More Oil, Less Democracy?: Theory and Evidence from Crude Oil Discoveries*

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Abstract

This paper exploits variation in the timing and size of oil discoveries to identify the impact of oil wealth on democracy. I use a unique dataset describing worldwide oil exploration, discoveries, and oilfield geology. Controlling for exploratory effort, I find that discovering oil significantly decreases a country's 30-year change in democracy, as measured by the Polity Index. I estimate that, on average, discovering 100 billion barrels pushes a country's democracy level 30 percentage points below trend. Excluding large Middle East producers from the sample does not affect this result. The estimated effect per barrel is larger for oilfields with higher quality oil and lower exploration and extraction costs. To explain these findings, I propose a theory of endogenous barriers to political entry. The deadweight cost of taxing oil is relatively low. To reap the profits from oil, incumbent dictators undertake costly expenditures to prevent entry and to monopolize the state.

JEL Classifications: H11, L12, L71, P26, Q34

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"You give me $18-a-barrel oil and I will give you political and economic reform from Algeria to Iran." Thomas Friedman.

This paper uses data on oil discovery and a theory of barriers to political entry to understand the effect of oil on democracy. Understanding the determinants of democracy is important. It affects resource allocation, income distribution, and international order when democratic and nondemocratic governments run the public sector differently (Mulligan, Gil, and Sala-i-Martin, 2004). Democracy promotion has been on the top of the U.S. foreign policy agenda since the end of the Cold War.[1] The current high energy price and the Iraq situation have made the question of the link between oil wealth and democracy more timely than ever.

It is widely thought that natural resource wealth is a curse.[2] Many earlier studies have documented a negative statistical association between the share of fuel exports in GDP and democracy (Barro, 1999; Ross, 2001). However, considerable disagreement exists over whether this relationship is causal (Alexeev and Conrad, 2005; Herb 2005). There is a problem of endogeneity because export depends on domestic consumption and both consumption and income may be correlated with democracy. When controlling for "initial" level of income in their regressions, these earlier studies create another endogeneity problem because the income is usually measured after oil discovery. Removing the oil component from the "initial" income level, the latter work argue that the oil curse disappears.[3] Fuel, however, is a noisy measure of natural resource.[4] As a flow variable, it also understates the oil wealth

[1]Carothers (2004) estimates that current democratization assistance from all sources, public and private, totals approximately $2 billion per year, not counting assistance to Iraq. However, hundred millions of dollars has been spent every year to subsidize its nondemocratic oil suppliers in military aid and training.

[2]The natural resource curse contends that wealth from natural resources hurt both political and economic development.

[3]Some other researchers turn also to omitted variables such as culture or religion (Huntington, 1998) and cite counterexamples like Norway and Venezuela (Smith and Kraus, 2005).

[4]Fuel includes mineral fuels, lubricants and related materials such as coal, petroleum, petroleum products,

of the swing producers who produce below their full capacity. Focusing on export also overlooks variation in exploration and extraction costs Classical measurement error alone leads to attenuation bias. An examination of the oil industry reveals that the bias is further exacerbated by the fact that large oil producers tend to have longer production life and lower exploration and lifting costs.

I address these problems from the literature by using a unique industrial dataset describing worldwide oil exploration, discoveries, extraction, and oilfield geology to provide new evidence on the effect of oil wealth on democracy. A theory of endogenous barriers to political entry argues that the relevant variable is the size of oil wealth. This I.O. approach suggests that it is oil wealth, instead of oil export dependence, provides incentive for dictators to monopolize the state. Because political leaders in democracies are more constrained to prevent political entry, the effect is expected to be weaker for democracies who discover oil. While oil exploration and extraction activities spread over time, a country's major discoveries are usually concentrated in a few years, known as peak discovery. Knowledge about the timing of oil discoveries is important because it helps to solve the endogeneity problem. Being a natural resource, the size, quality, and other cost-determining oilfields characteristics are arguably exogenous.[5] The amount of oil discovered, however, is potentially endogenous because oil exploration may be so (Bohn and Deacon, 2000).[6] Controlling for exploratory effort, however, the scenario of oil discovery provides a compelling setting for estimating the impact of oil wealth on democracy. There is another problem of measuring wealth from crude oil. A study of the oil industry shows that public data on oil reserves are unreliable because

natural gas, and electric current.

[5]The occurrence and distribution of oil depend on some unique combination of geological circumstances which happened hundred of million years ago. On the other hand, by the mid 1960s, when the world oil discovery peaked, most national borders had been drawn.

[6]According to my dataset, however, it is estimated that in all oil countries, except a very few number of minor producers, more than 90 percent of oil has been discovered.

reporting practice is notoriously bad for various reasons, and they tend to bias the estimate in different directions. Heterogeneity in oil quality and exploration and extraction costs are enormous. This unique industrial dataset makes adjustment to remove errors in reported oil reserves and includes other variables such oil quality and cost-determining geology.

