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Cursed Resources? Political Conditions and Oil Market Outcomes

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Cursed Resources?

Political Conditions and Oil Market Outcomes^{*}

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Abstract

We analyze how a country's political institutions affect oil production within its borders. We find a pronounced negative relationship between political openness and volatility in oil production, with democratic regimes exhibiting less volatility than more autocratic regimes. This relationship holds across a number of robustness checks including using different measures of political conditions, instrumenting for political conditions and using several measures of production volatility. Political openness also affects other oil market outcomes, including total production as a share of reserves. Our findings have implications both for interpreting the role of institutions in explaining differences in macroeconomic development and for understanding world oil markets.

KEYWORDS: Oil Supply, Oil Disruptions, Political Institutions, Energy Security

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I. Introduction

Development levels vary considerably across countries, and explaining why these differences exist is one of the central questions in economics. While scholars have long hypothesized that political institutions play an important role (see, *e.g.*, North (1981)), a recent literature has made progress identifying a causal impact of institutions on cross-country differences in macroeconomic outcomes.¹ Still, the mechanisms by which specific institutions affect economic outcomes to a great extent remain a “black box” (Acemoglu, Johnson and Robinson (2001) – hereafter AJR – p.1395).

This paper focuses on the influence of institutions on one particular industry: crude oil production. We document a pronounced negative effect of good political conditions on volatility in oil production, and this result is robust to using several different measures of political conditions. We also address the potential endogeneity of political structure, as suggested by the literature on the “resource curse.” We estimate two-stage least-squares regressions where we instrument for recent political institutions using institutions before oil was commercialized. We find that the negative relationship persists in these specifications. We also evaluate whether other macroeconomic differences across countries affect oil market outcomes, including financial openness and legal formalism. None of these factors has a significant effect on volatility once we control for institutions.

It is important to acknowledge that a country’s oil production may not necessarily be inefficient if it is volatile. To allow for this, we also construct volatility measures that control for market factors which *should* drive changes in a country’s oil output, and our results are robust to using these alternative measures.

Ideally, we would also like to measure oil output controlling for the natural resources available to the country, as this is analogous to studies that examine factors contributing to differences in economic development. With this goal in mind, we also examine the link between political institutions and a country’s average production as a share of its proven reserves. We find that countries with better political institutions produce a higher share, although we devote less attention to these results since the data on reserves are self-reported in some cases and could be systematically biased. Finally, we show that political institutions lead to volatility in the number of active wells, suggesting that the volatility is less likely to be driven by physical characteristics of a country’s oil fields.

¹ See Barro (1997), Hall and Jones (1999), Rodrik (1999), Acemoglu, Johnson, Robinson and Thaicharoen (2003), Perrson and Tabellini (2003), and Mulligan, Gil and Sala-i-Martin (2004) for varying perspectives on the influence of political institutions on economic outcomes.

Oil production provides a particularly convenient lens to view the possible microeconomic foundations for macroeconomic outcomes as oil is a commodity sold on a world market. This means that production decisions within a country should be driven by world demand and not local macroeconomic conditions. Was this not the case, our results would be less interesting as they could simply reflect the effect of political institutions on overall macroeconomic activity. Since oil demand is worldwide, however, we can be confident that our results reflect supply-side factors and not demand-driven output volatility.

Another reason that oil is well-suited to this analysis is that the unit of output (a barrel of oil) is of essentially homogenous quality and is consistently measured across countries. Finally, rich data are available on oil production and its determinants, such as reserves and the number of wells.

By documenting that political institutions affect outcomes in a particular industry, our results provide insight on how institutions affect aggregate economic output. For example, they suggest that while political institutions may work by influencing structural factors, such as by promoting a well-developed commercial sector or less reliance on agriculture (see, *e.g.*, Duarte and Restuccia (2010)), these cannot be the only mechanisms at play as institutions have effects within an industry. Although our results cannot address this hypothesis directly, they are consistent with the idea that well-functioning political institutions support efficient investment in crude oil production and prevent wars, domestic conflicts and nationalization episodes, which can severely limit a country's oil production capabilities. We support this interpretation with a detailed analysis of nearly 150 episodes when countries' oil output fell significantly. This analysis strongly supports the conclusion that poor political institutions undermine production, and provide insight on the mechanisms leading to the production declines.

Our results also provide insight on world oil markets. Like many energy markets, oil markets are characterized by extremely inelastic short-run supply and demand, meaning that even small fluctuations in either can lead to large swings in price. While much has been written about how systematic shifts in oil demand or supply affect prices (see, for example, Hamilton (2009) and Kilian (2009)), less is understood about the underlying determinants of short-run changes in supply.

Our results imply that political institutions in the countries endowed with oil reserves affect the volatility, and perhaps the level, of its production. To the extent countries with poor political conditions will have less stable production of other natural resources, our results suggest a useful metric for comparing different energy sources. As

U.S. policymakers attempt to drive shifts to new, alternative energy technologies, it is useful to be able to make these comparisons.

To explore the implications of our results for world oil markets, we construct annual, worldwide statistics that summarize the political institutions of oil-producing regimes. Generally, our indexes depict a reduction in the political conditions of oil producing countries between 1965 and 1978, followed by an increase that peaks sometime in the late 1990s or early 2000s, depending on which index is considered. In recent years most of the indexes show a modest decline starting around 2003.²

We next decompose the measures into “production share” and “internal conditions” indexes to show how changes in the aggregate measures are driven by changes across countries in their share of world oil production and changes within countries in political conditions. In the early part of our sample, changes in oil political conditions were mainly driven by changes in the production share, as Middle Eastern countries accounted for a larger and larger share of total production. Recent trends, however, appear to be driven by changes in internal conditions in addition to changes in the location of oil production.

We show that the higher the share of oil coming from countries with poor political conditions in any given year, as measured by the decomposed “production index,” the higher is the volatility of oil prices in that year. Within-country changes in political conditions, as measured by the decomposed “internal conditions index,” if anything have the opposite effect on oil price volatility, suggesting that it may take time before short-run changes in political conditions impact oil production.

While short-run production volatility within one country’s borders may be quickly counteracted by adjustments in other countries so that any resulting price volatility will be short-lived, there are reasons to be concerned about the volatility. For one, price volatility makes business planning difficult and raises the cost of hedging risk. It is particularly difficult for energy-dependent industries such as the airlines and automakers. It also raises concerns for many that speculation is contributing to price volatility and spikes causing many to call for tighter regulation of energy markets.³ Finally, we test whether countries with poor political conditions are more likely to cut back on oil production when prices are high and/or other countries are also cutting back.

² The dramatic growth in U.S. oil production more recently marks a reversal of this trend.

³ The Commodity Futures Trading Commission (CFTC) opened hearings in July 2009 to consider placing limits on the trading behavior of financial investors in futures markets for energy products. After the passage of Dodd-Frank, the CFTC enacted a position limits rule for

The next section of the paper discusses the mechanisms by which political conditions might affect oil markets. Section III presents our main empirical findings, documenting the negative relationship between political conditions and oil market volatility. Section IV interprets our findings and analyzes their implications for price volatility in world oil markets. We also discuss why our findings probably do not support an “energy-security” based argument for government intervention in energy markets. We conclude in section V with some thoughts on the lessons to be drawn from this analysis as well as possible future extensions of this research agenda.

II. Background

In this paper we seek to identify the role that political conditions play in driving the volatility of oil production. While the considerable literature debating the existence of a “resource curse” focuses on the causal relationship between a country’s oil wealth, or wealth from other natural resources, and macroeconomic and political outcomes (see van der Ploeg (2011) for a comprehensive survey), there has been little focus on the role governance plays in affecting oil supply.⁴

We discuss the resource curse literature briefly to motivate an important point about endogeneity. Within the extensive literature on the resource curse, a subset of papers consider whether “oil and mineral wealth tends to make states less democratic” (Ross (2001), p. 328).⁵ These papers (and others in this literature) highlight the point that we cannot treat political institutions as exogenous in any analysis of the role political conditions play in affecting oil supply, and they emphasize the need to instrument for a country’s political conditions.

Turning to the effect of institutions on energy markets, Bohn and Deacon (2000) consider how ownership risk affects the exploitation of natural resources in countries. They find that higher ownership risk decreases oil drilling and oil production whereas higher risk increases deforestation. Ownership risk affects oil and forestry differently due to differential capital intensity. While ownership risk encourages more rapid exploitation to extract resources before assets are (potentially) expropriated by the government, capital investment required to extract resources is also discouraged. Since oil production is relatively capital intensive (compared to forestry) this investment effect offsets the production effect. Our paper differs from Bohn and Deacon in several important

commodities including oil and gas in 2011. That rule was vacated by a U.S. Federal court in September 2012. The CFTC subsequently announced it would appeal that decision. See Miller (2013).

