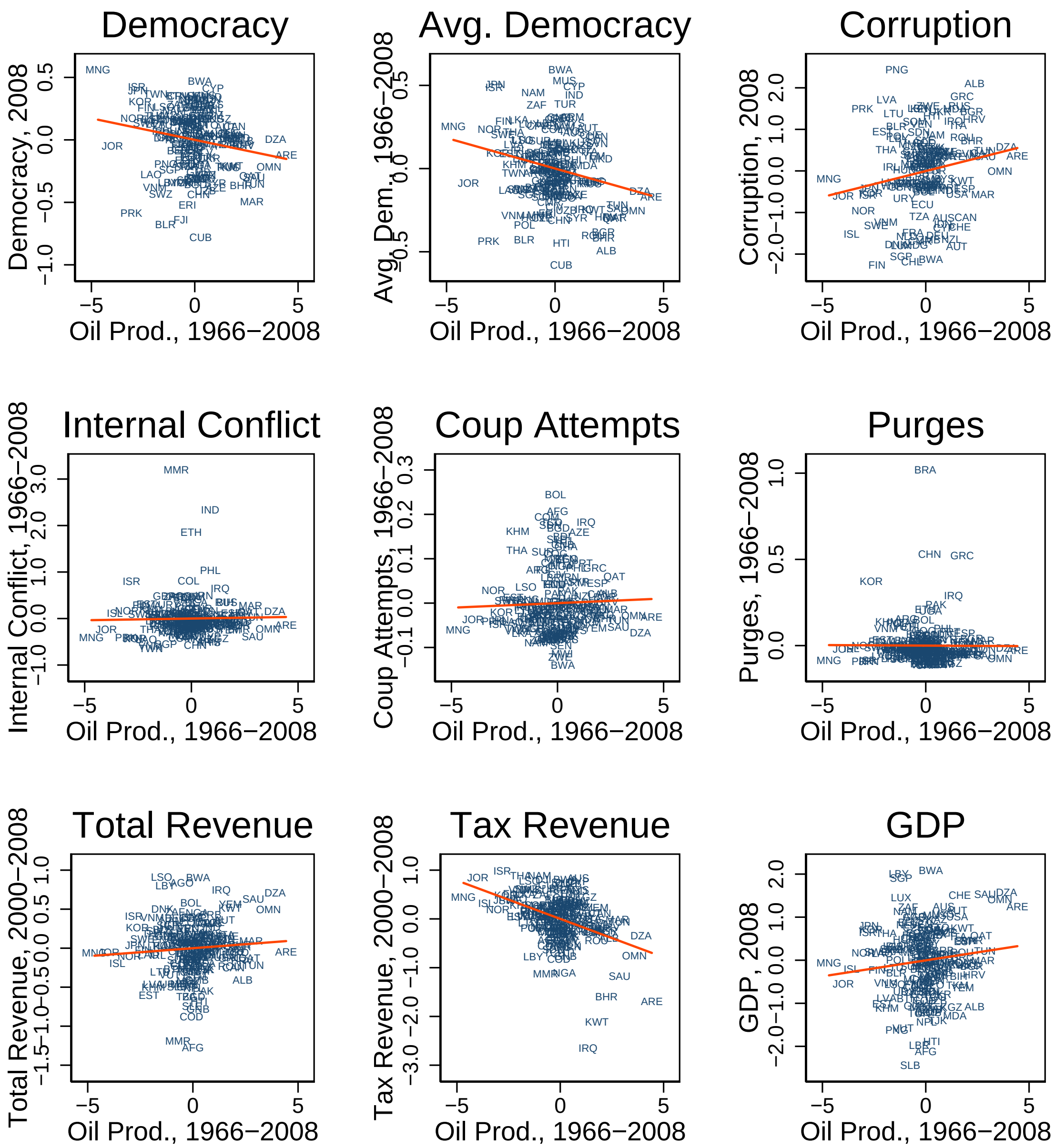
A.3 Figures

Figure A.1: First Stage



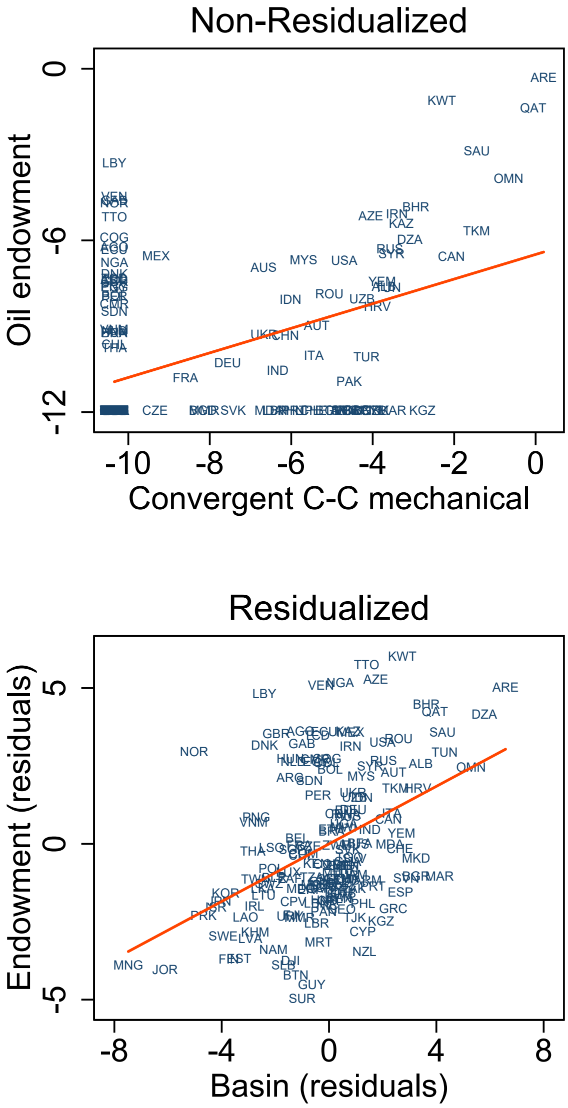
Notes. The figure plots oil production residuals against the residuals from *Basin*, where the residuals are obtained from separate regressions on the full set of geographic and climatic controls and region dummies.

Figure A.2: Second Stage



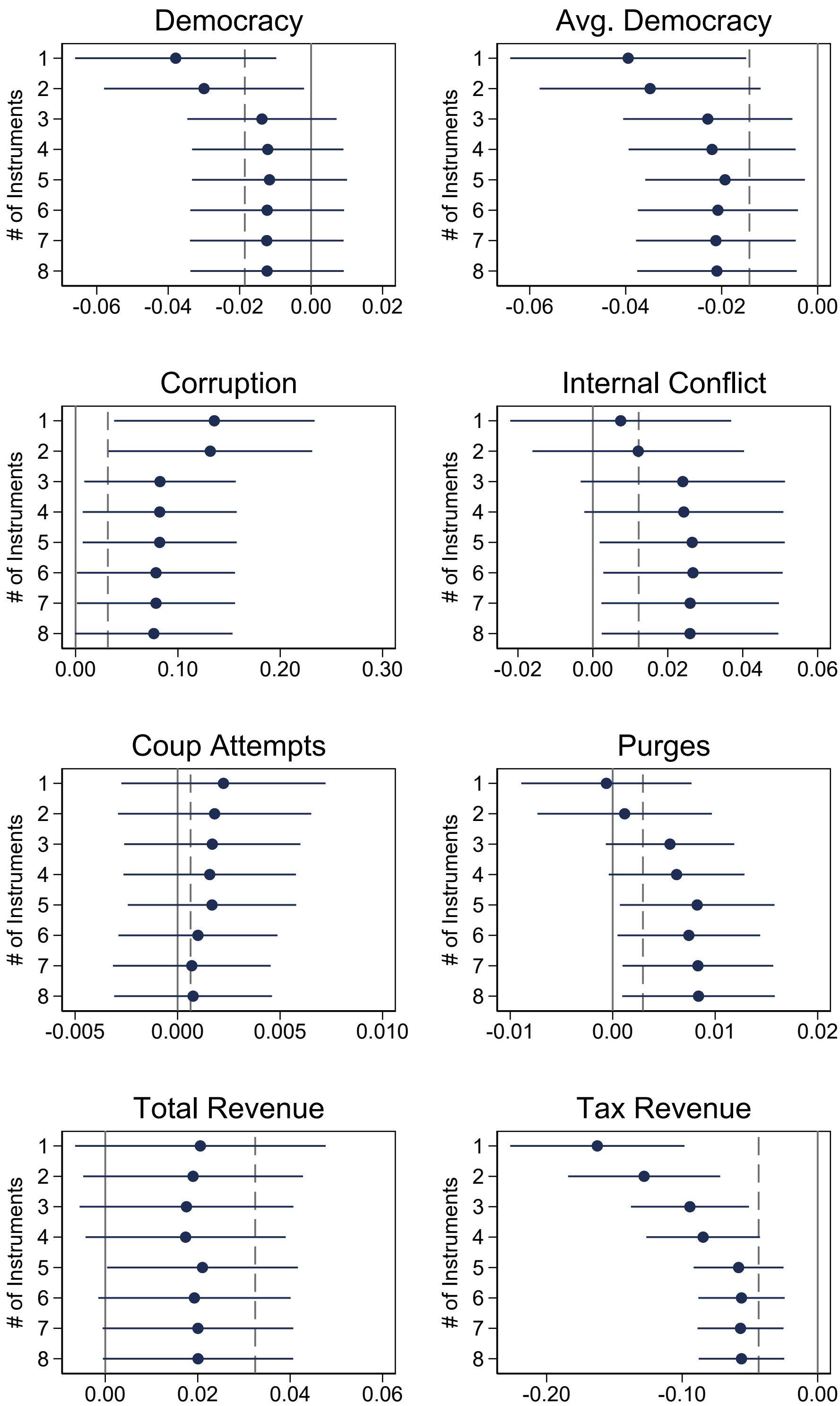
Notes. The figures plot outcome residuals against Oil Production predicted residuals. Each outcome residual is obtained by regressing the outcome variable on the full set of geographic and climatic controls and region dummies. The Oil Production predicted residuals are obtained by regressing the predicted values of Oil Production from the first stage on the full set of geographic and climatic controls and region dummies.

Figure A.3: Endowment and Basin



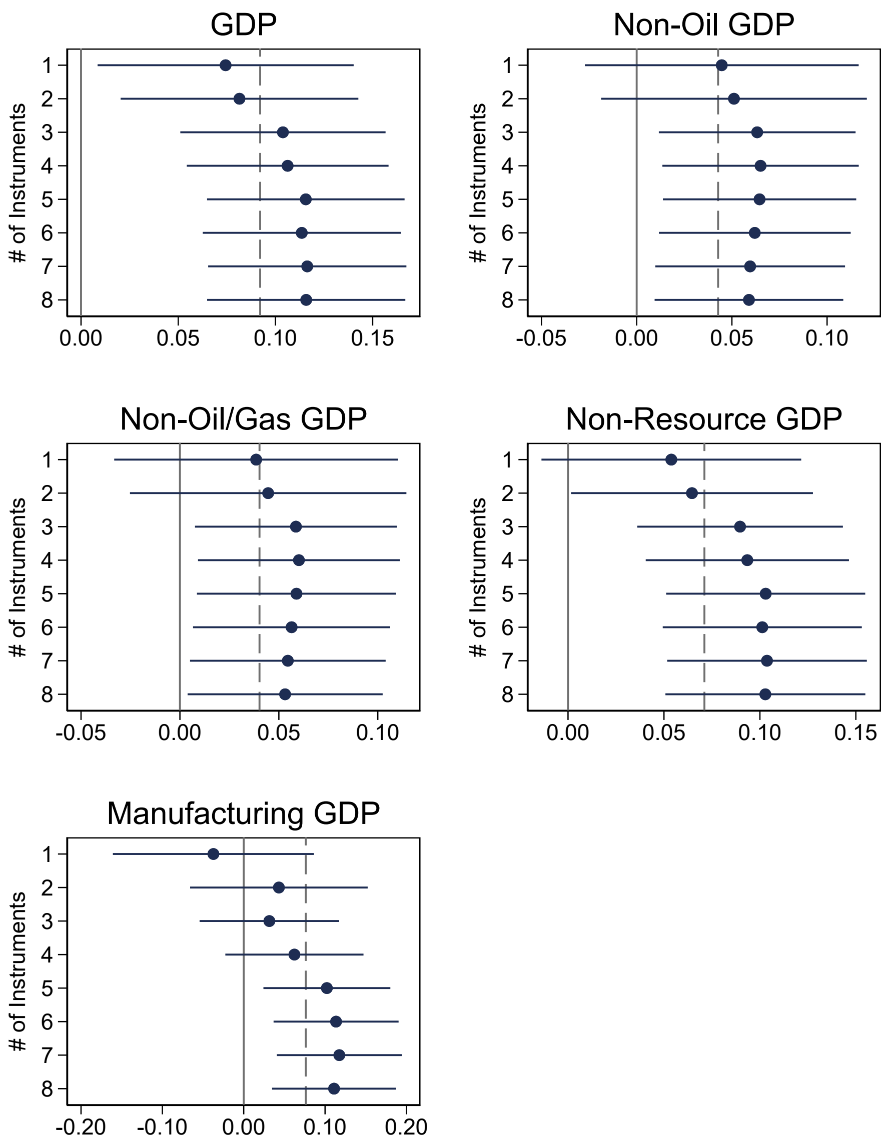
Notes. The figure plots oil endowment against *Basin*. The first graph is a raw scatterplot where the residuals are obtained from separate regressions on the full set of geographic and climatic controls and region dummies.