Controlling for the number of exploratory wells being drilled, I compare the change in democracy, as measured by the Polity Index, for countries before and after the peak discovery year.[7] I test the hypothesis that oil discovery has differential effect on political transition for democracies and nondemocracies by including an interaction between oil endowment and pre-discovery democracy score. To reduce measurement error, I also control for oil quality and oilfield depth in my regressions. Moreover, I identify two case studies to investigate the effect of oil depletion for countries in Middle East and the former Soviet bloc.

My analysis shows that larger quantity of oil discovery is strongly linked to slower transition to democracy. For nondemocratic countries, I estimate that discovering 100 billion barrels of oil pushes their democracy score more than 10 percentage points below trend three decades after the discovery. However, oil discovery has almost no effect for democratic countries. Adding controls for the number of wildcats, oil quality, and oilfield depth, the effect becomes almost three times bigger, suggesting the importance of the measurement problem. Moreover, the oil effect is larger the higher the oil quality and the lower the exploration and extraction costs. This negative impact of oil wealth on democracy is across the board rather than falls disproportionately on large oil producers from the Arab world. Finally, the case studies show that countries that deplete their oil resource sooner are less resistant to political liberalization compared with their oil-rich neighbors.

[7] I focus on disocvery, which is a quantity shock, instead of a price shock because the variable of interest is oil wealth. Oil resource is an durable asset which can last for more than 100 years. It is true that oil price fluctuates over time, but the impact on oil wealth in the long run should be small. For an analysis using the oil price shock, see Al-Ubaydli (2005).

2. Measurement Problems of Oil and the Data Sources

Profit encourages entry, and hence there is a tendency towards lower concentration as market size increases.[8] However, the strategy entry theory robustly shows that this fragmentation property breaks down when sunk cost is endogenous (Shaked and Sutton, 1987). Barriers to entry play a significant role in the political sector. Oil is attractive to dictators. It is a massive wealth generator because its supply is limited by geological constraint and differences in quality and cost across oilfields imply huge differential rent. The associated deadweight cost of expropriation is relatively low because unlike other forms of capital, the long run supply of oil is much more inelastic. This I.O. approach suggests that it is the easily appropriated profit from oil, rather than the importance of oil in the economy, which provides higher incentive for dictators to monopolize the state.[9] A careful examination of the determinants of oil wealth is therefore essential.

2.1. Brief Overview of the Oil Industry

The modern oil industry was born in 1846 with the drilling of the world's first oil well at Bibi-Aybat near Baku.[10] The early 1960s marked a watershed of the world oil industry: oil has the first time become the most important fossil fuel in the world.[11] Oil has always been a massive generator of wealth for individuals, companies and nations. It is estimated that Rockefeller's personal fortune would be worth $190 billion in today's dollar. King Fahd, the former ruler of Saudi Arabia, is said to have at least $20 billion of wealth. In 2002, the value of oil produced amounted to almost 700 billion dollars, which is a double of the value

[8] In a political market, one might therefore expect that a country tends to be more democratic when national income rises. This result can be interpreted as the Lipset hypothesis.

[9] I formalize this idea in the appendix.

[10] Baku was at that time part of the Russian Empire. About a decade later, Edwin L. Drake struck oil in Pennsylvania.

[11] OPEC was created in 1960, and global oil discovery also peaked in the early 60s. It then followed by a wave of nationalization of oil industry in the 70s. Today, we are consuming 30 billion barrels of oil a year, which constitutes 40% of traded energy and 90% of transport fuel. Other than as a source of energy, millions of products are also made from oil, including plastics, life-saving medications, clothing, and cosmetics.

of natural gas and five times of coal.[12]

Oil is derived from aquatic plant and animal remains that proliferated in some unique geological and climate settings millions of years ago. The geological structure determines not only quantity but also quality of oil. The world produces and trades more than 160 varieties of crude oil, which range widely in quality and hence value. The highest price of crude can exceed that of the lowest by some 40 percent.[13] Two main properties of crude are gravity and sulfur content. Lighter crudes produce a larger number of lighter products which have higher value. A high sulfur content has an adverse effect on the value of crudes, because it leads to higher operating costs for refineries and in many countries new legislation mandates low sulfur content for gasoline.