⁴ Mehlum, Moene and Torvik (2006) consider how institutions influence whether the presence of resource wealth leads to a resource curse or blessing. They do not control for any potential correlation between their institutions variable and the error term as we do below.

⁵ Papers include Ross (2001), Smith (2004), Basedau and Lacher (2006), Haber and Menaldo (2011), Alexeev and Conrad (2009), Tsui (2010), Tsui (2011) and Wacziarg (2012), among others. An affirmative answer to this question would indicate a resource curse while a negative answer a resource blessing.

respects. First, while they interpret weak institutions as indicative of “ownership risk,” in one specification, we include a variable that measures expropriation events in addition to the political conditions variable. The results of this specification suggest that political conditions affect oil production more through other channels (*e.g.*, government pressures to pursue nonmarket goals) than through expropriation risk, although this is based on only one, perhaps blunt, measure of ownership risk. Second, we treat governance institutions as endogenous and instrument for them in our empirical analysis.

This brief literature review makes clear a couple of key points. First, political conditions are endogenous and likely to be influenced by the existence and characteristics of oil markets in the country. Second, other factors impact both political conditions and oil market production. Unless we control for these factors, we are likely to mismeasure the relationship between governance and oil production conditions. In the empirical work that follows, we attempt to tease out the causal impacts of governance structures on oil production volatility while controlling for a number of these confounding influences that are likely to be correlated with both polity and oil production.

III. Empirical Analysis

We analyze the empirical relationship between a country’s political conditions and its oil production in several steps, first presenting our basic results on political conditions and volatility, then describing our approach to dealing with the possible endogeneity of political conditions, next testing the empirical relationship using several additional political conditions measures, and finally presenting several alternative specifications that evaluate whether other macro factors influence volatility in addition to political institutions. We also show results suggesting that political conditions influence the share of a country’s reserves that are extracted, although we place less emphasis on these results since reserve estimates could be misleading. Table 1 provides summary statistics on all of the variables used in the analysis.

Our basic regression is of the form:

$$V_i = \alpha_1 + \beta_1 PC_i + \mathbf{X}_i \boldsymbol{\gamma}_1 + \eta_i \quad (1)$$

where V_i is a measure of oil volatility in country i , PC_i is a measure of political conditions, \mathbf{X}_i is a vector of control variables included in some specifications and η_i is a random error. We estimate equation (1) across the 48 major

oil-producing countries.⁶ All our specifications are weighted by a country's average production within the appropriate time period, although the basic results are not sensitive to this weighting.⁷ The scale of oil production varies dramatically across the countries in our database (from 2007 production of 10,400,000 barrels per day in Saudi Arabia to 82,000 barrels per day in Cameroon and 98,000 barrels per day in Tunisia). We are concerned that variance, our dependent variable, is more likely to reflect measurement or data error for the smaller countries. For example, if in all countries, the last digit of the reported figure was generated randomly due to measurement error, the variance for the smaller countries would capture more of this noise. This is not classical measurement error as it will vary systematically by observation. To avoid bias introduced by systematic differences in scale, we weight by production.

Our base measure of political conditions is the Composite Democracy Index from the 2007 Polity IV Project.⁸ The composite score is defined as the difference between the Institutionalized Democracy index ($DEMOC_{it}$) and the Institutionalized Autocracy index ($AUTOC_{it}$). The former index is based on the competitiveness and openness of executive recruitment, constraints on the chief executive, and competitiveness of political participation. In effect it captures popular and institutional constraints on the executive (both directly and through competition) that restrain arbitrary action towards – among others – business and industry. Marshall and Jagers (2009) stress that other aspects of political openness such as rule of law follow from the principles embodied in this index. As such, we would expect that higher levels of DEMOC would be associated with lower volatility of arbitrary action towards business. The index ranges from zero to ten. The autocracy index is based on other measures of competitiveness and openness of executive recruitment, constraints on the chief executive, and competitiveness and regulation of political participation. Marshall and Jagers (2009) note that higher degree of AUTOC is associated with higher levels of direct oversight or control over social and economic activity. We would expect that higher levels of AUTOC would correlate with more arbitrary intervention in business activity that could have negative impacts on production. The index also ranges from zero to ten. The resulting combined polity score ranges from -10 (strongly autocratic) to +10 strongly democratic. For use in our index decompositions in Section IV,

⁶ The lack of within country over time variation limits us in the main to cross sectional analysis. In section III E, we report regression results using within country variation as a robustness check but are hampered by the lack of time-series variation within countries.

⁷ For example, without weighting, the first row of Table 2 yields a coefficient of -.0056** (.0020) in the first column and -.0043** (.0020) in the second column.

⁸ The Polity IV data are described in detail in Marshall and Jagers (2009) and are available on-line at <http://www.systemicpeace.org/inscr/inscr.htm>.

we rescale the index to range from 1 to 21 with higher values still indicating stronger democratic tendencies.

Country-level oil production data is from BP (2009).⁹

A. Basic Results

Table 2 presents versions of equation (1) estimated over two different time periods and without covariates. We use data from both 1965-2007, where the start date is constrained by the availability of the oil production data, and 1980-2007, where the start date is constrained by the availability of data on oil reserves, used in later rows of the table.

The results in the first row suggest that countries with higher polity scores have lower volatility, and the coefficient estimate is similar across the two different time periods. Considering the specification in the left-hand column, the magnitude of the coefficient on polity suggests that moving a country from the 25th percentile polity score of 4.1 (*e.g.*, Libya or Vietnam) to the 75th percentile polity of 16.4 (*e.g.*, Thailand or Ecuador), should reduce production volatility by .084, which represents approximately half a standard-deviation change in volatility. Also, the R^2 in that specification suggests that political conditions explain nearly one fifth of the volatility differences across countries. Figure 1 plots the data used to generate this set of results, where the size of each circle is proportional to the country's average production over the sample period.

We also measure volatility in oil production after controlling for changes in underlying market conditions. For example, if a country's oil production increases dramatically over the span of several years because of the discovery of new oil reserves, this would be considered appropriate, economically-motivated volatility. Similarly, profit-maximizing firms within a democratic country may cut back on production if world demand declines.

To separate the "excess" volatility from the market-driven changes in oil production, we consider the following formula:

$$\ln(Q_{it}) = f(S_{it}, D_{it}) + g(PC_{it}) \quad (2)$$

where Q_{it} represents country i 's production in year t , $f(S_{it}, D_{it})$ reflects output driven by both supply (S) and demand (D) factors, $g(PC_{it})$ captures the influence of political conditions (PC) on output

⁹ We dropped country-year observations when production less than 5 percent of average production in the country, so that production ramp-ups, such as in the UK, did not influence our results. Also, in 1985 and later, BP reports individual production for Russia, Kazakhstan, Azerbaijan and Tajikistan. We allocated pre-1985 Soviet production to those four countries in proportion to their late 1980s production. Our results are not sensitive to this decision and are almost identical if we ignore the Soviet period or use different allocation rules for the Soviet production.

We either estimate or calculate $\ln(\hat{Q}_{it}) = \hat{f}(S_{it}, D_{it})$ and then calculate the residual production:

$\hat{g}(PC_{it}) = \ln(Q_{it}) - \ln(\hat{Q}_{it})$. Our country-level measure of volatility is then:

$$V_i^1 = std.dev.(\hat{g}(PC_{it}) - \hat{g}(PC_{it-1})) \quad (3)$$

The second row of Table 2 reflects a specification where $f(\bullet)$ is an estimated country-specific quadratic time trend. At the field level, petroleum engineers have long understood that production will increase slowly at first as rig investment occurs, then more quickly and then decline as field depletion occurs (see Adelman (1990) for a model of depletion at the field level). For some of our countries, output is dominated by a handful of fields, so this relationship may hold at the country level. Because some countries began extracting oil long before the beginning of our dataset while others began during our dataset, we are concerned that the volatility measure might reflect changes in output driven by petroleum engineering factors, as countries with recent oil discoveries would go through both the slow and rapid increase in our data set. The results in the second row suggest that controlling for this possibility, the relationship between polity and volatility is even stronger, and, in the 1981-2007 time period accounts for almost half of the variation in volatility.¹⁰

The third and fourth rows of Table 2 calculate $f(\bullet)$ using information on world GDP, which affects world oil demand, and a country's reserves, which, as an abstraction, we take to be indicative of the country's ability to produce oil.¹¹ The reported specifications reflect a coefficient of one on both $\ln(\text{World GDP})$ and $\ln(\text{Reserves})$, although the results are quantitatively very similar if we impose different coefficients on either variable.¹² In both rows, the absolute value of the coefficient on polity declines, but remains statistically significant at the five-percent level.

Finally, the last row of Table 2 reports coefficient estimates that use a dependent variable measuring the largest single percent decline in annual production. The results similarly suggest that countries with poor political conditions are more prone to large output drops. A similar specification that used the largest single percent *increase* in annual production as the dependent variable yields a positive coefficient on polity, suggesting that countries with

¹⁰ These results do not appear to reflect over-differencing as they are very similar to results using the standard deviation of the residuals from the quadratic trend as opposed to the difference in the residuals.