Figure A.4: 2SLS Estimates by Size of Instrument Set, Tectonic-Subsidence Grouping



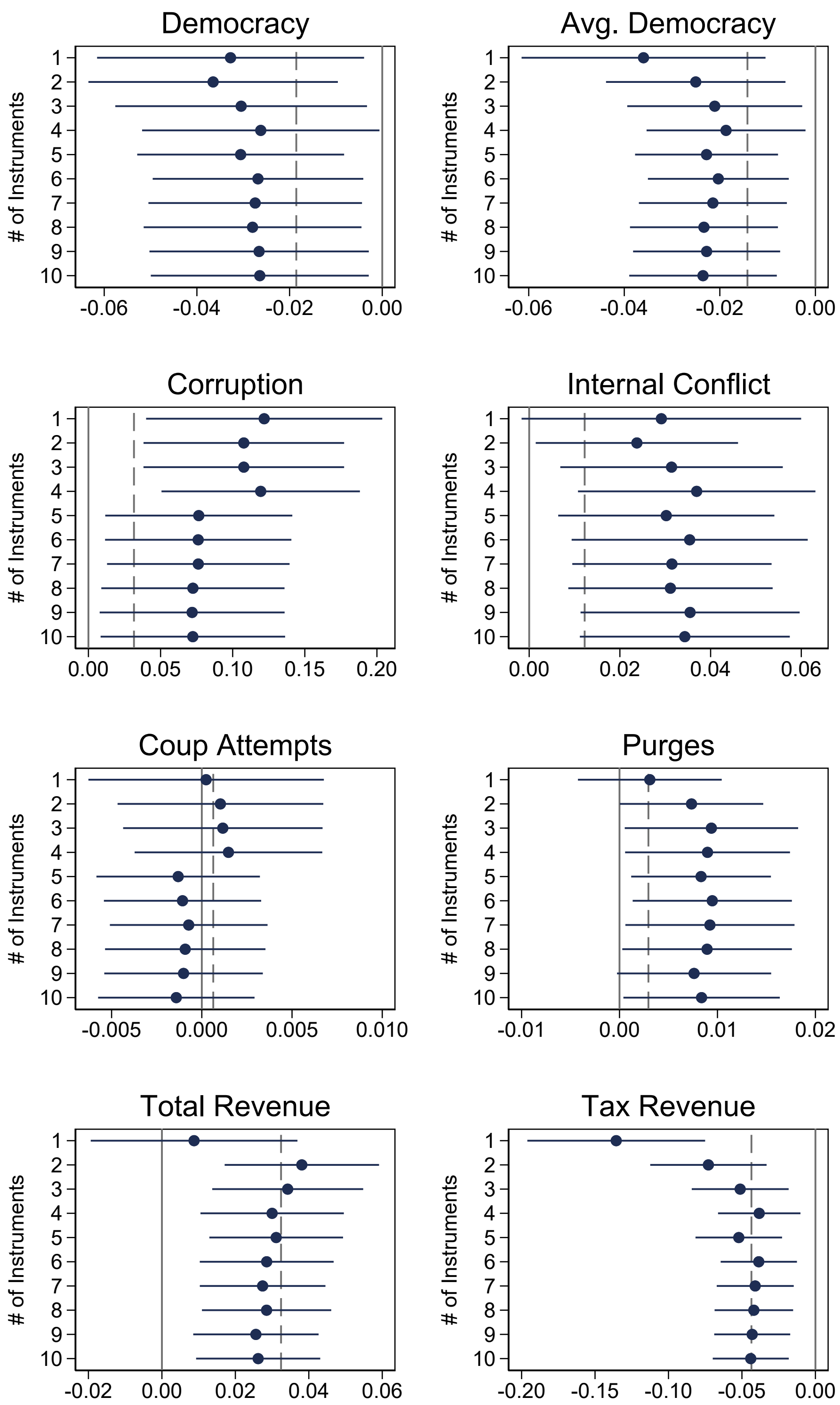
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.5: 2SLS Estimates by Size of Instrument Set, Tectonic-Subsidence Grouping



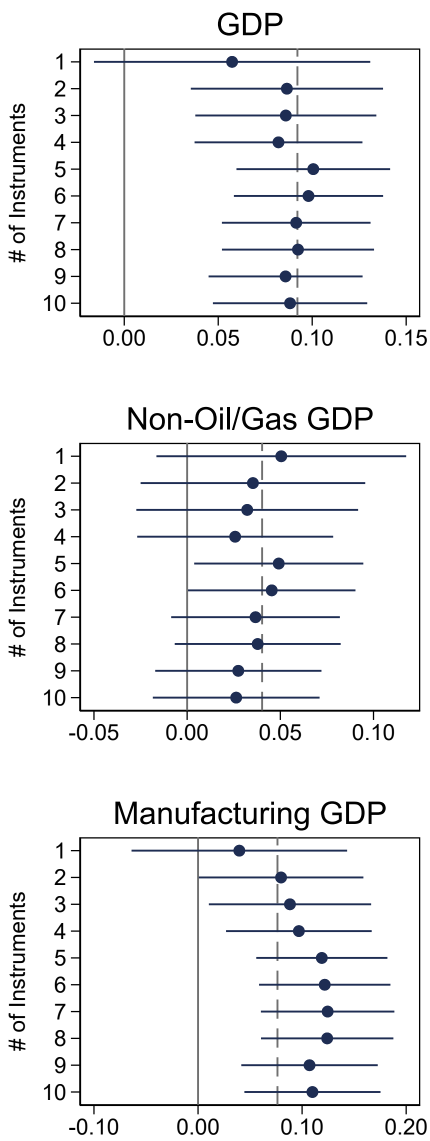
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.6: 2SLS Estimates by Size of Instrument Set, Final Component of Code Grouping



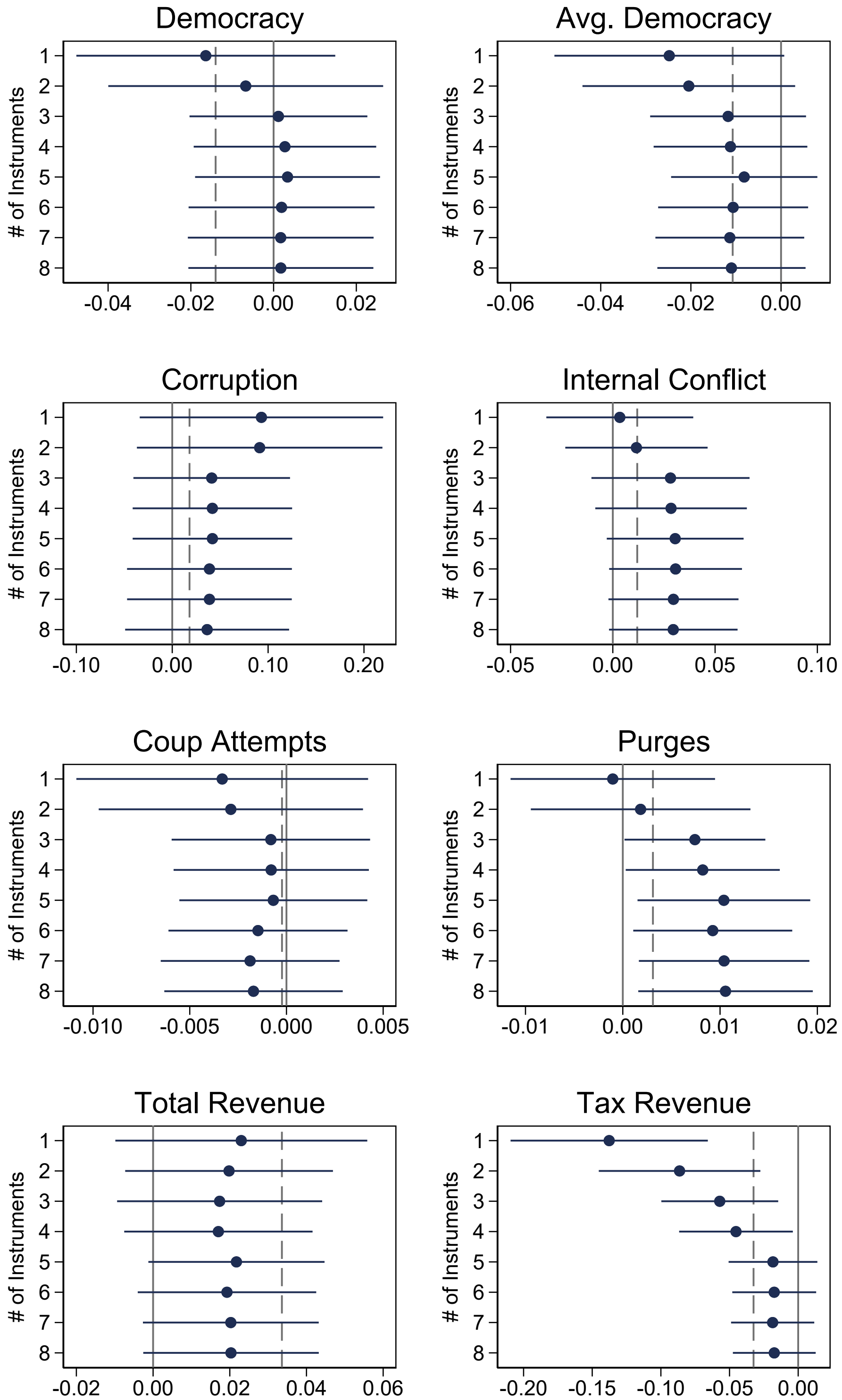
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.7: 2SLS Estimates by Size of Instrument Set, Final Component of Code Grouping



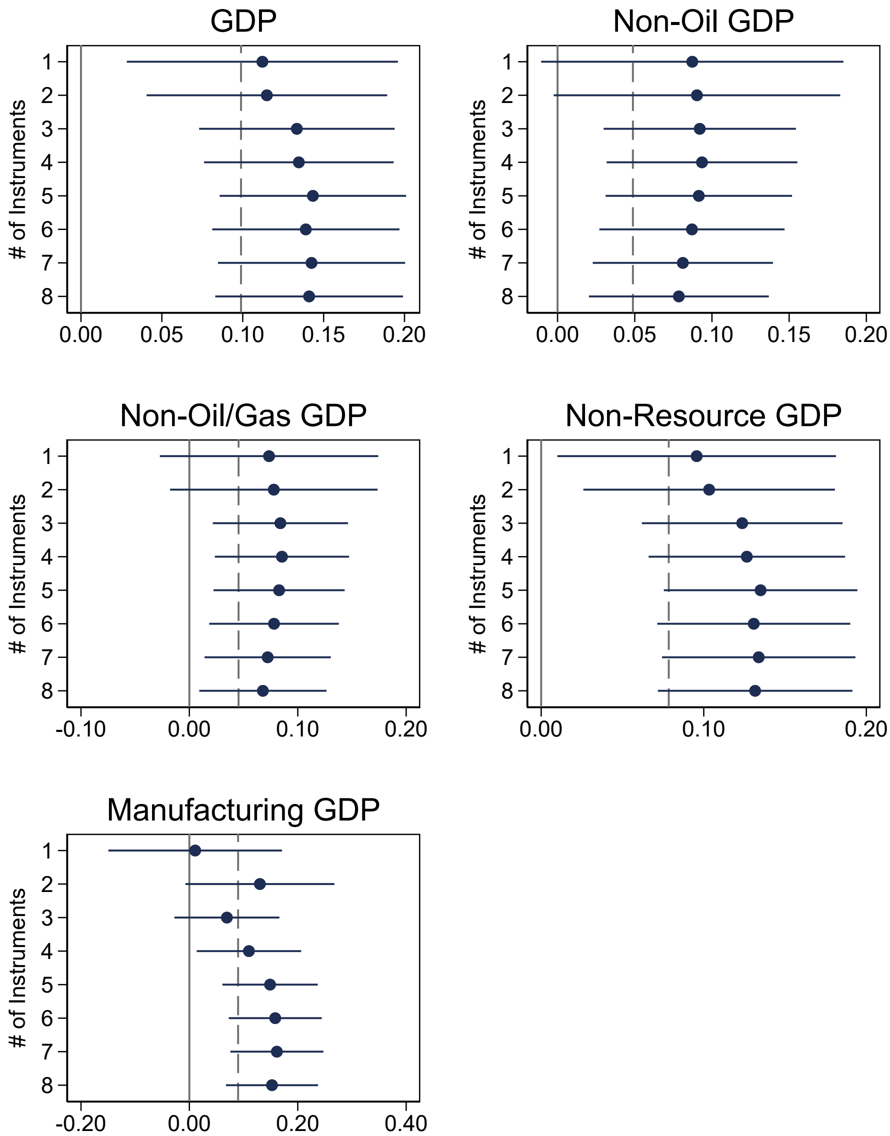
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.8: 2SLS Estimates by Size of Instrument Set, Tectonic-Subsidence Grouping (Controlling for Percentage Muslim in 1950)



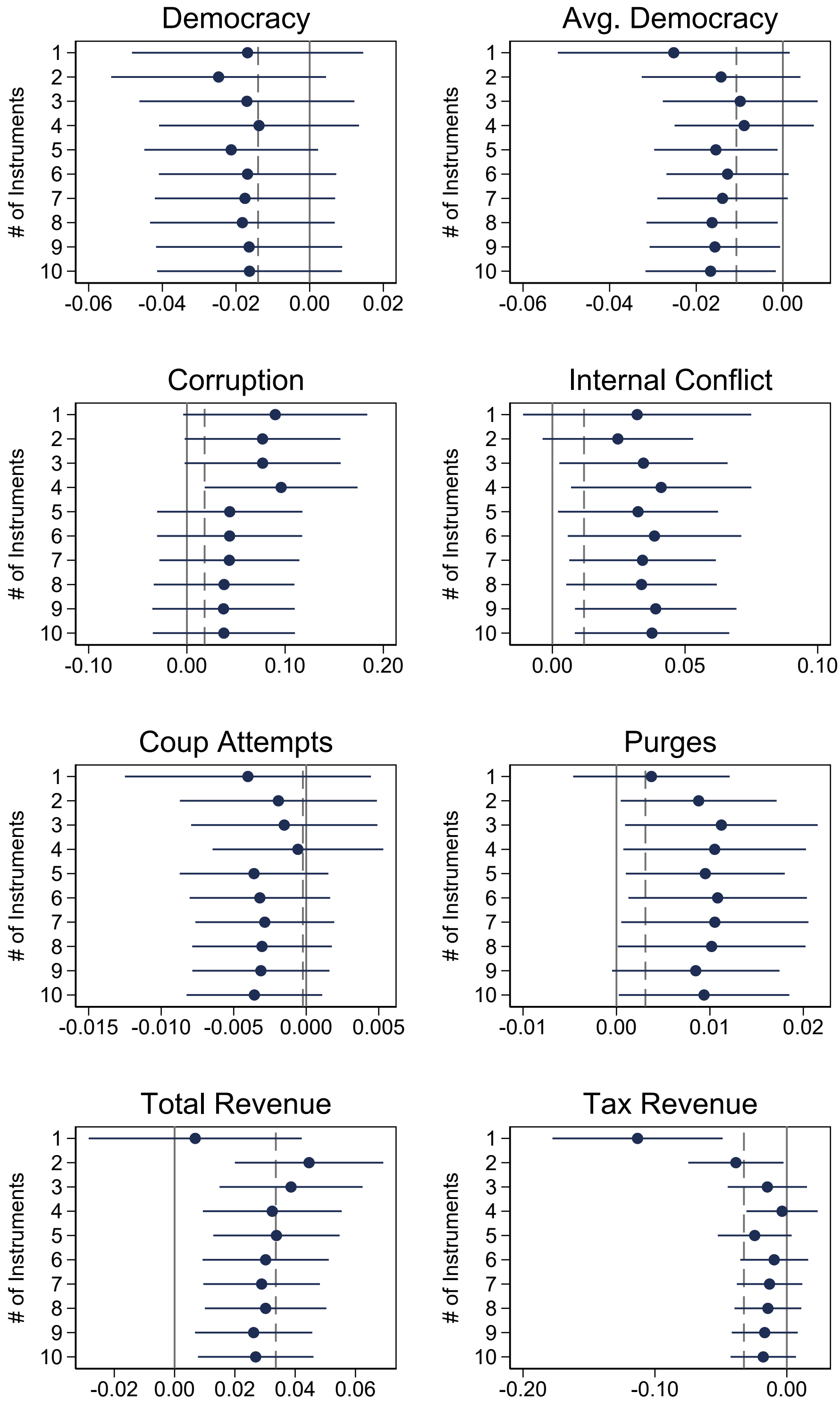
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.9: 2SLS Estimates by Size of Instrument Set, Tectonic-Subsidence Grouping (Controlling for Percentage Muslim in 1950)