Oil exploration is a risky business. Prospects are identified[14] and then tested by an exploratory borehole, known as a wildcat. It is rare for the first wildcat in a new area to succeed. Shallow offshore wells or deep onshore wells can cost more than $10 millions dollars each to drill. Even with the most advanced technology, the success rate of finding commercial oil is still less than half.[15] Therefore, after controlling for the number of wildcats, it is reasonable to think about variation in oil discovery as exogenous. Because of the heterogeneity in geological feature, some oil reservoirs are more easy to be found than others. For example, larger and shallower fields were discovered first. Giant fields are in general less costly to locate, because they are too large to miss. Since wildcat drilling is expensive, there

[12]Production of iron ore, the most important non-fuel mineral, is worth only 4% of that of oil.

[13]Algerian oilfields are famous for producing high quality light crude oil with low sulfur content, whereas Canada and Venezuela have many heavy oil reservoirs which are less valuable.

[14]Through the early 1900s, oil exploration was largely a matter of luck. Many of the world's prolific provinces were found with tools no more advanced than hammer, hand lens and notebook. Nowadays, to identify a prospective site for oil production, geologists use a variety of techniques such as core sampling and seismic testing.

[15]The odd was even smaller for the most part of the oil history. According to the U.S. Energy Information Administration, 46% of the exploratory wells found commercial quantities of oil or natural gas in the U.S. in 2003, and the figure was only 22% in 1973.

is a huge variation in the costs of finding oil across countries.

Oil at great depth or under deep water costs more to drill and operate the well than shallow, dry-land oil deposits. Extracting cost per barrel is lower for larger fields because of fixed investment. In the U.S., for example, the direct operating cost for primary oil recovery for a 12000-foot well is 3 times more expensive than that of a 2000-foot one. The Middle East is a region where the reservoir rock holds the oil in substantial pools which makes the cost of extraction low relative to other region. It is estimated that the cost of producing oil can range from as little as $2 per barrel in the Middle East to more than $15 per barrel in some fields in the United States, including capital recovery.

Production decision is determined by technological constraint as well as profit maximizing incentive. Production from swing producers, such as Saudi Arabia, are artificially constrained.[16] In terms of the reserves-production ratio, many OPEC countries can maintain production at the current rate for more than 50 years, while most of the rest of the world cannot last beyond 15 years. Given that approximately half of what is left to produce lies in these swing countries of the Middle East, and that the OPEC has more than two-third of the known global oil reserves, measuring oil wealth based on production or export is biased.

Being a stock variable, oil reserves provides a better measure of oil wealth. The full size of any known oil field can be estimated with reasonably accuracy early in its life. However, public reserves data are unreliable due to ambiguous definitions and bad reporting practices.[17] First, like many other self-reported data, a majority of countries report identical

[16] According to Kalicki and Goldwyn (2005), OPEC's capacity utilization was only about 50% in 1985-87. The capacity utilization grew after that. However, part of it is due to their cutting back on upstream investments.

[17] Today the oil industry in the principal producing countries is controlled by the state and hence is not subject to external audit. According to the EIA, among the 35 largest oil prodcuers in 2000, 56.2% of the oil and natural gas production came from government-owned companies. See Laherrere (2001) for a detailed discussion on the quality of the public data.

figures for years.[18] Another problem is the definition of oil. Geologists usually refer conventional oil to the easy, cheap stuff that has supplied most oil to-date.[19] However, there is no consensus across countries on the cut off between conventional and non-conventional oil.[20] Definition of reserves is also problematic. While most other countries report proven plus probable reserves, the United States reports only proven reserves because of financial and regulatory reasons.[21] On the other hand, the former Soviet Union was known to report proven and probable plus possible reserves. The measurement problem is exacerbated by that for some countries, reporting data on oil reserves is a political act. The spurious nature of the reserves reported by the major OPEC countries has long been recognized. The early numbers were too low, having been inherited from the foreign companies before they were expropriated. With no significant discovery during the eighties, these countries experienced huge increase in their reported reserves following the implementation of the production quota system, where the quota is set based on country reserves.[22]

2.2. Data Sources and Descriptive Statistics

I collect the following dataset to mitigate the above-mentioned identification and measurement problems.

Oil Discovery Data. The oil discovery data are obtained from Dr. Campbell at the

[18]This is highly suspicious as it implies every barrel that is produced is matched exactly by upward reserve revision or new discovery.

[19]It excludes heavy oil, extra-heavy oil, bitumen, deepwater oil, polar oil, oil from coal and shales, and gas liquids from gas fields.

[20]For instance, discrepancy can arise because of differential treatment of natural gas liquids and condensate. Another example is that in terms of heavy oil, Canada has a cutoff at 25API and Venezuela uses 22API, whereas other countries have still lower cutoff. And early in 2003, Canada has become the second-largest oil reserves in the world all of a sudden according to the Oil and Gas Journal, the most widely used oil data source, because the journal had included Alberta's vast tar sands, which is estimated to have more than 170 billions of oil, as part of the reserves.