¹¹ We have also estimated specifications using Kilian (2009)'s real demand variable, as he argues that it is a much better predictor of commodity demands than world GDP. The coefficient on polity was slightly smaller in absolute value, although still precisely estimated to be different from zero.

¹² The equation we estimate is a reduced form of the supply and demand equations under certain assumptions about the relationship between income, supply and demand elasticities.

higher polity scores are more likely to see large increases, and indicating that our results on volatility are driven by the large reductions.¹³ In the regressions that follow, we will report results based on the volatility measure used in the first row of Table 2, although our results are not sensitive to this decision.¹⁴

B. Reverse Causality

We argued in section II that our polity measure is likely endogenous and possibly correlated with the error term in regression equation (1). In Table 3 we report results using instrumental variables specifications. We assume that activities that took place before oil was commercialized in a country will reflect institutions independent of oil. The results in the second column use the polity measure before known commercialization, where we use a broad definition of known commercialization, dating it as the first year we see oil production in our data base unless we were able to find evidence of earlier commercialization in a PennEnergy's *Worldwide Oil Field Production Survey* or in Alexeev and Conrad (2009).¹⁵ The results in column three use a narrower definition, dating commercialization based only on outside sources.

The pre-commercialization instruments are valid if polity measures are persistent over time. In that case, the instruments will be correlated with the time-persistent components of the polity measures while post-commercialization impacts of oil on polity are uncorrelated with the instruments. In both cases, the first-stage coefficients are positive as expected and the F-statistics suggests that the instruments have good explanatory power.

Both instruments are only available for a subset of our countries. The broad polity variable is missing for Indonesia and Qatar, while the strict polity information is missing primarily for African and Asian countries. OLS results based on the same subset of the data are reported in the panel below the 2SLS results.

When we use the broad pre-commercialization polity instruments, the two-stage least squares result suggests a smaller impact of polity on volatility compared to the equivalent OLS specification. This could reflect a

¹³ The coefficient estimate from the specifications for the 1965-2007 data range is statistically significantly positive (0.0328, standard error = 0.0178), though the estimate from the specification for the 1980-2007 data range is positive but not statistically significant. Although one might think that large increases are mainly driven by “roundtrips” after large decreases, the variables measuring the largest one-year percentage decline and the largest one-year percentage increase are not all that negatively correlated in our data (correlation coefficient = -0.10 for the 1985-2007 data range and -.017 for the 1965-2007 data range).

¹⁴ As shown in an on-line appendix available at http://works.bepress.com/gilbert_metcalf/, results are smaller in magnitude if we exclude Iran, Iraq, and Kuwait but continue to be statistically significant, generally at the 1 or 5 percent level. Thus, while we believe that dismissing results as simply following from various conflicts Iraq has engaged in with neighboring countries is inappropriate, our results continue to hold when polity affects production through mechanisms other than major wars (e.g. poor management, distortionary incentives, etc.). Running unweighted regressions also reduces the statistical significance somewhat but does not change the basic analysis.

¹⁵ The field-level data are described at: <http://ogjresearch.stores.yahoo.net/worldwide-oil-field-production-survey.html>. Unfortunately, field-level production was only available for a small subset of the observations.

resource curse phenomenon if higher exogenous volatility in oil production facilitates more autocratic governments, perhaps because an autocrat is better able to smooth oil revenues over boom and bust periods. The results may be imprecise because the instruments are good at identifying whether countries end up with high or low polity scores but they do not pick up subtle differences across countries, which presumably provides additional power in the OLS results.

C. Alternative Political Conditions Measures

No single variable can capture the entire range of governance issues that help define a country's measure of political conditions. As a robustness check on our results using polity as our main independent variable we run regressions with the polity variable replaced by other measures of a country's internal political conditions. A similar story emerges. Specifically, we consider four additional measures:

Freedom House Political Rights (PR_{it}): Freedom House ranks countries on a variety of scales including political rights and civil liberties (next index). We use data from the 2008 Freedom House Survey.¹⁶ The political rights index is based on a checklist of ten questions that is converted to a seven point scale ranging from 1 (most political rights) to 7 (fewest political rights). For consistency with our other measures, we rescale the index to range from 1 (fewest political rights) to 7 (most political rights).

Freedom House Civil Liberties (CL_{it}): Based on the answers to fifteen questions, a score between 1 (most civil liberties) and 7 (fewest civil liberties) is awarded. As with the civil liberties index, we rescale the index to range from 1 (fewer civil liberties) to 7 (most civil liberties).

ICRG Expropriation Risks: Finally, we use the two expropriation measures used in previous macroeconomic work on institutions. The first, capturing the risk of expropriation in a country between 1982 and 1995, was used by Acemoglu, et al. (2001), while the second composite index was used by Hall and Jones (1999).

Results are reported in Table 4. Each panel of the table reports univariate OLS and 2SLS specifications, equivalent to both the upper and lower panels of the second column of Table 3. The results for both of the Freedom House variables are very similar to those in Table 3, suggesting a negative relationship between production volatility and internal conditions in both the OLS and 2SLS specifications, and all results are statistically significant at the ten percent level except for the 2SLS specification for the Freedom House Political Rights variable, which is significant

¹⁶ This database is available on-line along with a description of the methodology at <http://www.freedomhouse.org/template.cfm?page=15&year=2008>.

at the 11% level. In fact, even though the Freedom House and polity variables are constructed using different methodologies, they are highly correlated (correlations in excess of 0.92).

Both ICRG measures are negatively and statistically significant predictors of oil production volatility, and this holds for both the OLS and 2SLS specifications.

For three of the four measures, the estimated coefficients in the 2SLS regression are smaller in absolute value than the OLS coefficients. The ICRG risk of expropriation is the one exception to this pattern. The first-stage coefficients are positive and significant in all four cases, although the F-statistic suggests weak explanatory power using the ICRG risk of expropriation.

D. Additional Covariates

Table 5 reports results that include variables that capture cross-country differences in additional, nonpolitical, determinants of development. Our objective is to discern whether the strong relationship between political conditions and oil market volatility is mainly capturing an intermediate relationship between political conditions and another factor, such as financial openness. We do this by estimating versions of equation (1) that include several additional covariates described more fully below (represented by $Add.Cov._i$ below).

$$V_i = \alpha_2 + \beta_2 PC_i + \delta_2 Add.Cov._i + \mathbf{X}_i \boldsymbol{\gamma}_2 + \nu_i. \quad (4)$$

If there is an intermediate relationship between political conditions and the additional covariate, then β_1 from equation (1) will reflect both the direct effect of political conditions on volatility and the indirect effect, working through the covariate. Equation (4) will separately identify the direct effect, so if β_2 approximately equals β_1 from equation (1), this suggests that the relationship we have picked up so far is not due to an intermediate effect of political conditions on the additional covariate.

Panels A through D use Polity, Freedom House Political Rights, Freedom House Civil Liberties and the ICRG Composite Index, respectively. Each column in a panel reports results from a separate specification. All specifications include a control for the land area in a country (square miles) on the hypothesis that larger countries may be able to diversify production across sites and so control volatility. This hypothesis bears out as countries with larger land area appear to experience less production volatility. To save space, we do not report the coefficient on the land area variable, but in all specifications, it is negative and statistically significant at the five percent level or

higher.¹⁷ The economic impact is small, though, as the coefficient suggests that volatility falls by one-fifth of a standard deviation in countries with four million square miles more land area, which is more than a one standard deviation change in land area among our countries. The first column in Panels A-D, based on the same time period as the specification in the first row of the left-hand column of Table 2, only include the land area variable, and are included for purposes of comparison to the rest of the table.¹⁸

In the second column, we report results that include a measure of the country's financial openness: its gross stock of foreign assets and liabilities as a share of GDP.¹⁹ We include this variable to test the hypothesis that political institutions affect firms' ability to produce efficiently at least in part by altering their access to foreign capital.²⁰ Also, previous work has pointed to the importance of financial openness at the industry level. For example, Rajan and Zingales (1998) show that manufacturing industries that are more dependent on external finance grow disproportionately faster in countries that are financially open. While that paper's focus on manufacturing startups may appear irrelevant to the oil extraction industry, startups may provide many valuable support services to established oil extraction firms.

If political institutions affect oil market outcomes by influencing the degree of financial openness, we would expect the coefficient on financial openness to be negative and the coefficient on polity to fall in absolute value. In fact, in all four panels, the coefficient on the financial openness measure is *positive*, suggesting that countries with more financial openness are more volatile. It is not significant at conventional levels, and the coefficient on the polity variable is attenuated, but not appreciably so. The raw correlation between polity and financial openness for our countries is -.076. This result could reflect the fact that even in countries with considerable capital flows, foreign investment in the oil industry is limited. It may also simply reflect the fact that countries with considerable oil wealth are diversifying by investing abroad (*e.g.*, Saudi Arabia and other major Arab oil and gas producing states), which makes them appear more financially open.