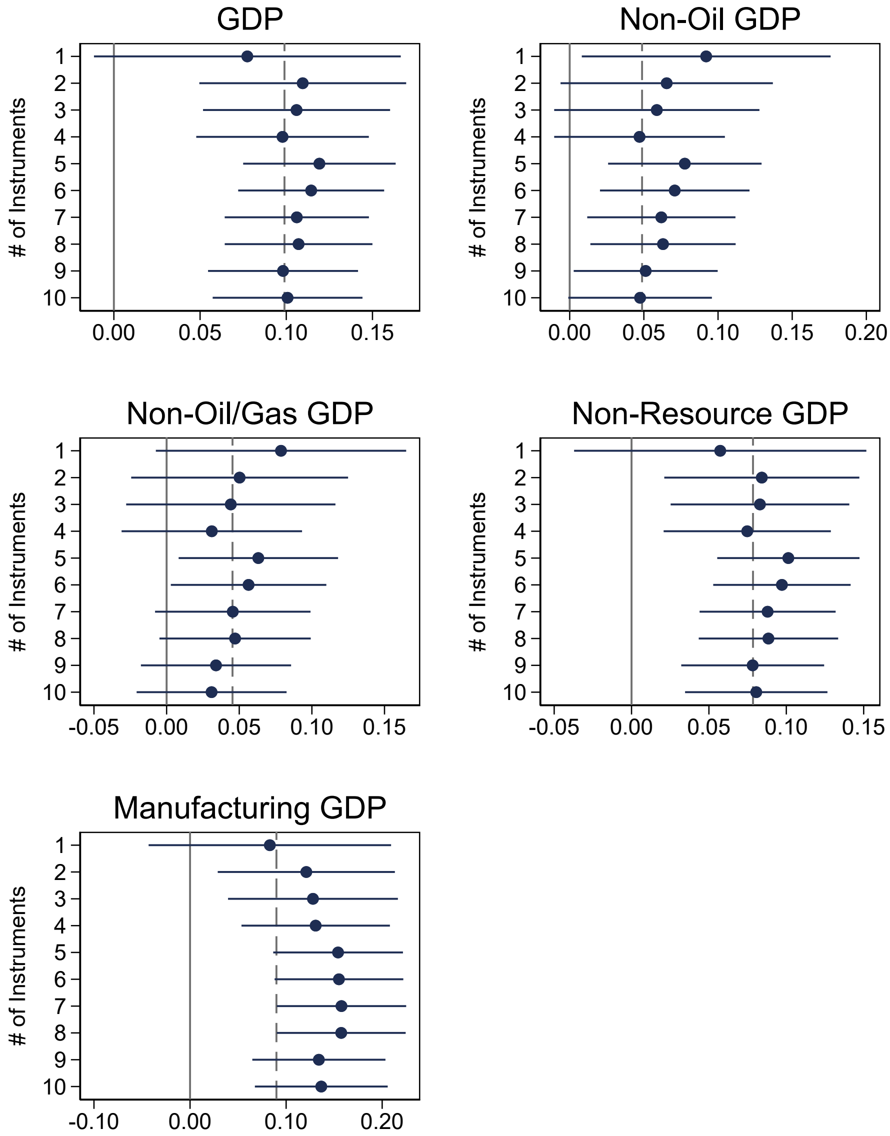
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.10: 2SLS Estimates by Size of Instrument Set, Final Component of Code Grouping (Controlling for Percentage Muslim in 1950)



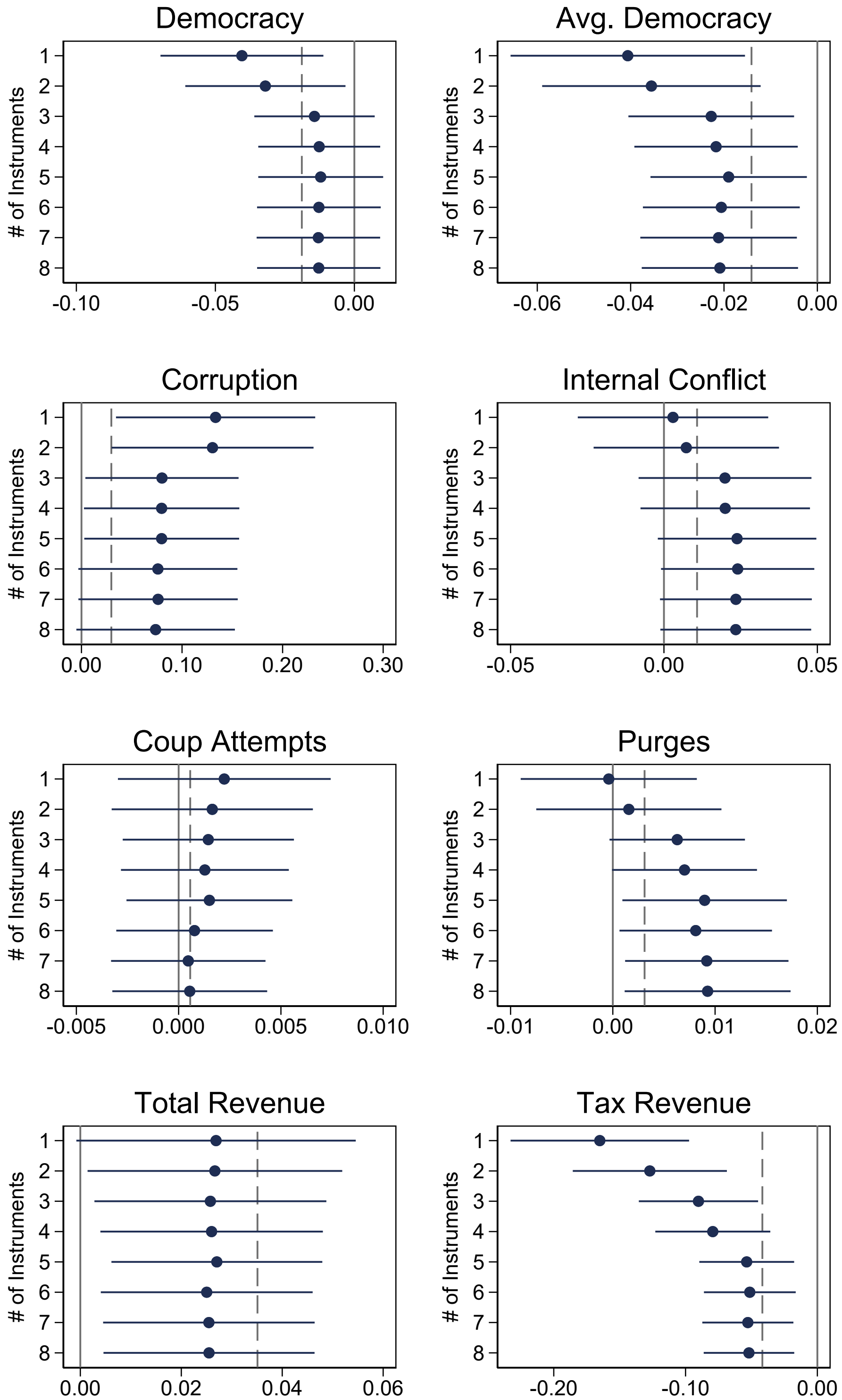
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.11: 2SLS Estimates by Size of Instrument Set, Final Component of Code Grouping (Controlling for Percentage Muslim in 1950)



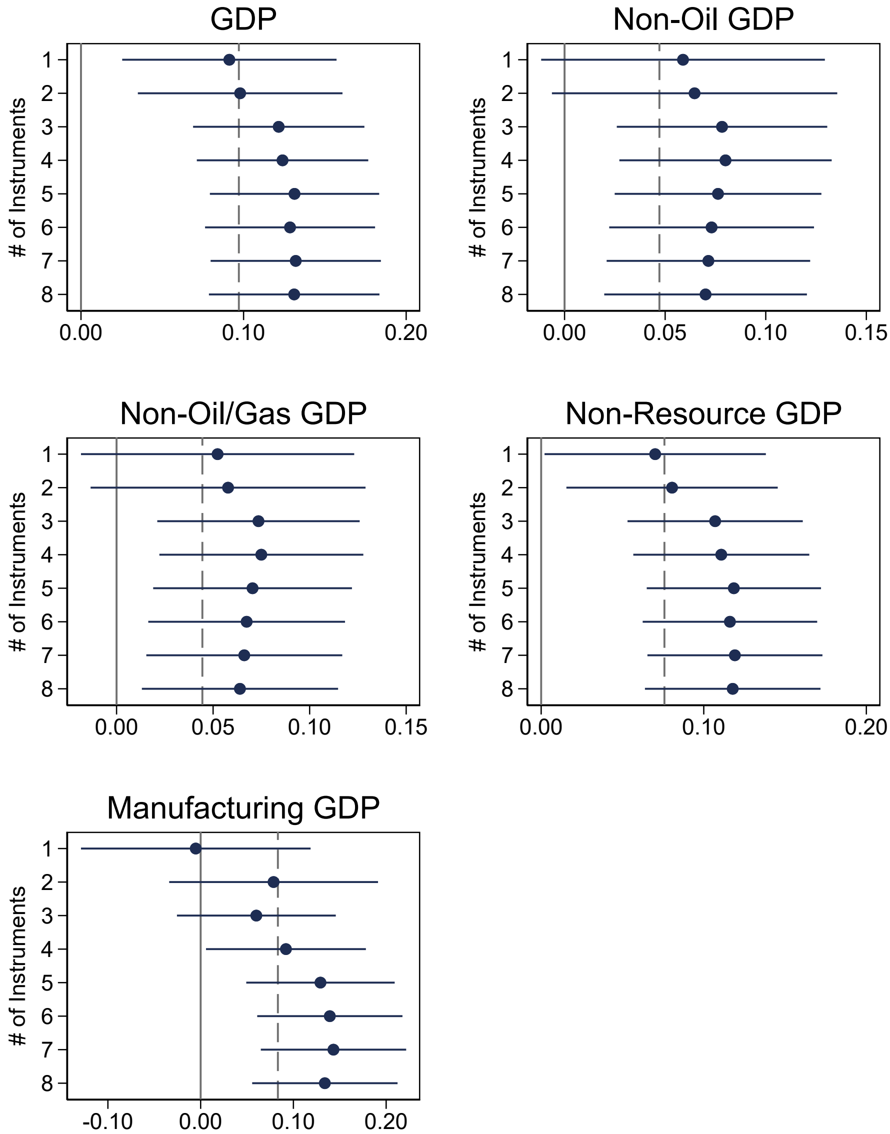
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.12: 2SLS Estimates by Size of Instrument Set, Tectonic-Subsidence Grouping (Controlling for Ethnic Fractionalization)



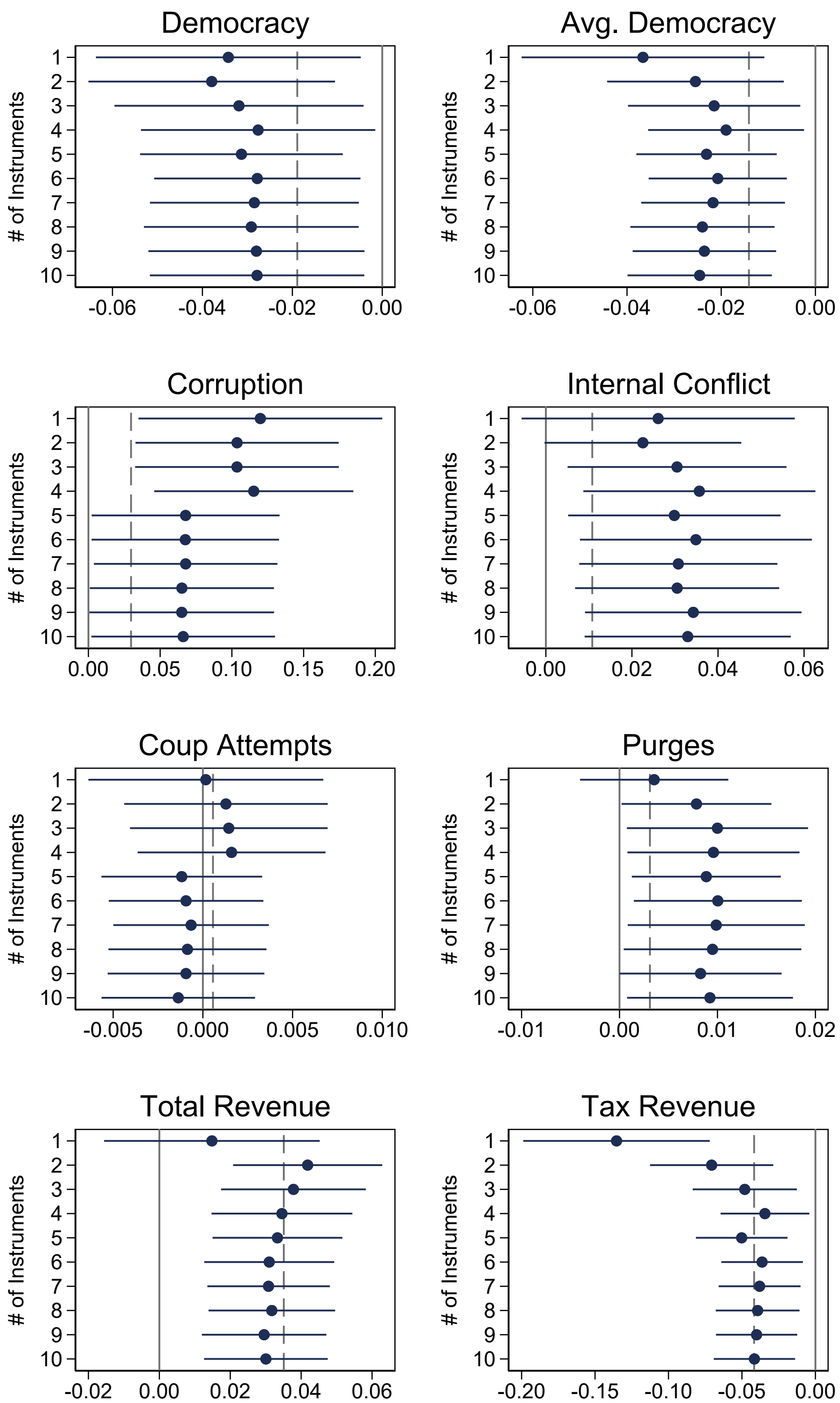
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.13: 2SLS Estimates by Size of Instrument Set, Tectonic-Subsidence Grouping (Controlling for Ethnic Fractionalization)



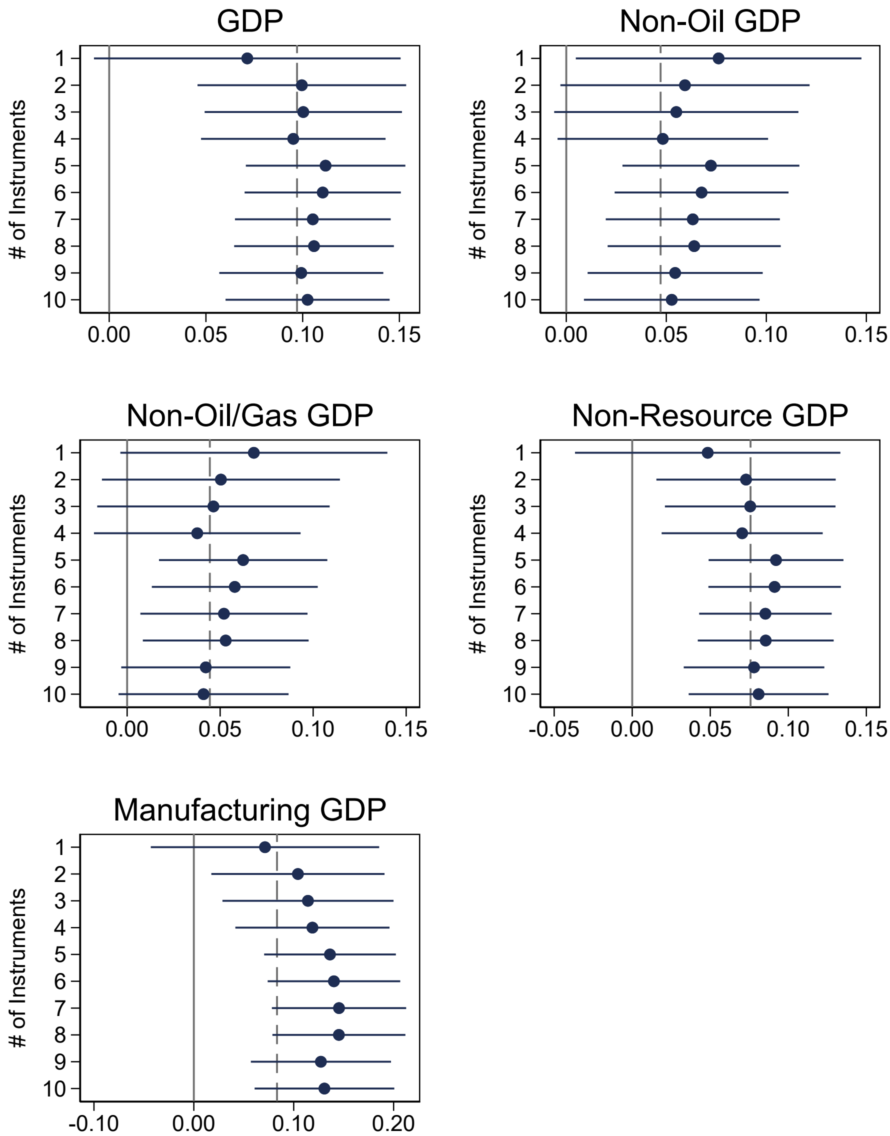
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.14: 2SLS Estimates by Size of Instrument Set, Final Component of Code Grouping (Controlling for Ethnic Fractionalization)



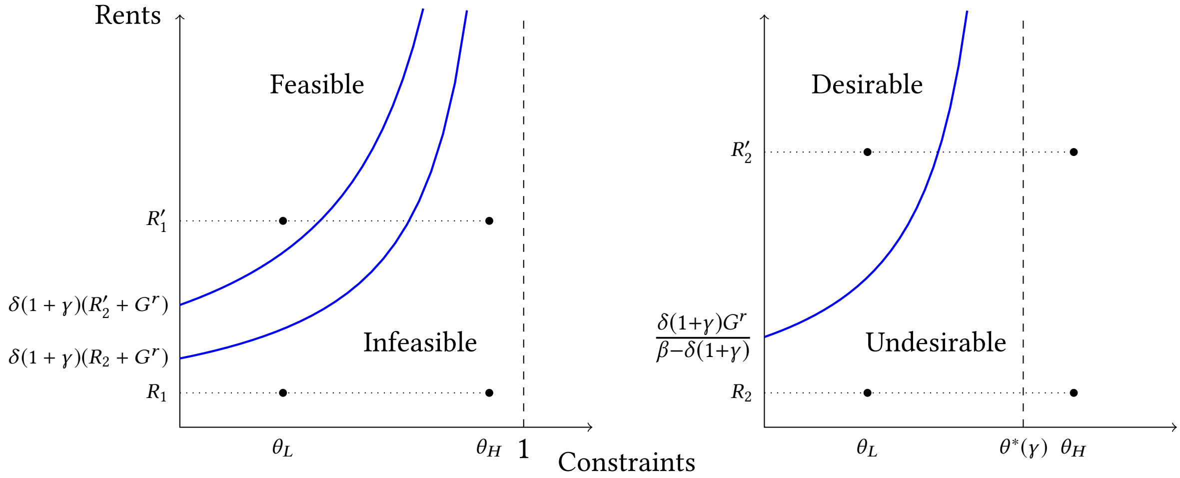
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.15: 2SLS Estimates by Size of Instrument Set, Final Component of Code Grouping (Controlling for Ethnic Fractionalization)



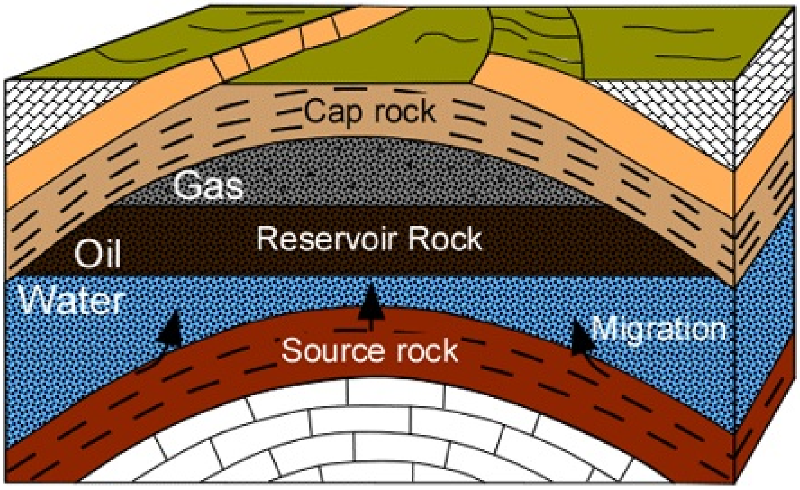
Notes. This figure plots point estimates and 90-percent confidence intervals for the coefficient on oil production, using optimal instrument sets of varying sizes. The gray, dashed line marks the value of the OLS estimate.

Figure A.16: Suppression Decision



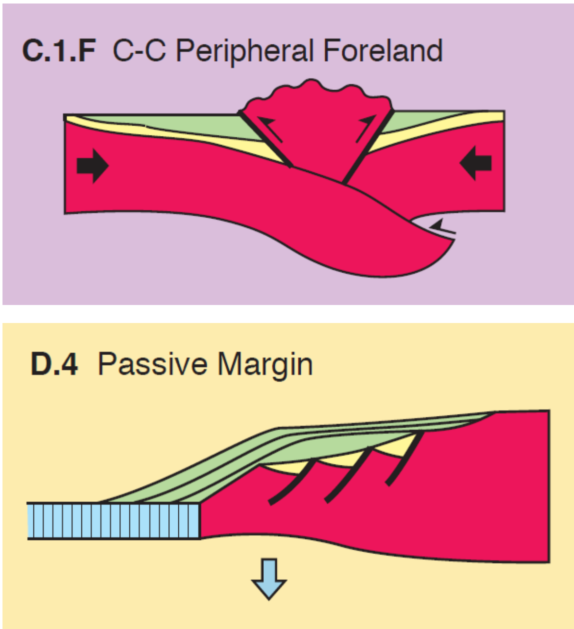
Notes. The figure shows the effect of a resource boom on the decision to suppress democracy in two different countries: one with weak executive constraints, θ_L, and the other with strong executive constraints, θ_H. In both countries period-one rents increase from R_1 to R_1', and period-two rents increase from R_2 to R_2'. The resource boom is balanced from the perspective of the country with weak constraints. Democracy is repressed if and only if (θ, R_1') lies above the blue line in the first graph (feasibility) and (θ, R_2') lies above the blue line in the second graph (desirability). Note that the increase in R_2 causes the blue line in the feasibility graph to shift upward, because it raises the reservation bribe of the rich group. In the country with weak constraints, the resource boom leads to repression, while the country with strong constraints transitions to democracy.

Figure A.17: Petroleum System



Source. Petrolia Haldimand Project.

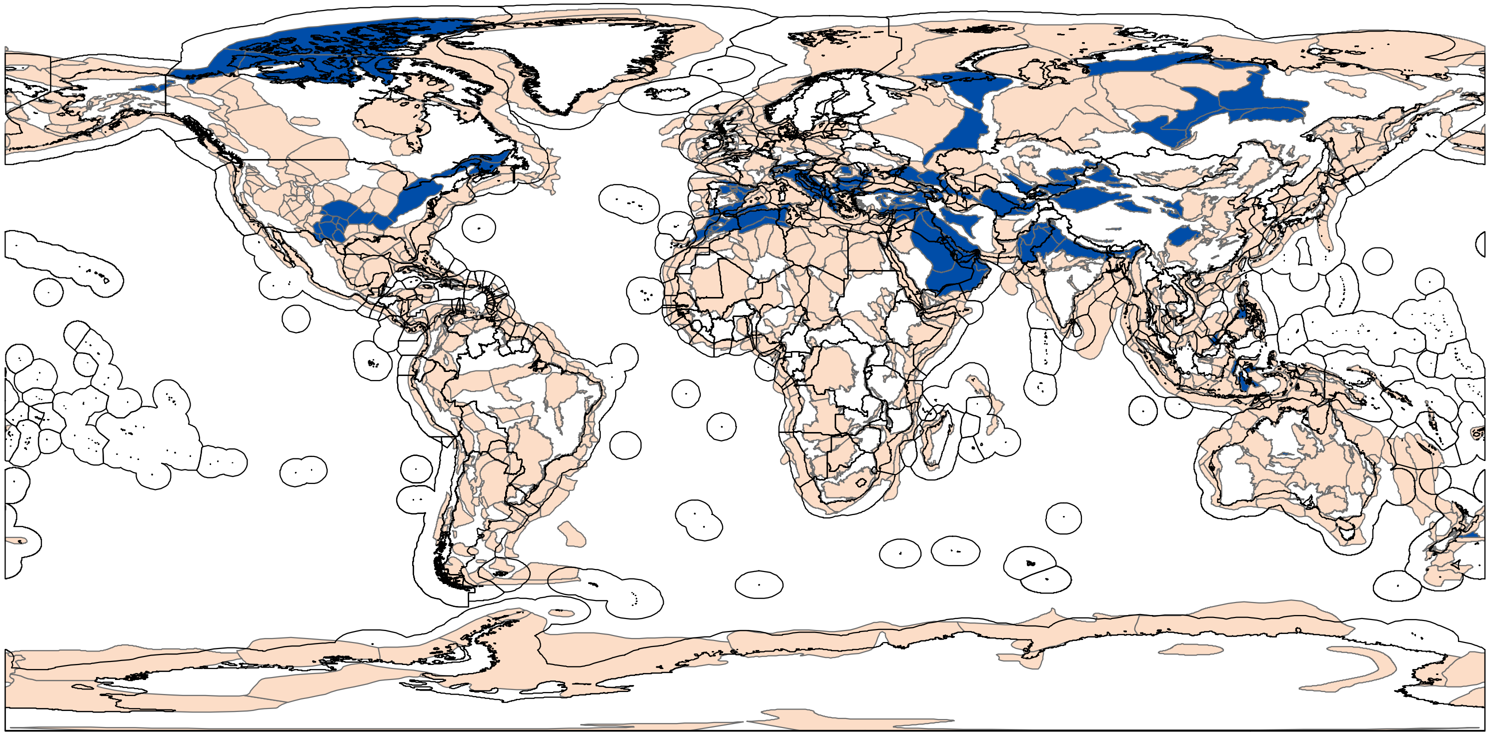
Figure A.18: Peripheral Foreland and Passive Margin Basins



Source. Fugro Robertson, Ltd. (2013).
Notes. The tan region is old sediments, and the light blue-green region is newer sediments.

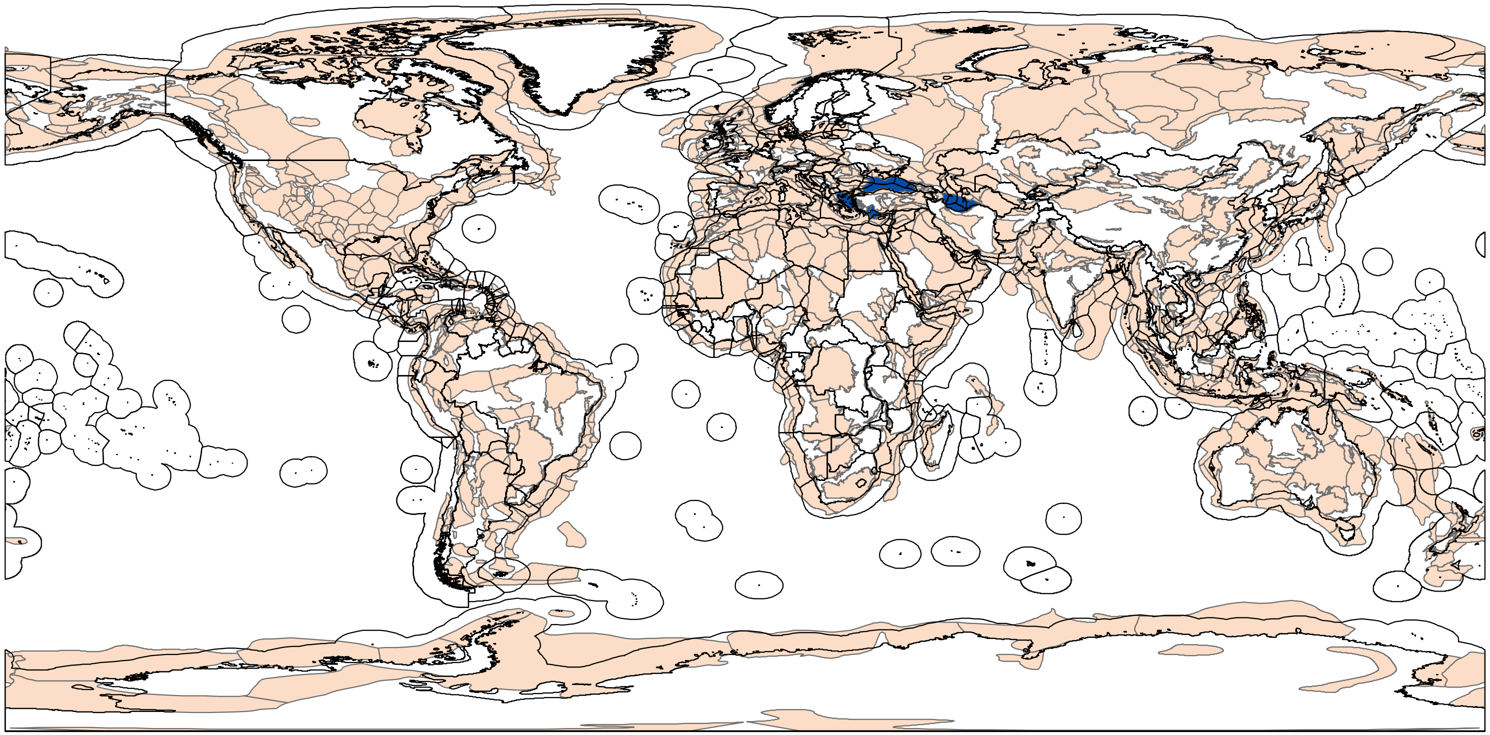
A.3.1 Basins grouped by plate-tectonic environment and primary subsidence mechanism