¹⁷ The reported coefficients in Table 5 are not sensitive to the inclusion of land area.

¹⁸ We have also estimated specifications that control for the share of a country's production from offshore fields. Offshore wells are considerably more expensive than onshore wells, so countries with a larger share of offshore fields may be more likely to reduce production when prices decline. Though our variable is somewhat coarsely measured, we found no indication of a relationship between offshore fields and production volatility. Results and more detail are available in the on-line appendix.

¹⁹ The data are described in Lane and Milesi-Ferretti (2006), and Kose, Prasad, Rogoff and Wei (2006) summarize the pros and cons of different financial openness measures. We have tried other variables, such as the Chinn-Ito Index (see Chinn and Ito (2006), and they are similarly insignificant.

²⁰ The literature on the relationship between financial openness and growth has recognized the potential relationship between political conditions and financial institutions (see, *e.g.*, Eichengreen, Gullapalli and Panizza (2009)).

The next set of specifications includes a dummy variable for countries that are in OPEC over the entire time period. Political conditions could drive OPEC membership, as, for instance, countries with institutions that support strong antitrust laws will not be in the cartel. Including the dummy also helps us assess whether the results in the first column are simply identifying differences between the large OPEC countries and the rest of the world or, alternatively, whether polity scores have an effect on production volatility even within OPEC and non-OPEC countries.²¹

In principle, it is not clear what the sign of the OPEC dummy would be, as OPEC membership could provide production discipline that reduces volatility. On the other hand, OPEC countries may adjust production to achieve price or profit goals in ways that could contribute to increased production volatility. In general, OPEC membership seems to be associated with high volatility, although the coefficient on the dummy is only significant in one specification. The coefficients on the political conditions variables are generally attenuated, suggesting that our results reflect, in part, the fact that countries with poor political conditions are in OPEC, but the coefficients on the political conditions variables are still negative, and significantly so in the case of polity, even with the OPEC dummy.²²

In the fourth column, we included an indicator variable for countries in which there were overt nationalization acts in the oil sector. Specifically, Guriev, Kolotilin and Sonin (2011) compiled a list of countries where there were, “forced divestments of foreign property,” [p. 12]. Their paper investigates determinants of these nationalization acts, including political institutions. Our results suggest that countries that have had overt nationalizations have more volatile oil production, although the coefficients on the nationalization variable are never statistically significant. The coefficient estimates on the political conditions variables are all smaller in absolute value, but, at least in the case of polity, still statistically significant. This suggests that nationalizations do impact volatility, but that political conditions appear to work through additional channels as well.²³

²¹ We have also estimated specifications that allow for a quadratic relationship between polity and volatility and found little evidence of important nonlinearities.

²² As the results with the OPEC dummy will be identified by both variation within OPEC and variation within non-members, the coefficient on polity could pick up stronger cartel compliance among low polity countries. This is not the only driver of the results, though, as we have estimated specifications using only non-members and find a strong negative relationship between political conditions and volatility.

²³ In unreported specifications, we also included a variable to measure the presence of a national oil company (NOC). An NOC may produce oil with more year-to-year volatility because it is constrained to pursue nonmarket objectives (Jaffee 2007). The coefficient on this variable was very imprecisely estimated in all specifications, although this is not altogether surprising since over our time period, all but four of the countries in our sample (Australia, Denmark, United Kingdom, and United States) had NOCs. This result is consistent with the idea that NOCs behave very differently depending on the political institutions within which they are operating.

The fifth column includes a country's average GDP per capita between 1965 and 2007. As we have discussed, previous work has found a strong, causal relationship between political conditions and economic development levels, as measured by GDP per capita, among other things. This appears true for the oil-producing countries in our data. For instance, the raw correlation between the political conditions variables and GDP per capita is strongly positive: 0.47 for polity, 0.59 for Freedom House Civil Liberties, 0.65 for Freedom House Political Rights and 0.76 for ICRG Composite Index. In the specifications in Panels B-D (which measure political conditions using Freedom House Political Rights, Freedom House Civil Liberties and the ICRG Composite Index), the coefficients on the political conditions variable are slightly larger in absolute value and remain statistically significantly negative. Contrary to expectations, the coefficient on GDP per capita is positive, though quite imprecisely estimated.

The results for the polity variable, on the other hand, accord with expectations. The coefficient on GDP is negative, though imprecisely estimated, and the coefficient on polity falls slightly in absolute value. This result suggests that, at least for polity, some of the same factors that hinder economic development contribute to higher oil market volatility. Taken together, the result in Panels A-D indicate that political conditions affect production volatility after controlling for the country's development level (as measured by per capita GDP). This buttresses the conclusion that political conditions can have real effects on production decisions in a particular market.

In the final column, we include a variable to measure countries' legal environments. These specifications are not directly analogous to the others in Table 5, as political conditions and legal environments are generally believed to arise independently. Previous work has evaluated "property rights institutions", which protect citizens from governments (and are generally measured by our political conditions variables), and contracting institutions, which facilitate commercial transactions between citizens, as competing explanations for different economic development levels. Measures of contracting institutions include variables such as the number of legal procedures required to settle the collection on an overdue payment.²⁴ La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998) show that countries in which the legal system derives from the French (civil-law) tradition have weaker contracting institutions (*e.g.*, higher number of procedures) than countries with legal systems derived from the English (common law) tradition. Acemoglu and Johnson (2005) show that contracting institutions matter little for macroeconomic

²⁴ Our variable "World Bank Procedure Count" is from World Bank (2004).

growth once differences in political institutions are accounted for. We find a similar result for oil production volatility.²⁵

E. Specifications Using Within-Country Variation

The regressions reported above use average political conditions measures over the sample, so the coefficients are identified by cross-country differences in political conditions. Our instruments pick up only those components of political conditions which were pre-determined before oil was a major factor in a country's economy, but our exclusion restriction will be violated if there is an omitted variable correlated both with poor political conditions and volatile production. For instance, if there is something about dominant religious institutions in a country that leads both to strong, unchecked executives and to volatility in production, our results cannot be interpreted causally. In this section, we focus on variation in the political measure as the source of instability in oil production.

1. Regression-Based Analysis

We estimated several specifications similar to those reported in Tables 2 through 5 using the variance in polity over our time period as the explanatory variable of interest. The coefficients, except for the univariate OLS specification, are all positive. All coefficients are statistically indistinguishable from zero. Positive coefficients, suggesting countries with more volatile political conditions have more volatile production, are generally consistent with the conclusions suggested by our previous results.

An alternative specification replaces the polity measure with the change in polity defined as the difference between the average value across the last third of a country's observations and the average of the first third of observations. The production volatility measures are also re-defined as the difference between the volatility for the last third of a country's observations and the first third of observations. The results are small and indistinguishable from zero. There appears to be too little variation in polity scores within countries over time to identify the role of changes in political conditions on oil production volatility.

2. Analysis of Specific Cuts

To verify that the cross-sectional results are not spurious, we took advantage of our small sample size and scrutinized 142 individual country-year observations that represented large reductions in oil production. These large

²⁵ We have also estimated 2SLS specifications, using pre-oil commercialization political conditions and legal origins as instruments, and the results are very similar to those reported.

reductions account for much of the variance we seek to understand. The variance (unweighted) of the percent change in production across country years is 44 with all observations. It falls by a factor of four, to 11 when we exclude the 142 country year observations that we analyze as well as the following year, as that year often reflects a mean-reverting increase.

Specifically, we started with the set of country-year observations where daily average oil production dropped by more than 100,000 barrels from the previous year. The smallest cut reflected slightly less than a one percent reduction. The list also reflects the top 16 largest percent reductions in our data set. The largest percent reduction that we did not consider (because it reflected a cut of less than 100,000 barrels per day) was in Egypt in 1972 and reflected a 28 percent reduction.

For each country-year observation, we searched the business press for explanations and descriptions of oil production in the country around that time period. We classified each cut as belonging to one of the eight categories listed in Table 6, and described more fully in the on-line appendix.

Each country-year observation is reported in the appendix table along with its explanation category. We also verified the categories against several historical descriptions, including Hamilton (2013), Smith (2009), Adelman (2002), and Yergin (1991).

We interpret the first four categories in Table 6 (natural disasters, technical failures, high extraction costs and mature fields) as more likely driven by market or exogenous forces and less likely reflective of political institutions. This distinction is not complete, as it is conceivable that, for instance, a natural disaster could lead to a greater production loss in a country with poor institutions if those institutions inhibited infrastructure investment. Our reading of the individual case histories suggests this is not the case, however. For instance, natural disasters have led to production reductions in both the U.S. (Hurricane Katrina) and Ecuador (6.9 magnitude earthquake in March 1987), though their development levels and political conditions differ.

The share of reductions driven by market or exogenous forces is much higher in countries with high polity ratings. Of the 75 observations from countries with polity ratings above 10, almost half of the reductions were attributable to market or exogenous factors, while for countries with low polity ratings, the share is less than six percent. The difference remains pronounced even if we exclude all OPEC-related reductions (the last category): market and exogenous factors account for 60 percent of the observations in high polity countries and 15 percent of

the observations in low polity countries. This analysis supports the interpretation from the previous sections that poor political institutions lead to volatile oil production.

F. Political Conditions and Other Oil Production Outcomes

Overall, our results suggest a robust causal relationship between political conditions and oil production volatility. To further explore the role of political institutions, Table 7 reports results from a specification where we examined the volatility in the number of wells in a country.²⁶ The coefficients on polity suggest that the number of wells is also more volatile in countries with poor political conditions, consistent with the hypothesis that poor political conditions impact infrastructure investment and supply decisions. Put differently, this helps confirm that the results in Tables 2 through 5 do not reflect a spurious correlation between physical or other determinants of oil production and political institutions, but instead can be interpreted causally. The 2SLS results are nearly twice the magnitude of the OLS estimates, consistent with the presence of measurement error in the polity measure, and the results are statistically significant at the one percent level.²⁷

The results in Table 8 speak to whether political conditions affect not just the volatility of oil production but also the absolute level. We consider the mean of production as a share of total reserves by country, under the theory that reserves are exogenous to political conditions and mainly reflect a country's natural oil endowment. The coefficient on polity is positive, suggesting that countries with good political conditions are extracting a greater share of their total reserves over the time period we examine.²⁸ This could reflect several factors. For instance, it could reflect profit-maximizing withholding by monopoly state-owned oil companies in low polity countries. Smith (2009), for instance, notes that OPEC's main success as a cartel has been in avoiding new production capacity, such that installed production facilities extract just 1.5 percent of proved reserves per year in OPEC countries versus 5.6 percent of proved reserves elsewhere. OPEC is not the entire explanation for the results in Table 8, though, as the result is robust to the inclusion of the OPEC dummy variable. The results are also robust to instrumenting for political conditions. While in no way dispositive, the result is consistent with the hypothesis that poor political conditions impede production.

²⁶ We obtained data on producing wells from PennEnergy's Oil & Gas Journal Energy Database. Data do not reflect shut in, injection, or service wells.

²⁷ Specifications including the OPEC dummy are very similar to those reported in Table 7.

²⁸ In a discussion of the joint determination of governance and resource reliance, Haber and Menaldo (2011) conjecture that rulers in authoritarian states may extract at high rates to obtain revenue needed for political survival (p. 2). Our results do not support this conjecture.

IV. Implications

Having documented the importance of a country's political conditions to its oil production, we explore how changes in average political conditions of oil producing countries affect price volatility in world oil markets. This allows us to explore whether the results we find at the micro level aggregate up to the macro level. It also allows us to analyze the impacts on volatility of changes in political conditions within countries versus changes across countries in world production shares.

To conduct this analysis we construct several indexes of the political conditions of oil-producing countries over the past several decades. In all cases we construct a political conditions measure according to the following formula (where I_{it} represents one of the political conditions measures described in the previous section for country i in year t and Π_t is a global index based on the underlying measure):

$$\Pi_t = \sum_i \omega_{it} I_{it} \quad (5)$$

ω_{it} is the share of country i 's oil production in world production for year t . We normalize all of the indexes by dividing by the value in the first year that the index is available. The oil conditions index, Π_t , is a convenient measure of the average political conditions in oil-producing countries weighted by production.

Figure 2 plots the various indexes over time. The polity index begins in 1965, when the oil data are first available, while the Freedom House and ICRG indexes are constrained by data on the political conditions. Consider first the polity measure in the upper left corner of the figure. The index is initially deteriorating, falling from its 1965 value by 30 percent before bottoming out in the late 1970s. It then rises, peaking in the early 2000s about 10 percent higher than its 1965 level before beginning to deteriorate again. A similar picture emerges from the Freedom House indexes (note that these indexes starts seven years later). Both ICRG indexes rise through the 1980s and 1990s and then show signs of leveling off or even declining in early 2000.

A. Changes in Production Shares versus Changes in Internal Conditions

What explains the changes in the various indexes? Log differentiation of equation (5) yields:

$$\hat{\Pi}_t = \sum_i \frac{\omega_{it} I_{it}}{\sum_k \omega_{kt} I_{kt}} (\hat{\omega}_{it} + \hat{I}_{it}) \equiv \sum_i \phi_{it} (\hat{\omega}_{it} + \hat{I}_{it}) \quad (6)$$

where a hat indicates a percentage change (*e.g.*, $\hat{S}_{it} = \frac{dS_{it}}{S_{it}}$). Changes in the oil index can be decomposed into changes in underlying country conditions and changes in countries' shares of world oil production following the work of Boyd and Roop (2004) and Metcalf (2008). Using a Fisher perfect decomposition, we decompose the oil index (Π_t) into an internal-conditions index ($\tilde{\Pi}_t^{Pol}$) and production-share index ($\tilde{\Pi}_t^{Prod}$). The internal-conditions index, $\tilde{\Pi}_t^{Pol}$, measures the change in the oil index holding the world oil production shares constant.²⁹ It thus isolates the importance of political changes in oil producing countries. The oil production share index, $\tilde{\Pi}_t^{Prod}$, on the other hand, measures the change in the political conditions index holding country-specific political conditions constant. This index isolates the changes in world production and their contribution to the overall index. These indexes (known as Fisher Ideal Indexes) have the desirable property of perfect decomposition. This means that the oil index can be decomposed into these two indexes with no unexplained residual:

$$\Pi_t = \tilde{\Pi}_t^{Pol} \tilde{\Pi}_t^{Prod} \quad (7)$$

Figure 3 reproduces the three indexes available over the longest time periods (in blue) and plots each against its two components. Consider the upper left graph on Figure 3 where oil conditions are measured using the polity index. The upper gray line with squares is the internal conditions index, $\tilde{\Pi}_t^{Pol}$, while the other gray line, which is below the overall index in the later years, is the production share index, $\tilde{\Pi}_t^{Prod}$. Between 1965 and 1987 changes in the production share index drive changes in the overall index. In the first decade oil is increasingly produced by countries with poor political conditions measures. This partly reflects the growing share of OPEC and the USSR (share of world oil production rising from 61 percent in 1965 to 69 percent in 1976) and the declining share of the United States (26 percent to 14 percent over the same period). Over the next decade OPEC's share of world oil production dropped from 51 percent in 1976 to 28 percent in 1985. This followed the expansion in non-OPEC oil production following the two oil shocks of the 1970s, in particular the development of North Sea oil (rising to a world share of 6 percent by 1985) and a rebound in the U.S. share of world oil production.

²⁹ We describe the construction of the Fisher indexes in the on-line appendix.

For the next twenty years changes in the production shares of world oil played little role in the steady rise in the overall index. Rather a transformation of the world political order occurred. Beginning in the mid-1980s, Gorbachev introduced democratization efforts leading up to the dissolution of the Soviet Union in 1991. Also, Mexico's polity score increased in 1988, when it held its first election with a serious opposition candidate in many years.

The decline in the oil index that began in 2003 can be explained roughly equally by declines in the internal conditions index and the oil production index. The recent expansion in U.S. oil production will likely blunt if not overturn the recent downward trend in average polity. The recent overthrow of the Libyan dictator Qaddafi in 2011 and the shut-down of Libyan oil production is a dramatic illustration of the on-going importance of political conditions for oil market stability. While pre-rebellion oil production in Libya constituted less than two percent of global oil supply, the loss of the 1.6 million barrels per day of Libyan oil contributed to sharp increases in the global price of oil. The Brent price rose by ten percent in less than two weeks following the first protests in Benghazi following the arrest of a human rights activist and over twenty percent within two months before the International Energy Agency coordinated a release of 60 million barrels of oil from member country reserves.³⁰ Today in the post-Qaddafi, Libya still struggles to maintain production.³¹

In sum, the oil index constructed from the polity measure first declines and then rises to a peak in the early 2000's before starting to decline again. Changes in the index are driven over the first half of the data by changes in the oil production share index. The internal conditions index drives changes for most of the second half of the sample.

A similar story holds for the Freedom House political rights index. Changes in both the internal conditions and the production share indexes appear to contribute to changes in the overall index prior to the mid-1980s. After that year the influence of the internal conditions index dominates until the early 2000's. Similarly the Freedom House civil liberties index shows a mixture of influences. The internal conditions index appears to dominate from roughly 1985 to the early 2000's and the production share index dominates in the last several years.