Figure A.19: Basins: Convergent Continent-Continent Tectonics, Mechanical Subsidence



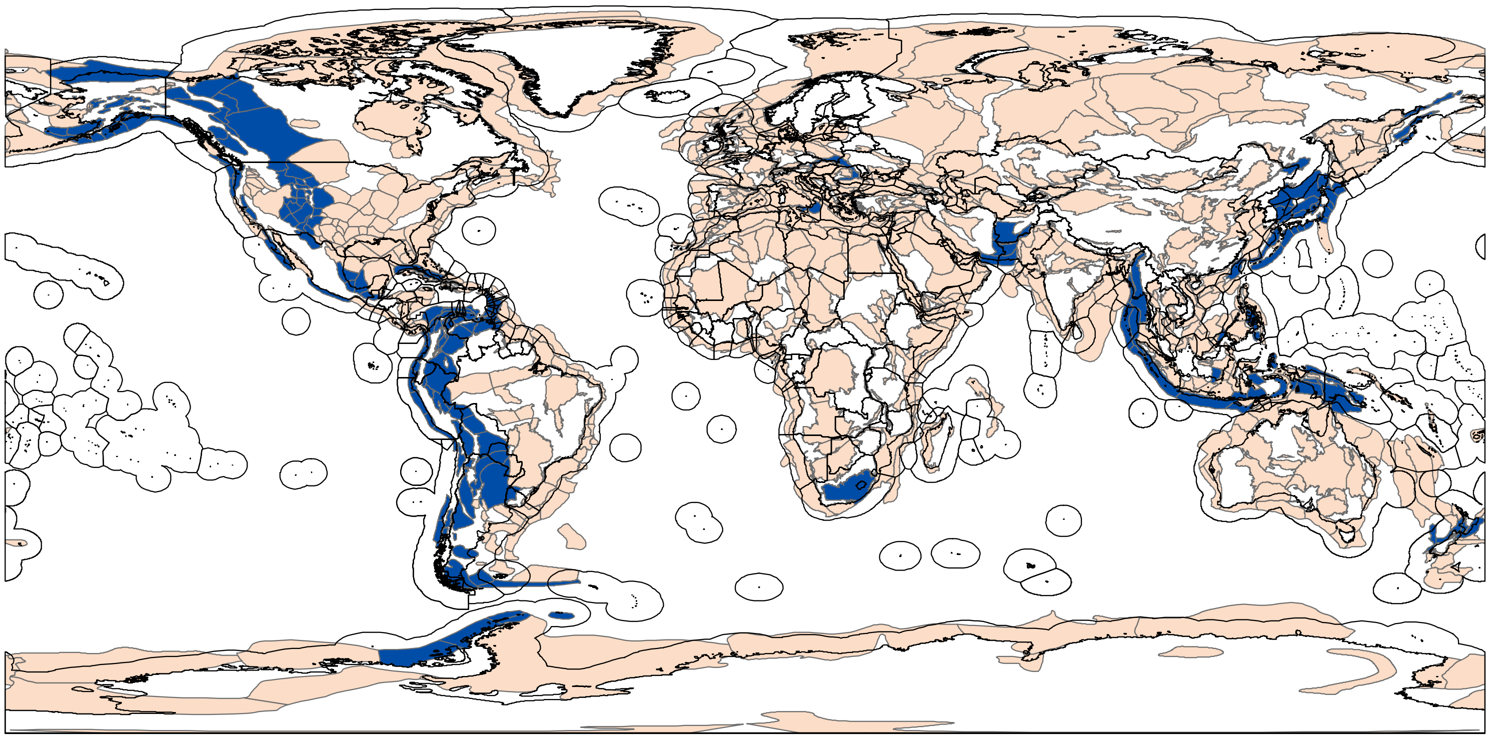
Source. Fugro Robertson, Ltd. (2013).

Figure A.20: Basins: Convergent Continent-Continent Tectonics, Thermo-Mechanical Subsidence



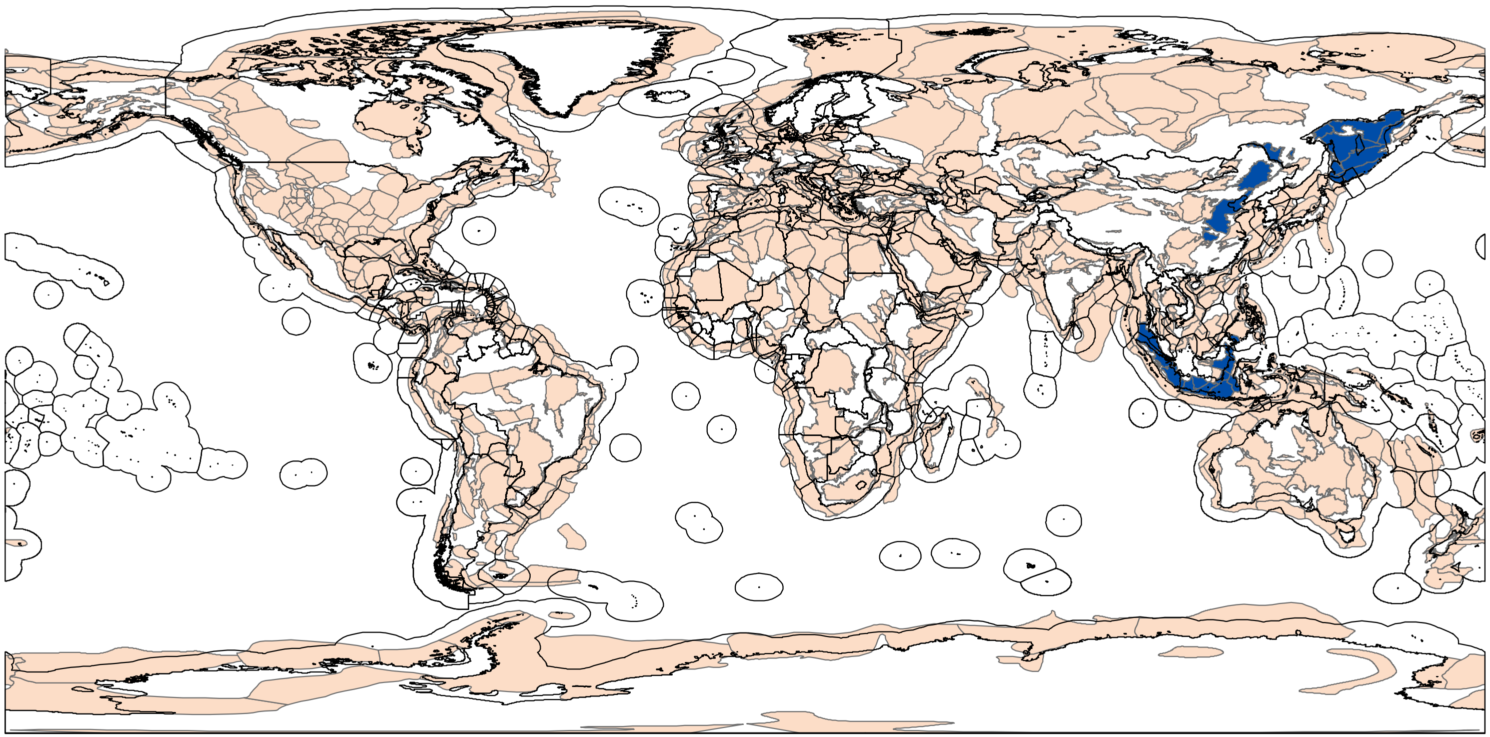
Source. Fugro Robertson, Ltd. (2013).

Figure A.21: Basins: Convergent Ocean-Continent Tectonics, Mechanical Subsidence



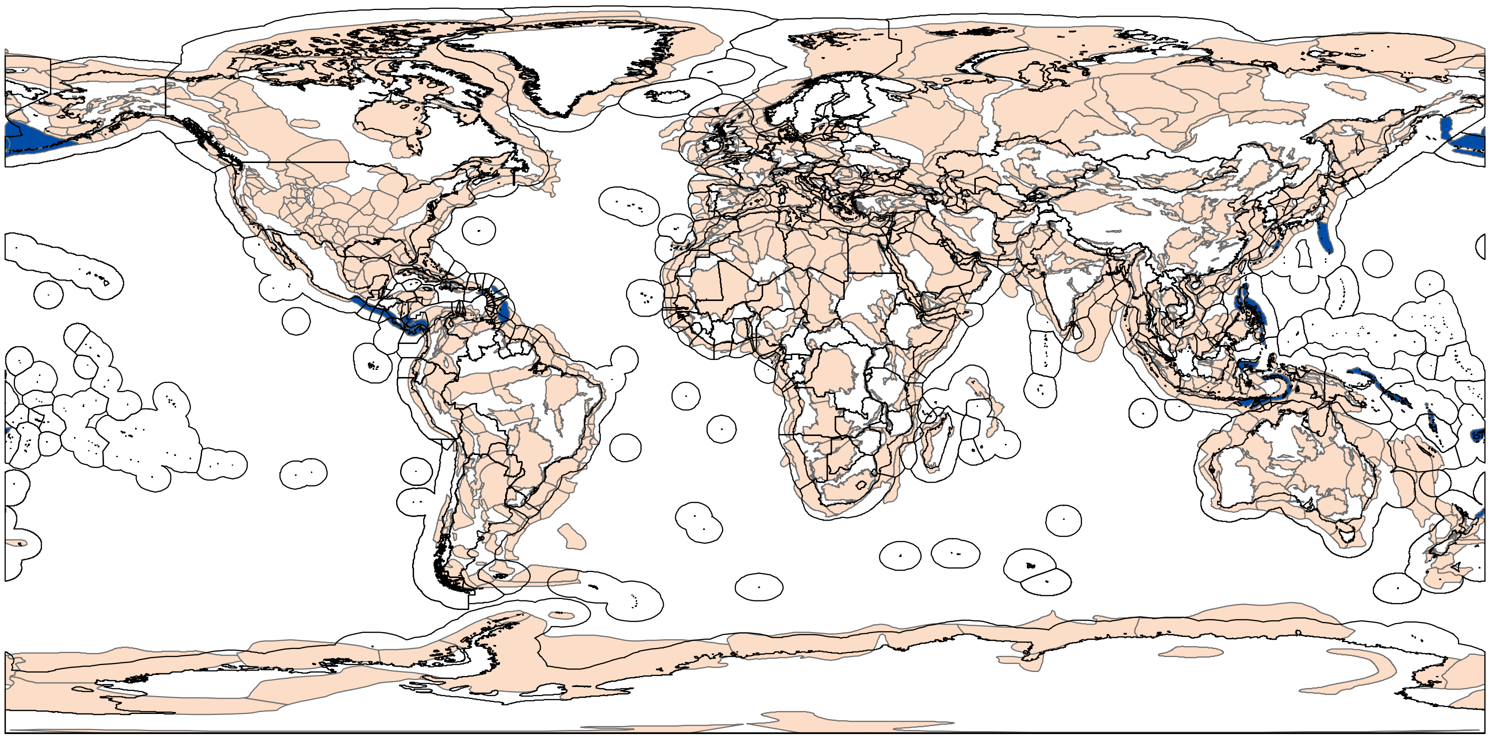
Source. Fugro Robertson, Ltd. (2013).

Figure A.22: Basins: Convergent Ocean-Continent Tectonics, Thermal Subsidence



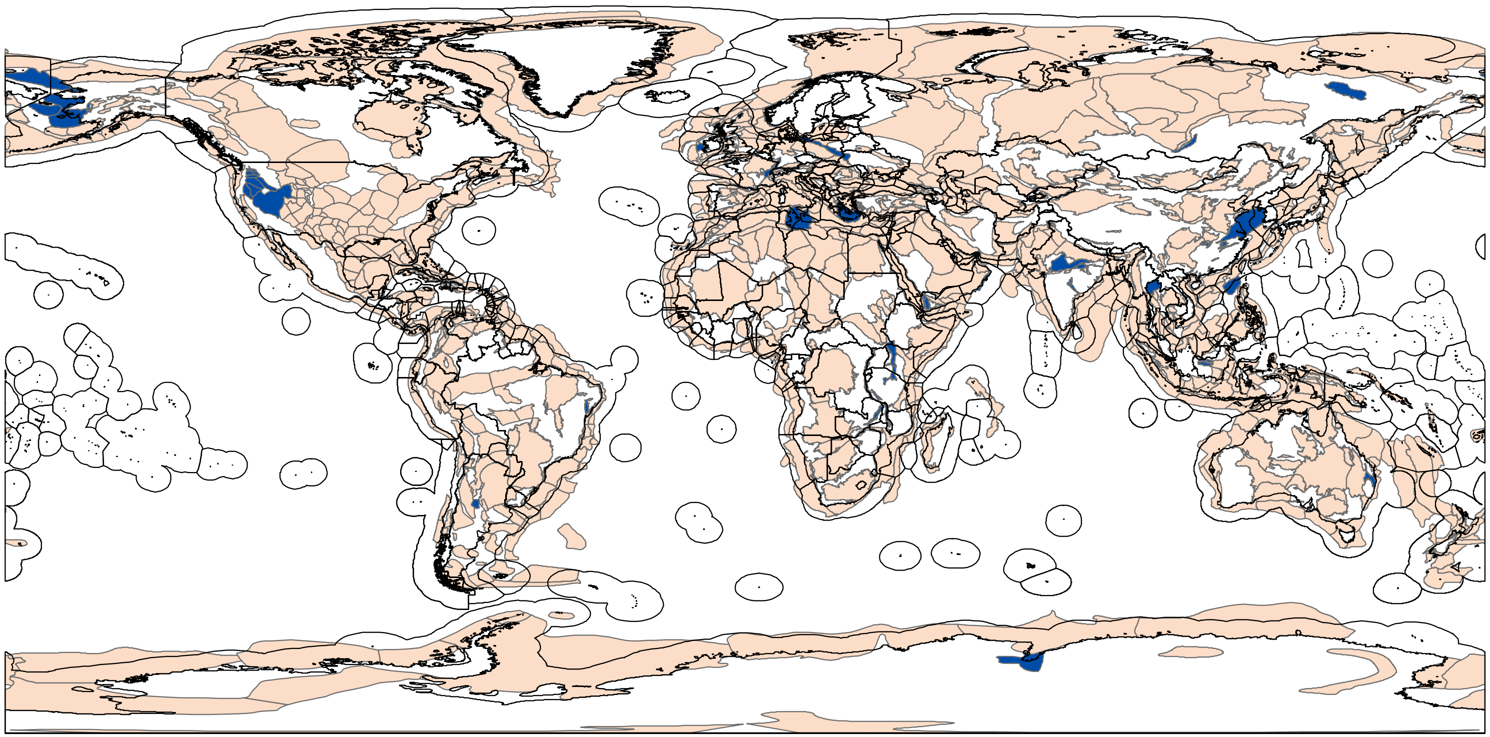
Source. Fugro Robertson, Ltd. (2013).