³⁰ A timeline of the Libyan revolution is available at Reuters (2011). Brent spot price data are reported by the U.S. Energy Information Administration which also details the IEA response to the price rise in U.S. Energy Information Administration (2012).

³¹ A recent Reuters story details protests that have shut down roughly one-third of Libyan production. See Shennib and Gumuchian (2013).

In sum, the data suggest that there has been considerable variation over the past forty years in the political structure of oil producing countries. That change has been driven at times by changes in the political structure within oil producing countries and at other times by changes in production shares across countries.

Note that these indexes will not fully describe the expected volatility in the world oil market as they do not capture the correlation in supply reductions across countries. For example, if supply reductions in countries with sound political institutions are more likely to be correlated with reductions in other countries, than, even if the analysis in section III suggests that the countries have less volatile production, the volatility could be nonetheless more likely to lead to large price increase. In fact, the opposite is true. Supply reductions in countries with poor political conditions are more likely to occur in years when other countries are also reducing productions. For example, considering the 142 major cuts analyzed in Section III E2, in years in which high polity countries experienced one of the reductions, total production across all other countries increased by 880,000 barrels per day, in years in which low polity countries experienced one of the reductions, total production across all other countries increased by only 130,000. The difference is statistically significant at the five percent level. Note that the difference between high and low polity countries does not appear to be driven entirely by OPEC-related cuts, as the difference persists even when we look at cuts excluding those in the last category of Table 6. This suggests that increased world output from low polity countries should have a greater impact on world oil prices.

B. Political Conditions and Macroeconomic Indicators

A natural question to ask is whether the changes over time in the weighted-average political condition have in fact impacted world oil markets. For instance, we might suspect that as production moves away from countries with poor political conditions, which we demonstrated in the previous section had more volatile production, volatility in prices would decline. Table 9 reports results from simple time series regressions which use two of the three indexes depicted in the upper left panel of Figure 3, decomposing the polity measure, to predict oil price volatility.³² We measure oil price volatility in two ways. In the first and third columns, we measure the within-year variance in the spot price (using data from the Global Financial Database, Commodity Price series). As spot prices are only really meaningful beginning in the early 1980s, we use data from the last 25 years of our sample (1983-2007). In the second and fourth columns, we measure price volatility using the absolute value of the difference

³² Although the indexes are not additive, the results for the third index were similar to the linear combination of the other two indexes, so we report results using only two of the three indexes.

between the oil forward contract closing price traded three-months prior to delivery minus the delivery date's closing spot price. (The last daily trade in a month is used as the monthly observation of spot price and as the contract delivery date.) This measure will capture unexpected changes in the market over the short run, which could be driven by supply-side disruptions caused by the political conditions in the oil-producing countries.

The top panel of Table 9 uses the overall political conditions index as the independent variable, and the bottom panel uses the production share index as the independent variable. The results at the top of the table suggest that there is little, or if anything positive, correlation between the overall polity index and price volatility, which is inconsistent with our hypothesis. The results at the bottom without a trend suggest a distinct negative effect of increasing the production share index on price volatility. The coefficient estimates fall and become statistically insignificant when we add a linear trend, although with only 25 observations over time, it may be too difficult to detect a relationship based on deviations around a trend. Overall, the results may suggest that it takes time before short-run changes in political conditions impact oil production in a country, but that shifts in production to countries with long histories of good governance will lead to lower price volatility.

C. Interpreting Our Results

We have argued that a link exists between political conditions in a country and the stability of the country's oil production. Empirical evidence suggests that more democratic countries have more stable production over time. Moreover our preferred political conditions index of oil supply suggests a downturn in polity among oil producing nations in the early part of the last decade. The current boom in oil production in the United States is likely to offset if not overturn this trend.

One should not, however, interpret our results as suggesting a new rationale for government intervention in energy markets to promote energy security. For example, it would be incorrect to interpret our results as supporting a policy of more domestic supply to reduce oil imports. We say this first because supply shocks of the sort that we investigate in this paper – country-specific and largely idiosyncratic shocks – can in general be quickly replaced in world markets by other suppliers. Thus price shocks are for the most part short-lived.³³ Second, oil is a fungible commodity and price shocks arising from a supply shortfall anywhere in the world affects all oil consumers regardless of the source of their particular oil. As noted by Deutch and Schlesinger (2006) and the National Research

³³ This is not to suggest that idiosyncratic supply shocks are entirely unimportant. They can contribute to an atmosphere of concern about supply that feeds into a precautionary demand shock as described by Kilian (2008). Also, as noted above, low polity countries are more likely to have supply reductions that are correlated with other countries reductions.

Council (2009), among others, a country's vulnerability to oil shocks depends on its consumption of oil relative to the size of its economy rather than its imports.

The results do enhance our understanding of the relationship between political governance and energy supply and more generally of the connections between political institutions and economic performance. In that vein, our paper can be viewed as a contribution towards opening up Acemoglu, Johnson and Robinson's "black box" to see an example where governance affects the workings of a particular market, one that happens to be of particular importance to the world economy.

V. Conclusion

We have analyzed how political conditions in oil producing countries affect the volatility of oil production as well as other oil market outcomes. We show that there is a pronounced negative relationship between the short-run volatility in oil production in a country and its political openness, with very democratic regimes exhibiting less volatility in their oil production than more autocratic regimes. This result holds across several robustness checks including using different measures of political conditions, instrumenting for political conditions and using different measures of oil production volatility.

Our findings suggest a potentially important interplay between governance and resource abundance following recent findings in the resource curse literature. van der Ploeg and Poelhekke (2009) find that resource abundance adversely affects economic growth less through a direct natural resource channel than through an indirect commodity price volatility channel.³⁴ Mehlum, et al. (2006) as well as Butkiewicz and Yanikkaya (2010) find that resource abundance is more likely to adversely affect countries with weak institutions than strong ones. Together these papers suggest – when combined with our findings – that there is the potential for a vicious resource spiral. Countries with weak institutions are likely to have volatile oil production that in turn can contribute to volatile oil prices globally. Volatility in turn adversely affects institutions in resource rich countries, especially those with weak institutions to begin with. Whether this dynamic process is relevant and important is left for future research.

We next document that the average political conditions of oil producing countries has changed markedly over the past thirty-five to forty years. Using the polity composite democracy index, for example, we find that our oil index falls by 30 percent between 1965 and 1976 and then nearly doubles over the next twenty-eight years. Over

³⁴ They extend these findings in van der Ploeg and Poelhekke (2010).

the past five years it has fallen by roughly five percent. We then decompose that index into a political index that controls for the distribution of oil production across countries and a production share index that controls for the political structure of producing countries. Again using the polity measure, early changes in our oil security index are driven by the distribution of countries producing oil while latter changes are driven more by changes in political conditions within producing countries.

One should be cautious in drawing policy recommendations from this finding. It does suggest that a research agenda focusing on the role of political institutions in affecting global energy markets is a fruitful one. This paper takes a reduced form approach. Subsequent research will be important to begin to understand the mechanisms that affect supply volatility and what the implications are for policy. Also, our index measures could be used to analyze the potential risks associated with different renewable energy technologies, many of which (for instance, solar electricity and electric vehicles) rely on natural resources that are available in a limited set of countries.

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Table 1. Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum	Years Covered
Oil Production Volatility Measures					
Stdev[lnQ _t – lnQ _{t-1}]	0.191	0.163	0.029	1.001	1965-2007
Stdev[(lnQ _t – lnGDP _t) – (lnQ _{t-1} – lnGDP _{t-1})]	0.198	0.160	0.062	0.986	1965-2007
Stdev[lnQ _t – lnQ _{t-1}]	0.158	0.180	0.020	1.001	1980-2007
Stdev[(lnQ _t – lnGDP _t) – (lnQ _{t-1} – lnGDP _{t-1})]	0.169	0.175	0.051	0.986	1980-2007
Stdev[(lnQ _t – lnGDP _t - lnReserves _t) – (lnQ _{t-1} – lnGDP _{t-1} – lnReserves _{t-1})]	0.230	0.192	0.059	0.987	1980-2007
Largest one-year percentage decline	0.212	0.179	0.000	0.867	1965-2007
Largest one-year percentage decline	0.168	0.169	0.000	0.867	1980-2007
Volatility in Wells	0.221	0.209	0.000	0.896	1980-2006
Production/Reserves	0.061	0.035	0.007	0.175	1980-2007
Explanatory Variables					
Polity	10.0	7.0	1.0	21.0	1965-2007
1900 Polity Broad	8.9	7.2	1	21	See text
1900 Polity Strict	7.4	6.7	1	21	“
Freedom House Political Rights	3.4	2.1	1.0	7.0	1972-2007
Freedom House Civil Liberties	3.6	1.8	1.0	7.0	1972-2007
ICRG Risk of Expropriation	7.5	1.5	2.5	9.9	1982-1997
ICRG composite index (aggregate of 5 ICRG measures)	31.0	8.1	14.6	49.4	1982-1997
Financial Openness	1.3	1.0	0.3	5.8	1970-2007
OPEC Membership	0.2	0.4	0.0	1.0	1965-2007
Act of Nationalization	0.5	0.5	0.0	1.0	1960-2006
National Oil Company	0.9	0.3	0.0	1.0	1965-2007
Average GDP per Capita	5724	7683	328	30013	1965-2007
World Bank Procedure Count	27.2	11.9	11.0	54.0	2004
Common Law Origins	0.3	0.4	0.0	1.0	NA
Land Area (millions of square miles)	2.1	3.5	0.0	17.1	1965-2007
Source: Various (see text).					

Table 2. Volatility and Polity

<i>Volatility Measure</i>	<i>Data range: 1980-2007</i>		<i>Data range: 1965-2007</i>	
	<i>Coefficient on mean(Polity)</i>	<i>R²</i>	<i>Coefficient on mean(Polity)</i>	<i>R²</i>
Stdev[lnQ _t – lnQ _{t-1}]	-0.0068*** (0.0023)	0.185	-0.0060** (0.0024)	0.175
Stdev[(lnQ _t – β ₁ t – β ₂ t ²) – (lnQ _{t-1} – β ₁ (t-1) – β ₂ (t-1) ²)]	-0.0070*** (0.0022)	0.227	-0.0062*** (0.0022)	0.209
Stdev[(lnQ _t – lnGDP _t) – (lnQ _{t-1} – lnGDP _{t-1})]	-0.0052** (0.0023)	0.124	-0.0048** (0.0023)	0.120
Stdev[(lnQ _t – lnGDP _t – lnReserves _t) – (lnQ _{t-1} – lnGDP _{t-1} – lnReserves _{t-1})]	-0.0054** (0.0026)	0.119		
Largest one-year percentage decline	-0.0116*** (0.0036)	0.244	-0.0133*** (0.0038)	0.247
<p>Robust standard errors in parentheses. All specifications are weighted by a country's average production within the appropriate time period. The first two columns present results where the dependent variable is estimated over the range 1981-2007, where the first year is one year after the data begins since the dependent variables are in first differences. The two right-most columns present results where the dependent variable is estimated over the data range 1966-2007. N = 48, rows 1-3, 5; N=47, row 4 (data on reserves in Cameroon are not available).</p> <p>* - p-value less than 10 percent ** - p-value less than 5 percent *** - p-value less than 1 percent</p>				

Table 3. Volatility and Polity: Two-Stage Least Squares

	2SLS	2SLS
	1900 Polity (Broad)	1900 Polity (Strict)
Polity	-0.0031 (0.0035)	-0.0038 (0.0026)
First-stage F-statistic	48.66	55.29
	OLS	OLS
Polity	-0.0063** (0.0025)	-0.0045** (0.0019)
R ²	0.186	.1633
Obs	46	33

Robust standard errors in parentheses. All specifications are weighted by a country's average production between 1965-2007.

* - p-value less than 10 percent

** - p-value less than 5 percent

*** - p-value less than 1 percent

Table 4. Oil Production Volatility Regressions: Alternative Political Measures

	OLS	2SLS
Freedom House Political Rights	-0.0169** (0.0081)	-0.0150 (0.0091)
R ²	0.114	
First-stage F-statistic		63.06
Freedom House Civil Liberties	-0.0188** (0.0082)	-0.0154* (0.0092)
R ²	0.124	
First-stage F-statistic		68.14
Risk of Expropriation	-0.0349* (0.0175)	-0.0407** (0.0186)
R ²	0.175	
First-stage F-statistic		4.89
ICRG composite index	-0.0050** (0.0024)	-0.0046** (0.0022)
R ²	0.120	
First-stage F-statistic		19.81

N = 48 for OLS specifications (46 for last two measures). N = 46 for 2SLS specifications (44 for last two measures). Robust standard errors in parentheses. The specifications for the first two alternative measures are weighted by a country's average production between 1972 and 2007. The specifications for the last two alternative measures are weighted by a country's average production between 1982 and 1997. 2SLS results use 1900 Polity (Broad) as the instrument.

Table 5. Volatility and Political Conditions with Additional Covariates

<i>PANEL A</i>	Bench- mark	Financial Openness	OPEC	Act of National- ization	GDP per capita	WB Procedure Count
Polity	-0.0047** (0.0020)	-0.0040*** (0.0015)	-0.0048** (0.0019)	-0.0038* (0.0022)	-0.0041 (0.0028)	-0.0041* (0.0021)
Covariate		0.0308 (0.0187)	-0.0047 (0.0413)	0.0215 (0.0270)	-0.0010 (0.0022)	-0.0021 (0.0015)

<i>PANEL B</i>	Bench- mark	Financial Openness	OPEC	Act of National- ization	GDP per capita	WB Procedure Count
FH Political Rights	-0.0149** (0.0062)	-0.0125*** (0.0037)	-0.0109 (0.0069)	-0.0102 (0.0072)	-0.0157* (0.0082)	-0.0119** (0.0057)
Covariate		0.0370 (0.0225)	0.0512 (0.0448)	0.0337 (0.0318)	0.0004 (0.0022)	-0.0025 (0.0015)

<i>PANEL C</i>	Bench- mark	Financial Openness	OPEC	Act of National- ization	GDP per capita	WB Procedure Count
FH Civil Liberties	-0.0165** (0.0063)	-0.0144*** (0.0035)	-0.0120 (0.0075)	-0.0120 (0.0082)	-0.0191** (0.0092)	-0.0136** (0.0058)
Covariate		0.0383* (0.0222)	0.0465 (0.0473)	0.0292 (0.0356)	0.0010 (0.0023)	-0.0026* (0.0015)

<i>PANEL D</i>	Bench- mark	Financial Openness	OPEC	Act of National- ization	GDP per capita	WB Procedure Count
ICRG composite index	-0.0040* (0.0022)	-0.0022** (0.0011)	-0.0021 (0.0020)	-0.0015 (0.0040)	-0.0103* (0.0061)	-0.0039** (0.0016)
Covariate		0.0411 (0.0322)	0.1069* (0.0548)	0.0586 (0.0580)	0.0079 (0.0060)	-0.0046** (0.0021)

Land area is included in all specifications, but coefficient estimates are not shown. Standard errors are in parentheses. All regressions are cross-sectional OLS with one observation per country. Each column in each panel reports results from a separate regression. N = 48 for all cells in Panels A-C (except 47 for the Financial Openness specifications). N = 45 for Panel D (except 44 for the Financial Openness specification).

Table 6. Large Production Reductions by Category

Reduction Explanation	Share - Overall	Share- High Polity Countries	Share- Low Polity Countries
Natural Disaster	1%	47%	6%
Technical Failure	4%		
High Extraction Costs	3%		
Mature Fields	19%		
Nationalization	10%	53%	94%
Domestic Conflict	13%		
International Conflict (War, Embargo, Blockade, etc.)	10%		
Market Power	40%		
N	142	75	67

Source: Authors' analysis. See appendix on-line at http://works.bepress.com/gilbert_metcalf for details.

Table 7. Volatility in Oil Producing Wells and Polity

	OLS		2SLS	
Polity	-0.0116* (0.0064)	-0.0116* (0.0066)	-0.0204*** (0.0074)	-0.0206*** (0.0076)
Land Area		-0.0010 (0.0102)		-0.0018 (0.0075)
R ²	0.251	0.252		
First Stage F-Statistic			21.09	16.40
<p>Robust standard errors in parentheses. All specifications are weighted by a country's average wells between 1980 and 2006. Producing wells data from the Oil & Gas Journal Energy Database. Wells totals do not include shut in, injection, or service wells. There are 48 observations in the OLS regressions and 46 in the 2SLS regressions. 2SLS results use 1900 Polity (Broad) as the instrument.</p> <p>* - p-value less than 10 percent ** - p-value less than 5 percent *** - p-value less than 1 percent</p>				

Table 8. Oil Production as a Fraction of Reserves and Polity

	OLS		2SLS	
Polity	0.0035*** (0.0008)	0.0020** (0.0007)	0.0042*** (0.0008)	0.0030*** (0.0009)
Land Area		-0.0004 (0.0010)		-0.0003 (0.0009)
OPEC		-0.0424*** (0.0125)		-0.0378*** (0.0146)
R ²	0.457	0.622	0.463	0.653
First Stage F-Statistic			28.38	14.01
<p>Robust standard errors in parentheses. All specifications are weighted by a country's average production between 1980 and 2007. OLS regressions have 47 observations and the 2SLS 46. 2SLS results use 1900 Polity (Broad) as the instrument.</p> <p>* - p-value less than 10 percent ** - p-value less than 5 percent *** - p-value less than 1 percent</p>				