Figure A.23: Basins: Convergent Ocean-Ocean Tectonics



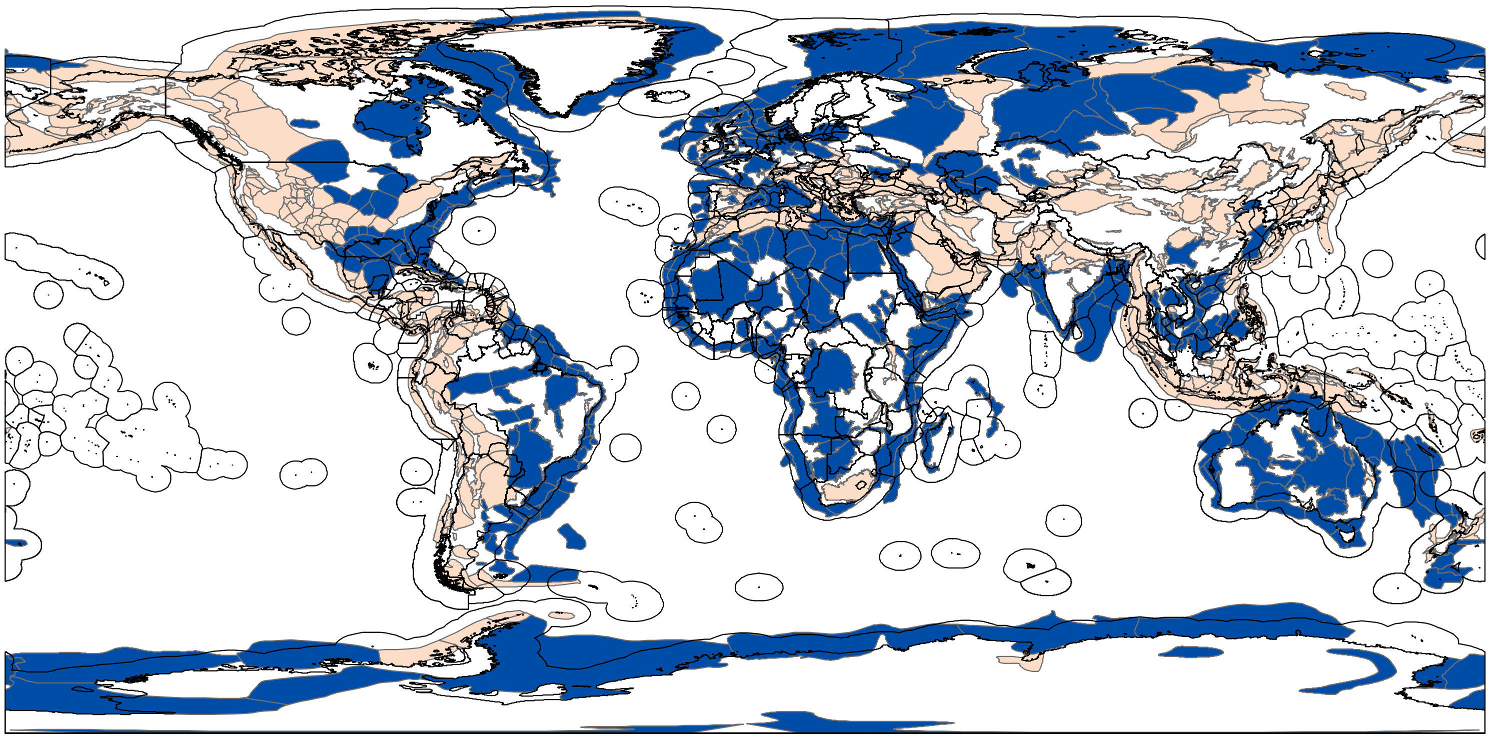
Source. Fugro Robertson, Ltd. (2013).

Figure A.24: Basins: Divergent Tectonics, Mechanical Subsidence



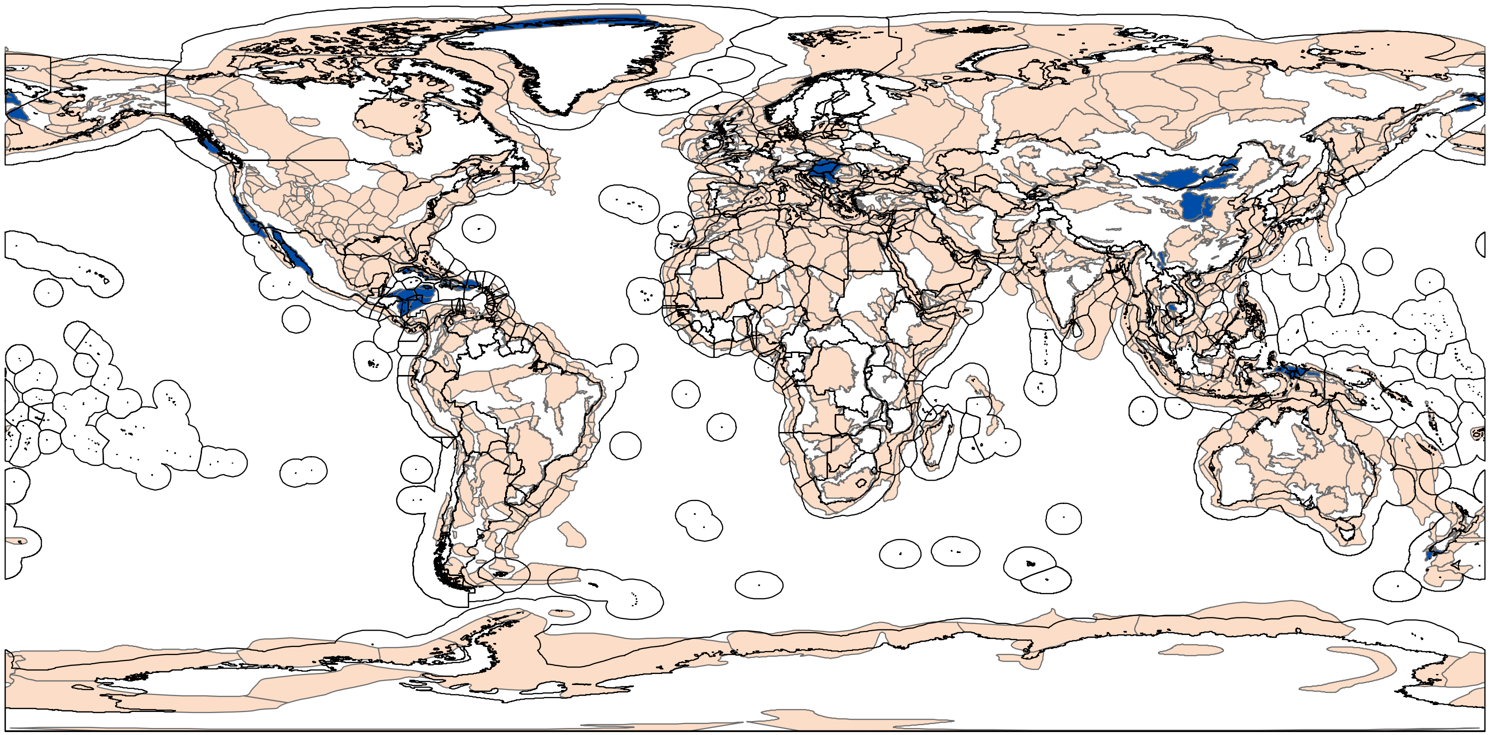
Source. Fugro Robertson, Ltd. (2013).

Figure A.25: Basins: Divergent Tectonics, Thermal Subsidence



Source. Fugro Robertson, Ltd. (2013).

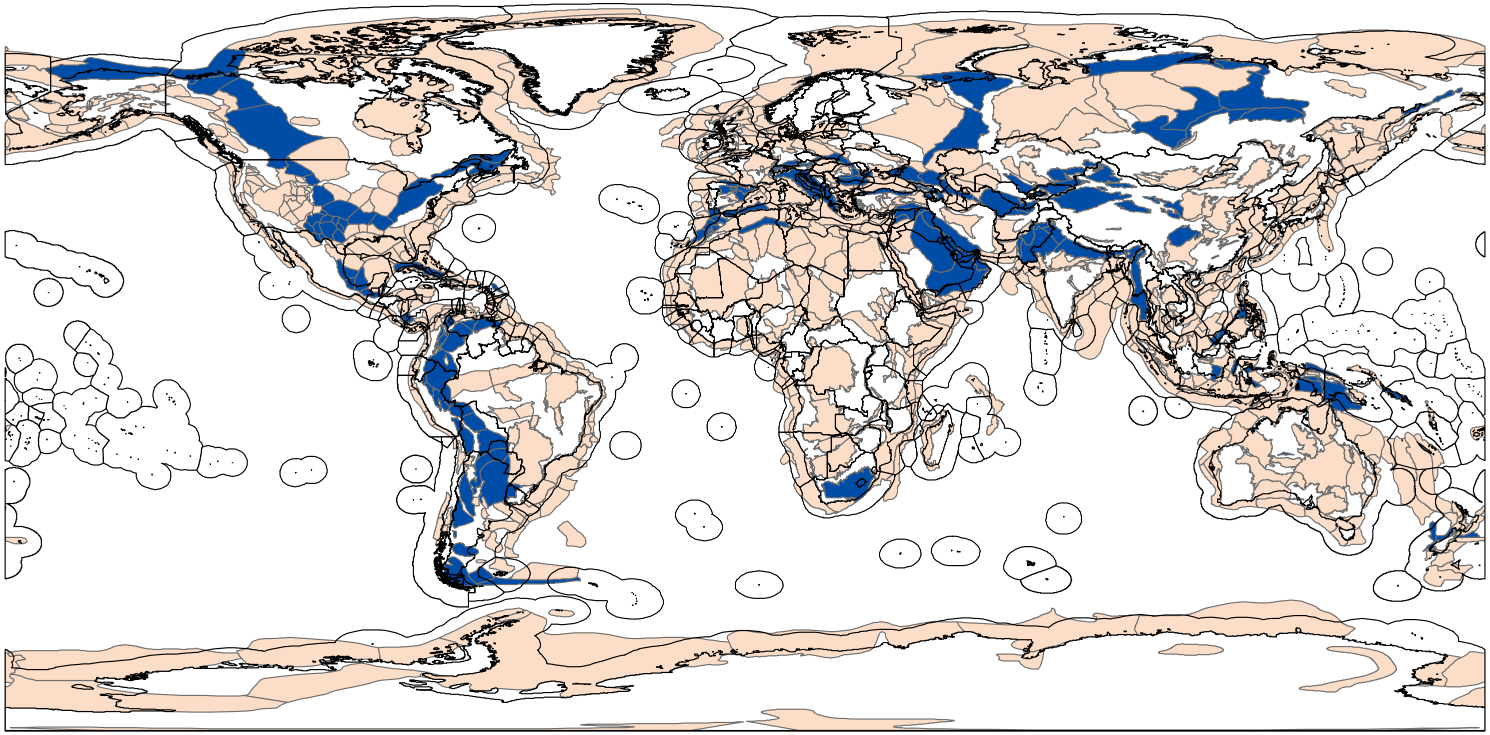
Figure A.26: Basins: Wrench Tectonics, Mechanical Subsidence



Source. Fugro Robertson, Ltd. (2013).

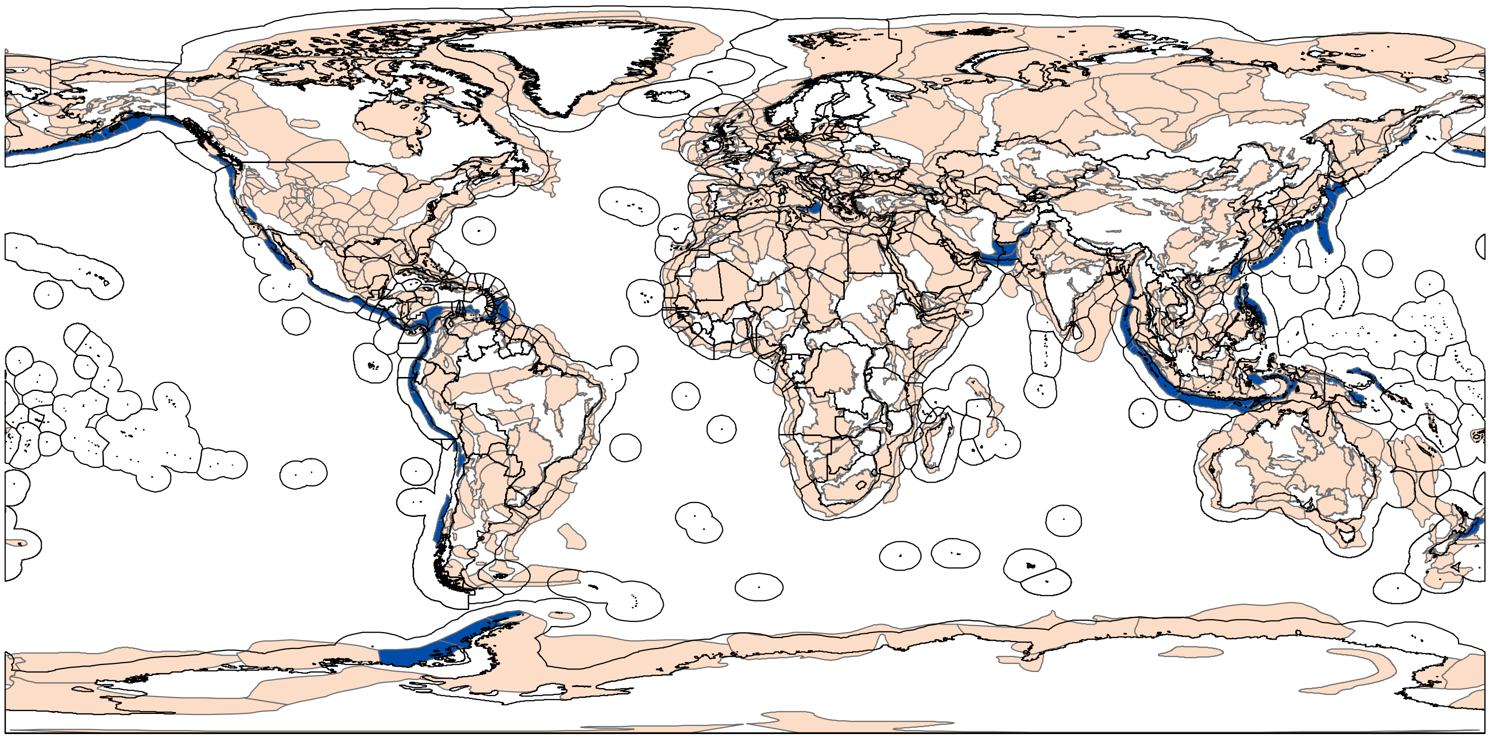
A.3.2 Basins grouped by final component of Fugro Tellus code