Table 9. Oil Price Volatility and Political Conditions

	Spot Price Volatility	Forward minus Spot Price	Spot Price Volatility	Forward minus Spot Price
Polity Index	0.1526 (0.0921)	9.147*** (2.505)	0.0027 (0.1456)	-11.33 (7.67)
Trend			0.0021 (0.0019)	0.2929** (0.1083)
R ²	0.129	0.153	0.155	0.653
Polity Production Share Index	-0.5395* (0.2728)	-45.65** (17.91)	-0.2347 (0.6391)	-14.77 (16.99)
Trend			0.0015 (0.0025)	0.1332 (0.0343)
R ²	0.056	0.405	0.161	0.600
Regressions are run using data from 1983 through 2007 (25 observations). Estimated using a Prais-Winsten transformation to adjust for the presence of serial correlation. * - p-value less than 10 percent ** - p-value less than 5 percent *** - p-value less than 1 percent				

Figure 1. Production Volatility and Polity

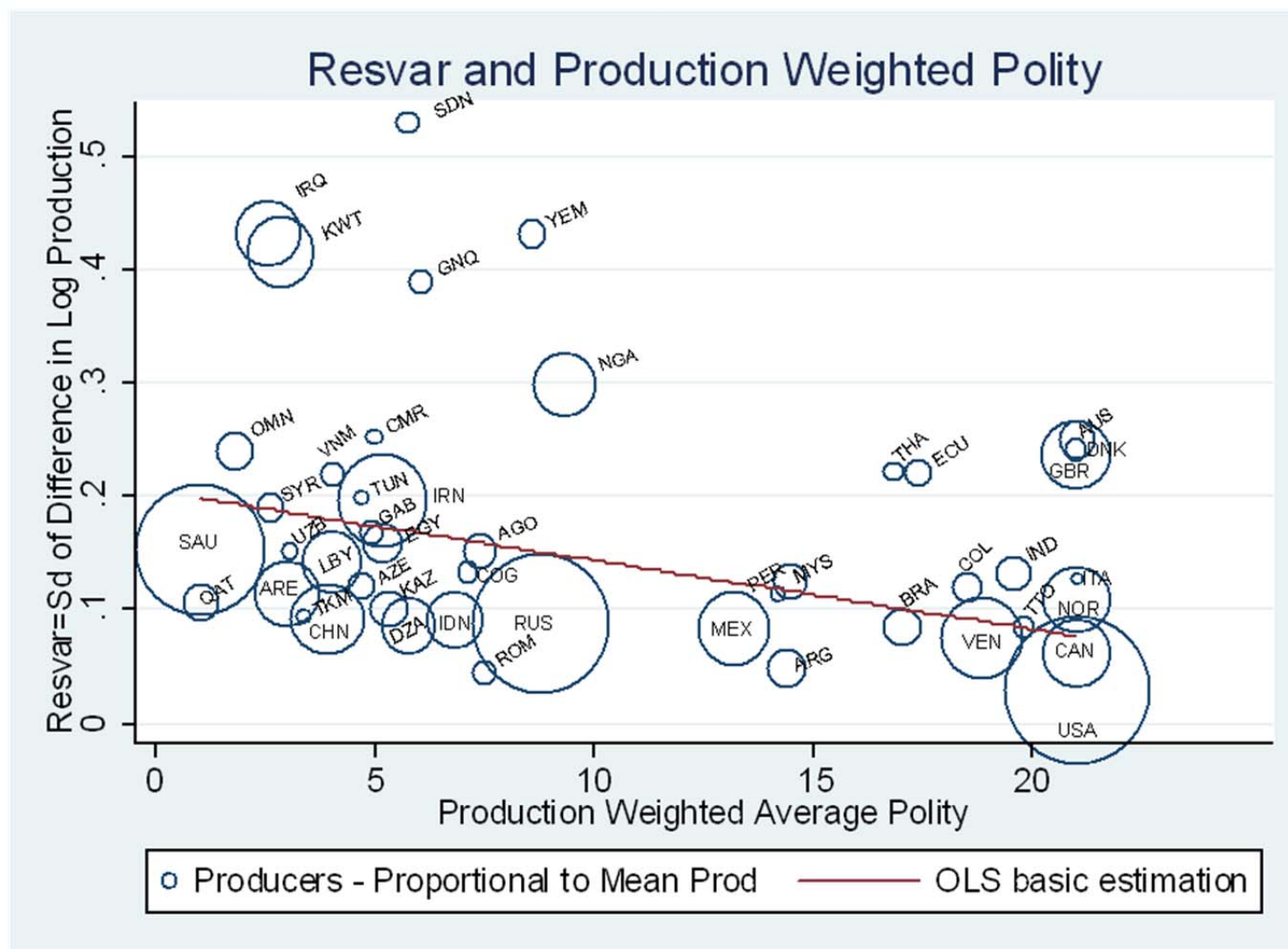


Figure 2. Political Conditions Indexes

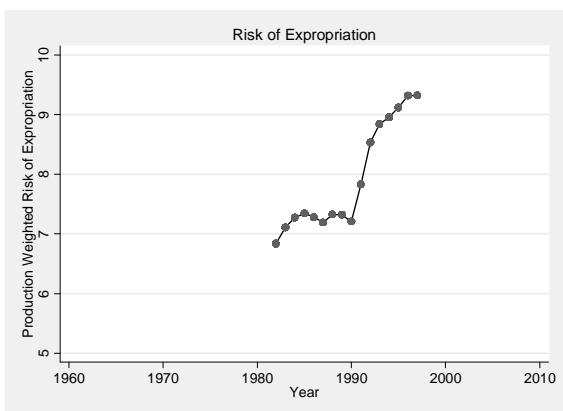
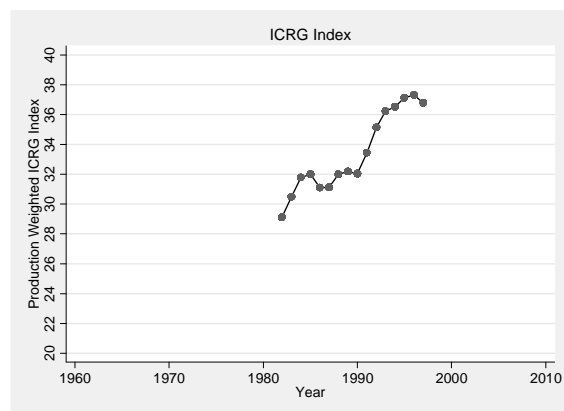
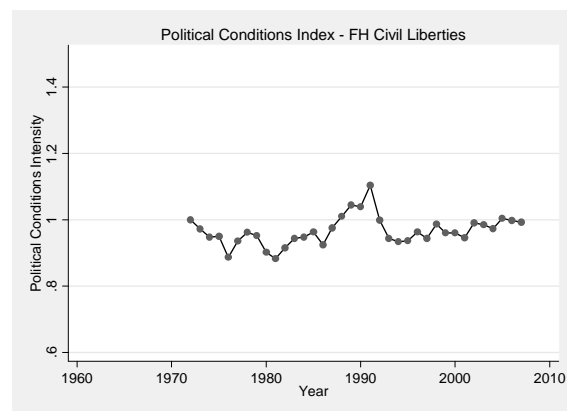
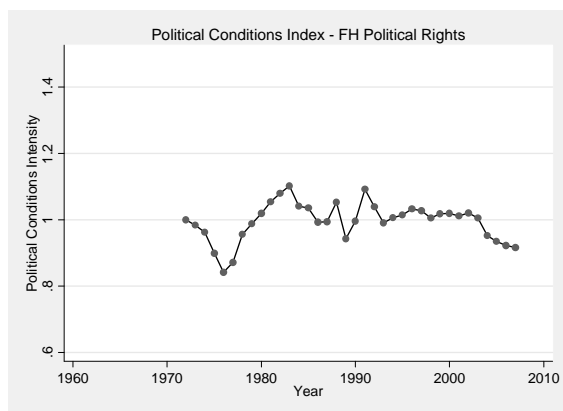
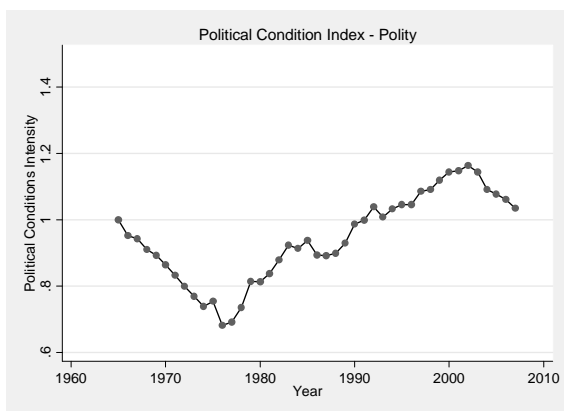


Figure 3. Political Conditions Index Decompositions