Figure A.27: Foreland Basins



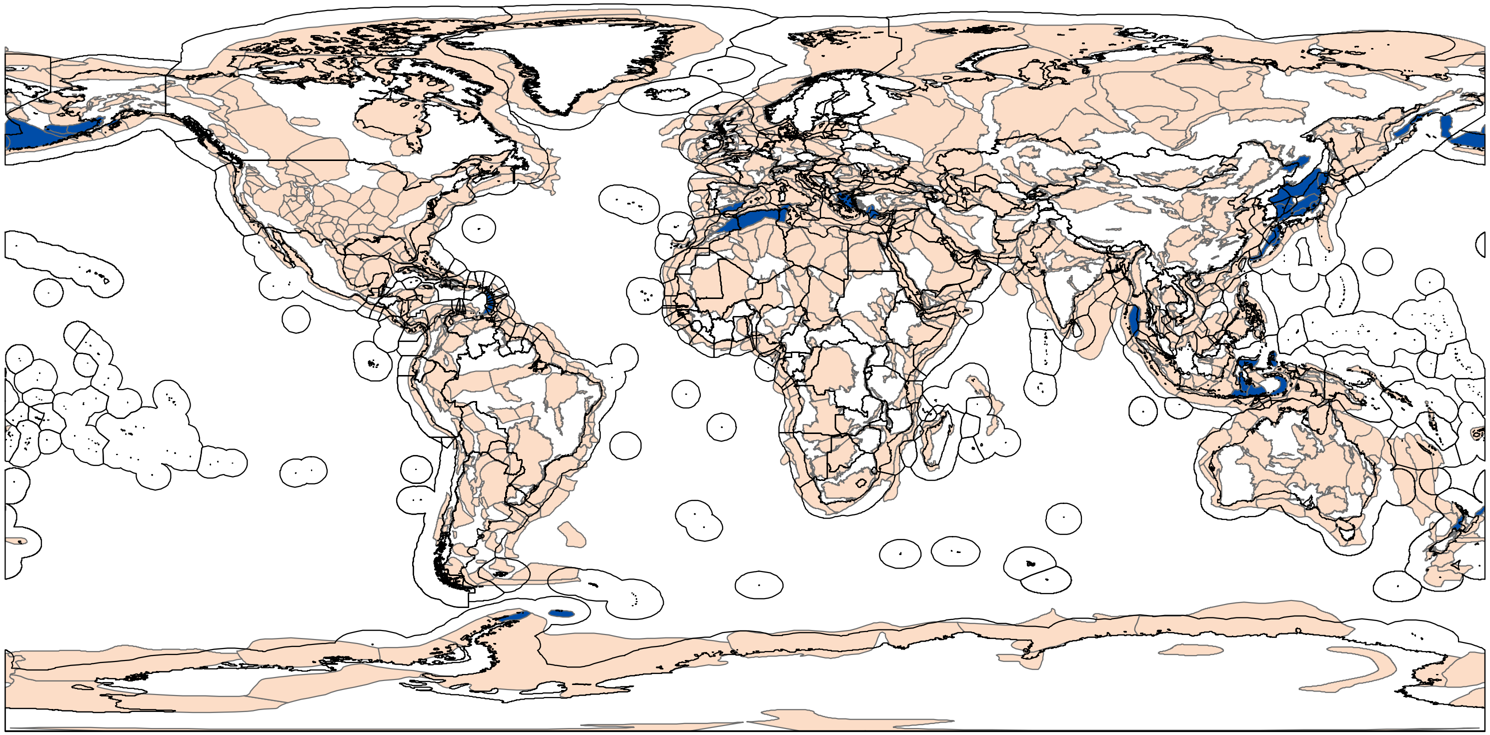
Source. Fugro Robertson, Ltd. (2013).

Figure A.28: Fore-Arc Basins



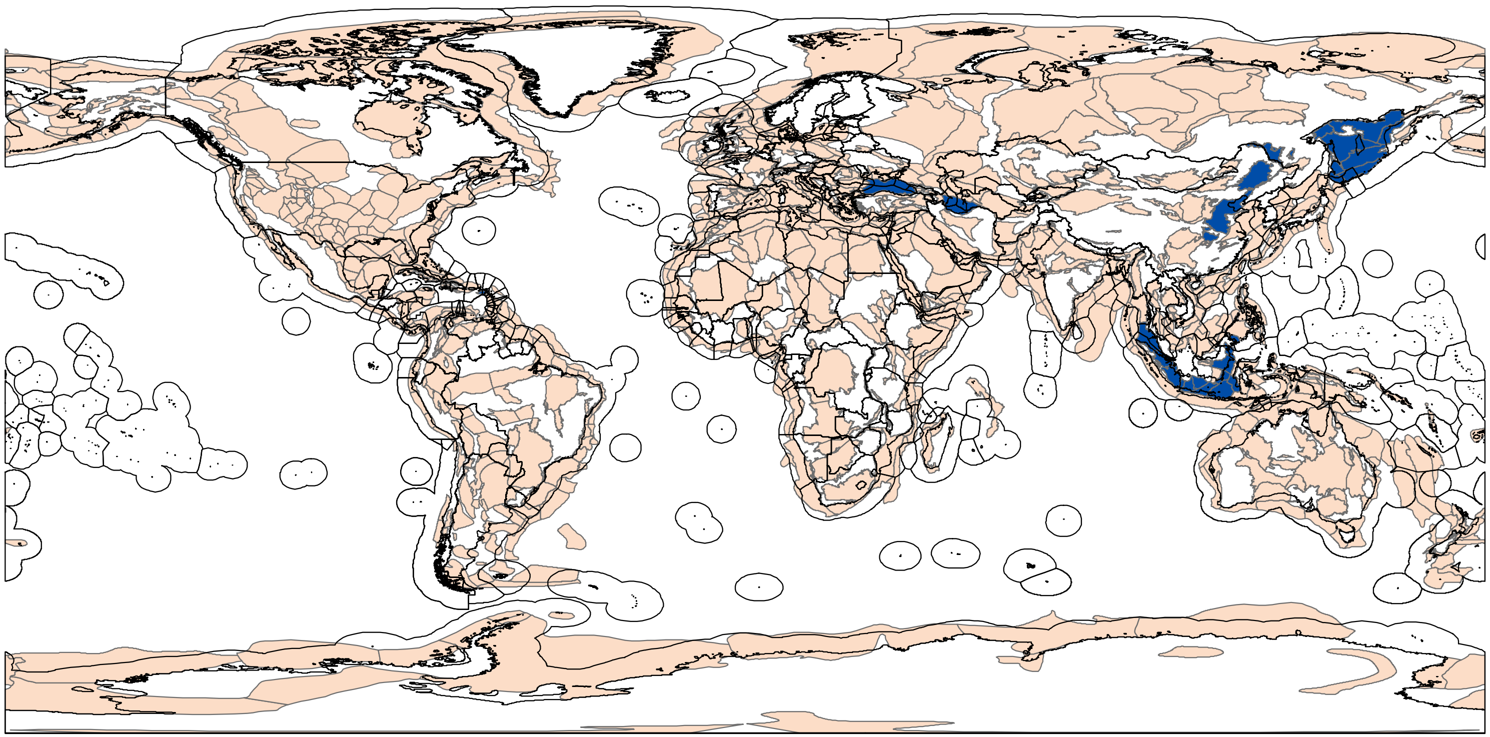
Source. Fugro Robertson, Ltd. (2013).

Figure A.29: Extensional Basins



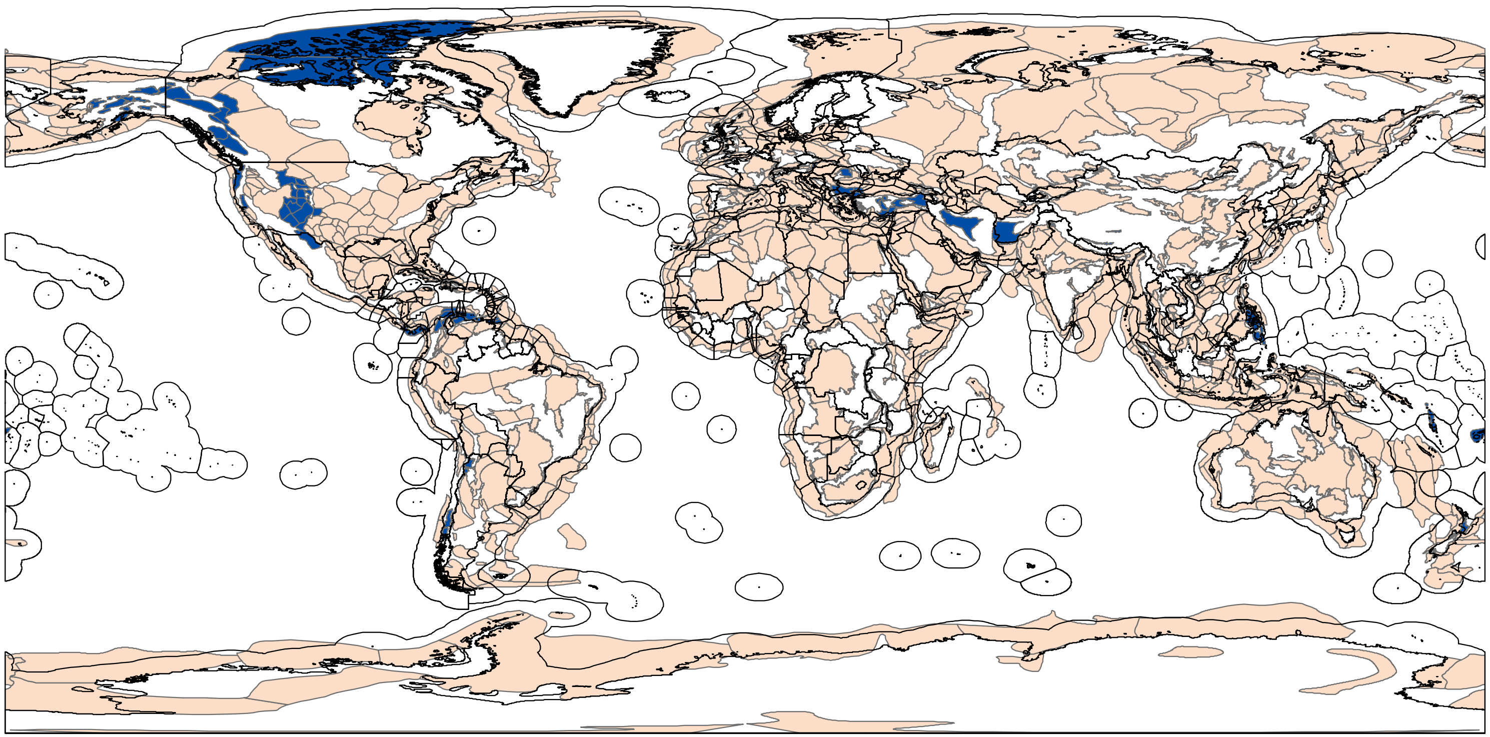
Source. Fugro Robertson, Ltd. (2013).

Figure A.30: Convergent Sag Basins



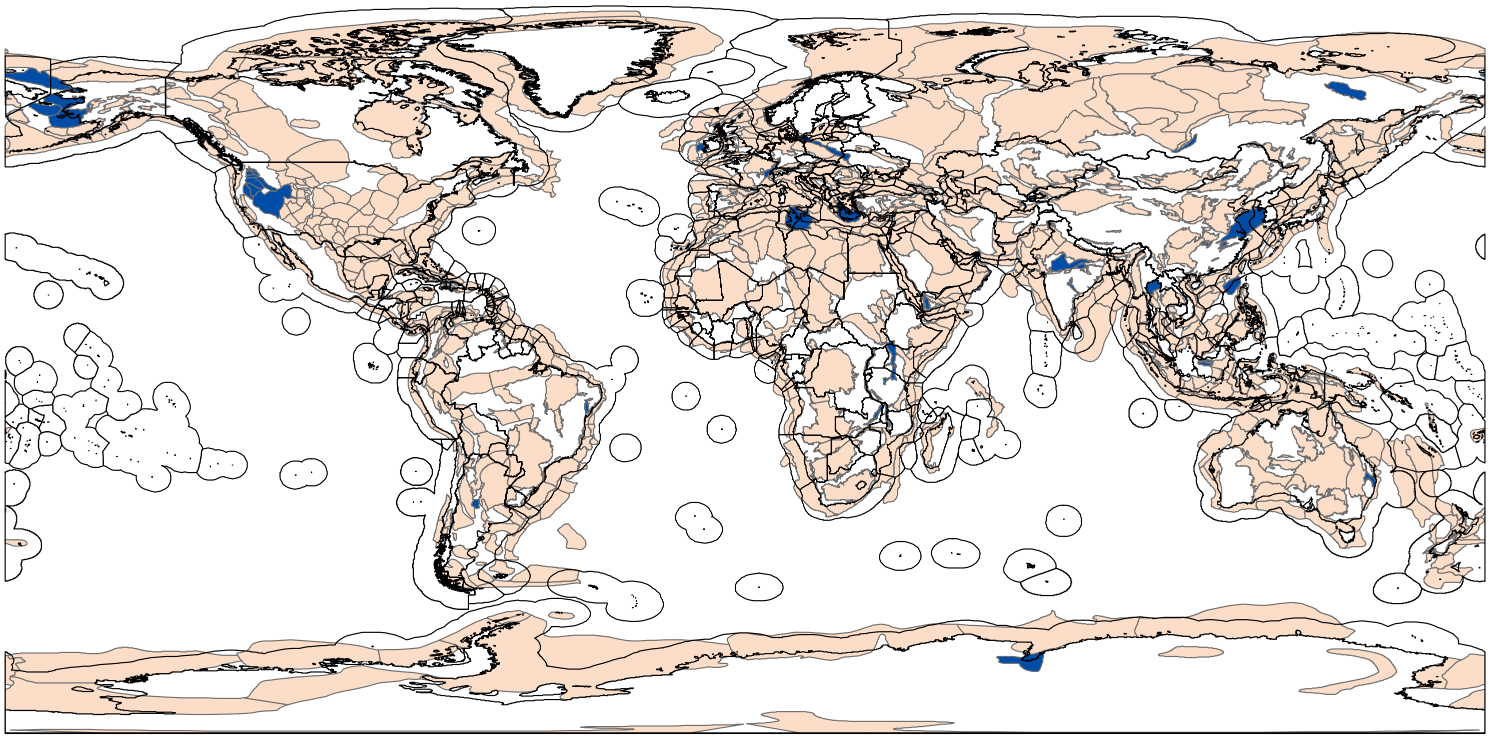
Source. Fugro Robertson, Ltd. (2013).

Figure A.31: Convergent Wrench Basins



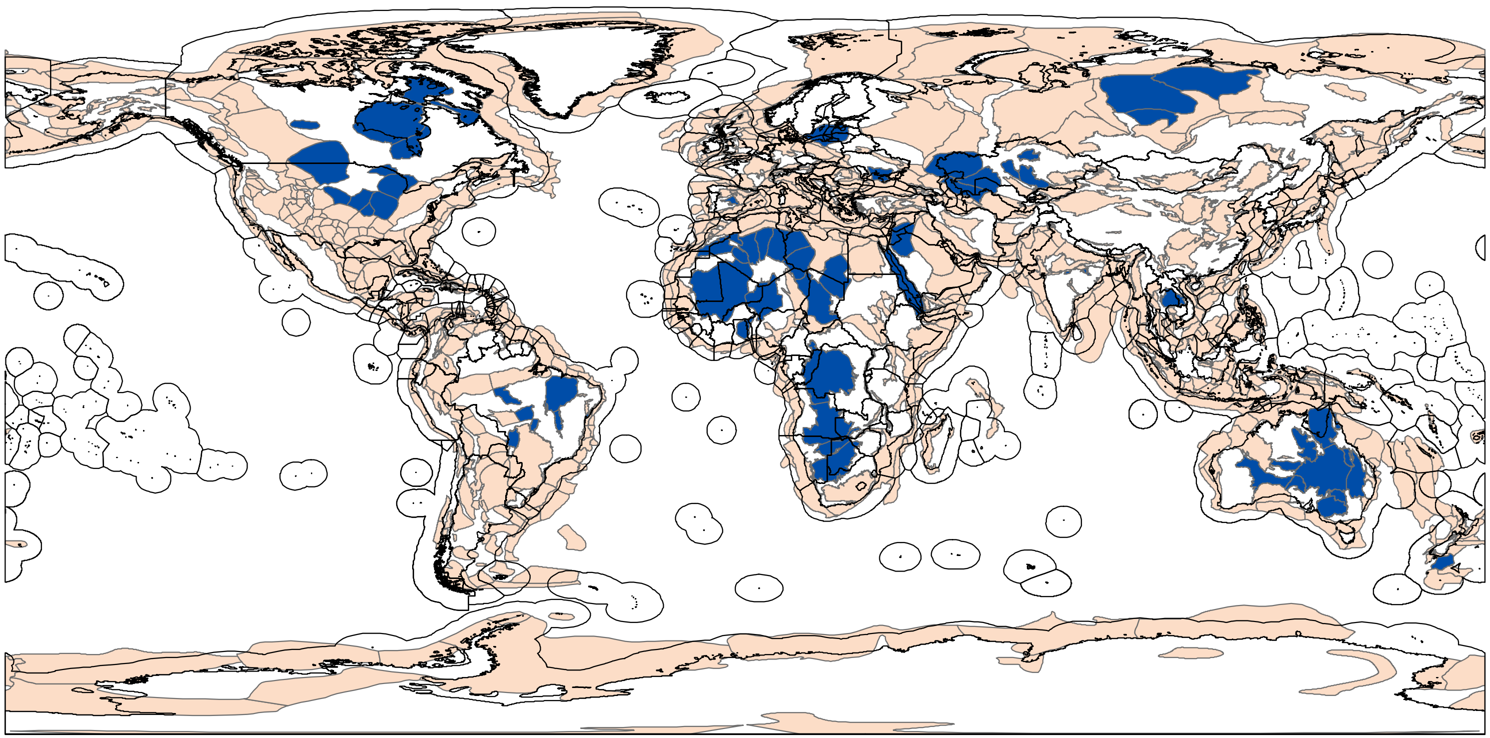
Source. Fugro Robertson, Ltd. (2013).

Figure A.32: Rift Basins



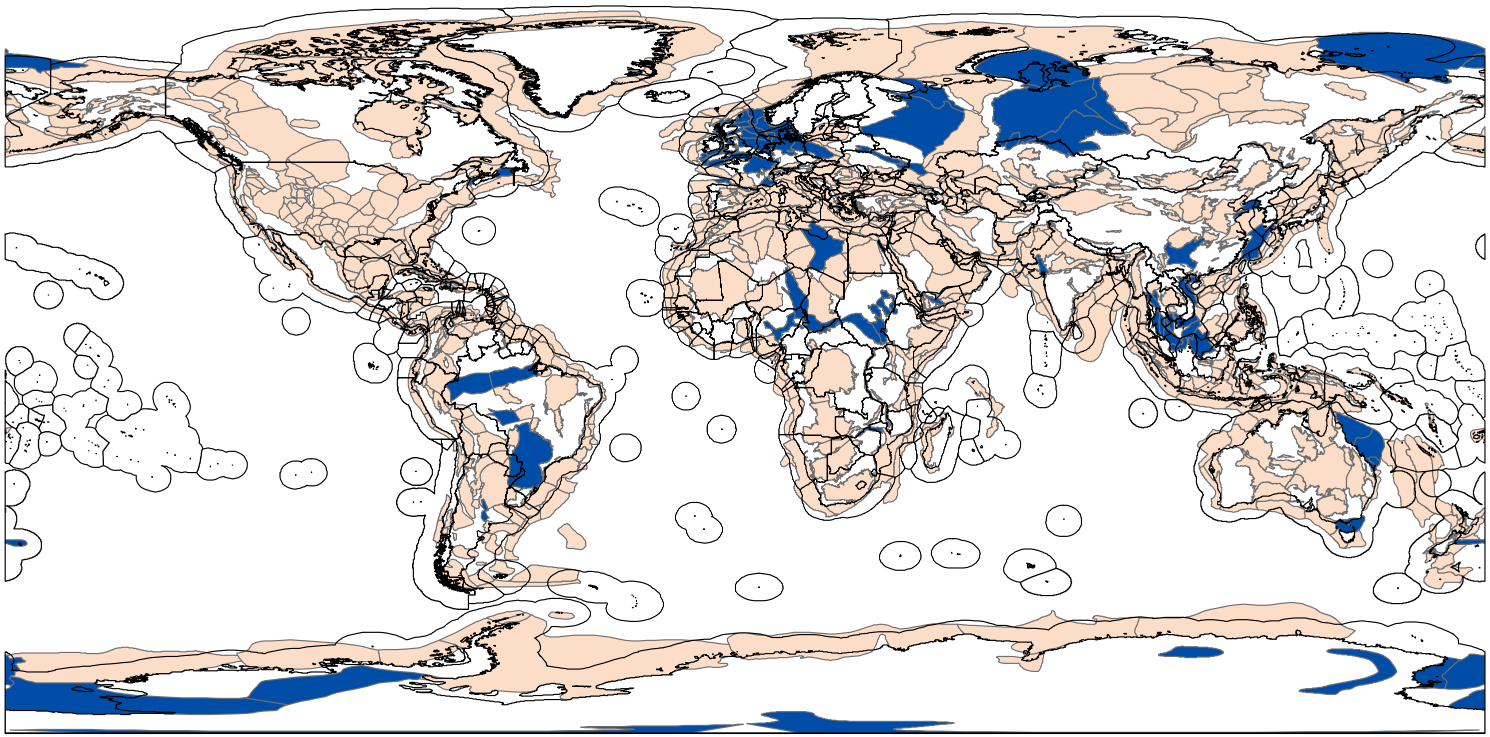
Source. Fugro Robertson, Ltd. (2013).

Figure A.33: Intracratonic Sag Basins



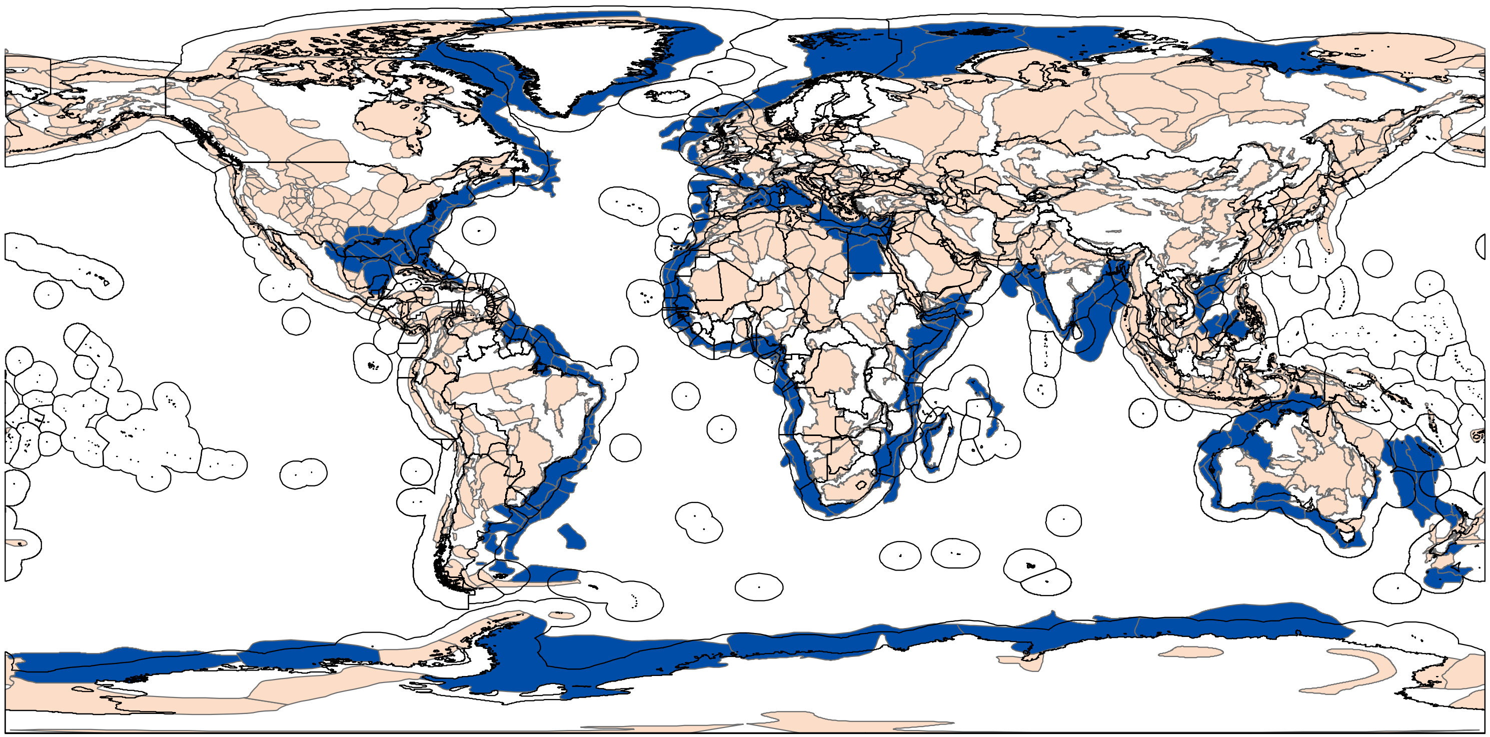
Source. Fugro Robertson, Ltd. (2013).

Figure A.34: Post-Rift Sag Basins



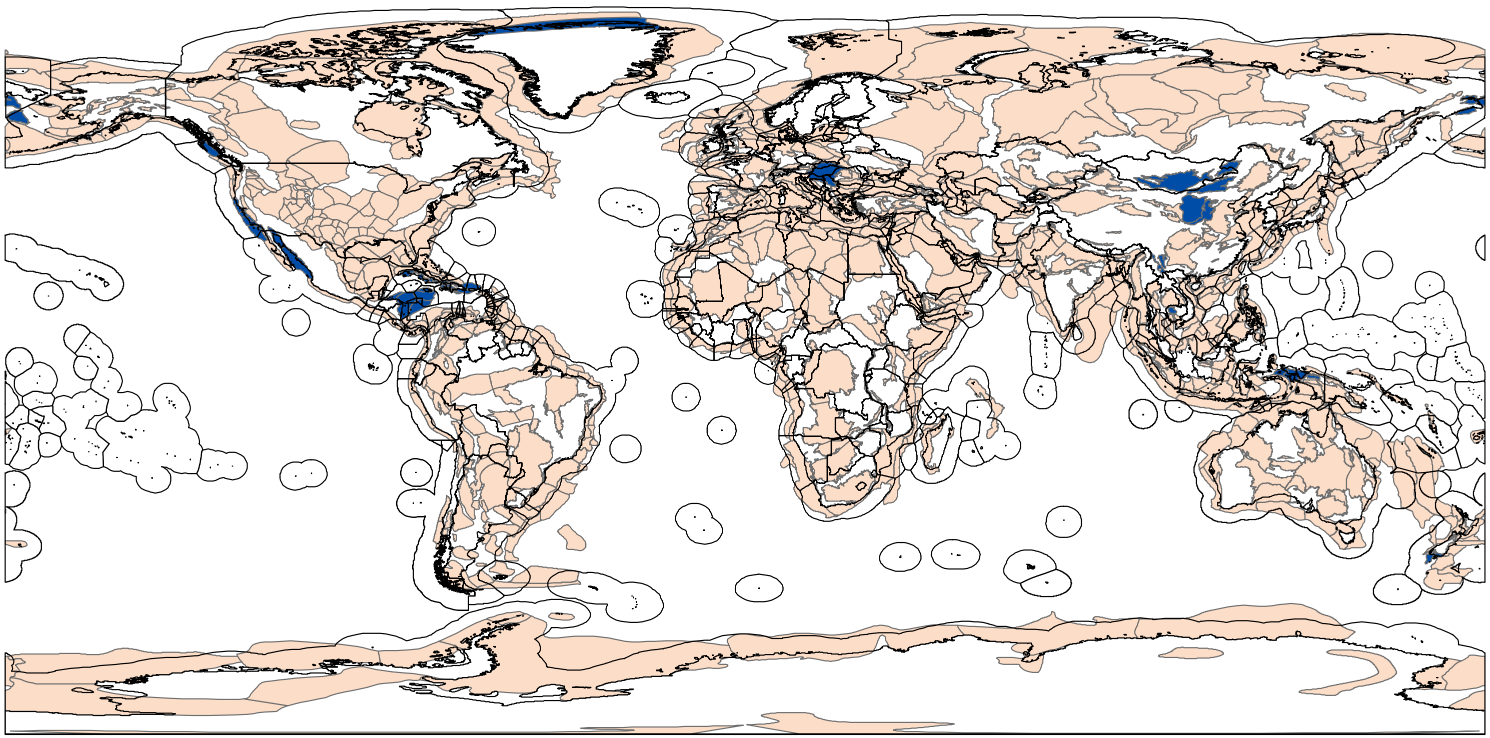
Source. Fugro Robertson, Ltd. (2013).

Figure A.35: Passive Margin Basins



Source. Fugro Robertson, Ltd. (2013).

Figure A.36: Wrench Basins



Source. Fugro Robertson, Ltd. (2013).