[21]Since initially reported proven reserves of most large old fields understated what the field would ultimately yield by about one-third, because such fields were subject to successive phases of development, each of which added reserves, this gives rise to the illusion of reserves growth in the United States but not the rest of the world.

[22]This problem of suspect political reserves also occurred earlier on when Mexico understated its reserves in calculating compensation following the nationalization of the assets of foreign oil companies.

Association for the Study of Peak Oil (ASPO), an non-profit organization which is devoted to gather the industrial data to study the date and impact of the peak and decline of world oil. A major advantage of this dataset over the public data is that adjustments are made to remove any identified non-conventional oil and the total production for any period of implausible unchanged reserves. These adjustments are substantial. For example, oil reserves are revised downward by 97 percent and upward by 233 percent for Canada and Kazakhstan respectively.

The dataset contains the size and year of oil discovery for the top 65 oil countries. For each country a variable TOTAL DISCOVERED is coded as the total oil discovery up-to-date. ULTIMATE is the sum of total discovered and estimated discovery in the future. The variable PEAK DISCOVERY DATE gives the year when oil discovery peaked.

The ASPO dataset covers most oil countries. For the rest of the world, oil endowment is either insignificant or nil. Total discovery for these countries are imputed from adding cumulative production to reserves from the public data. Peak discovery date is imputed using the regional peak year. Since these countries have less incentive to misreport and the figures are either zero or very small, measurement error is bounded to be negligible.

Oil Quality Data. Data on oil quality come from the World Oil and Gas Review, published by an international energy company ENI. The Review publishes oil production by quality and country since 1994. There are ten categories of oil, ranged from the highest quality ultra light to the lowest heavy and sour. I index the quality from one to ten and compute an average oil quality for each country.

Oilfields Geology as Proxies for Costs..Data on costs are confidential and unreliable when available.[23] I therefore turn to some cost-determining oilfields characteristics as indirect

[23]The only reliable cost is development cost and it displays significant heterogeneity: cheap development is

measures of cost. The ASPO dataset has a variable GIANT which measures the fraction of oil found in giant oilfield, defined as one with more than 500 million barrels of ultimate recovery. Because giant fields are more easy to find, larger fields have lower average cost in general.[24] The dataset also includes one direct measure of finding cost: WILDCAT, the number of wildcats being drilled.

Costs are also said to be higher for offshore than onshore fields. The Oil and Gas Journal (O&GJ) conducts a survey called Worldwide Oil Field Production Survey. This survey includes data on FIELD TYPE, a variable which tells whether a field is onshore or offshore. Baker Hughes, a leader in oilfield services, provides a dataset on international rig count by field type since 1982. I use the average of the two measures in my regression to reduce any measurement error.

Another important oilfield characteristic is depth. The O&GJ dataset contains a DEPTH variable which measures the depth of oilfield. The American Association of Petroleum Geologists (AAPG) also publishes a dataset Giant Oil and Gas Fields: 1868-2004, which contains a similar variable. This dataset documents only giant fields, but it also reports the size of each giant field so that I can compute a weighted measure. Again, I take the average of the two measures for my regression analysis.

Democracy Index and Other Variables. The dependent variable DEMOCRACY is taken from the Polity IV dataset. It contains coded annual information on regime and authority characteristics for all independent states (with greater than 500,000 total population) in the world and covers the years 1800-2003. I focus on their "polity" index as a measure of democracy, and I normalize it to a 0-1 scale, where 1 being the most democratic. Other controls

about 1 000 $/b/d; North sea development about 5 000 $/b/d, deepwater about 10 000 $/b/d. See Laherrere (2003). Simmons (1999) discusses how the published cost data are misleading due to the usual accounting practice.

[24] Average cost of oil from giant fields can also be lower because of the presence of other fixed cost.

include income, population, the fraction of Muslim population, ethnic fractionalization, a dummy for whether a country has a British legal origin, and a dummy variable for whether a country is communist. Income and population data are taken from Maddison's Monitoring the World Economy: 1820-1992, because it contains historical data which are needed for my analysis.[25] Data on Muslim are obtained from the World Christian Database. Ethnic fractionalization data are taken from Alesina et al. (2003). Legal origin data are from Easterly's Global Development Network Growth Database. Whether a country is Communist or not is based on the 26 Communist countries listed by Kornai (1992). Finally, because some countries had found oil before they became independent, I impute zero to these missing democracy scores, i.e. I assume these countries were the least democratic. This is not an unreasonable assumption because they were either colonies or protectorates. A dummy will be included to control for this.[26]

Descriptive Statistics. Figure 1 shows the oil discovery time series. The global discovery peaked in the early 1960s, as shown in Panel A. Total oil discovered and peak discovery year at the country level are summarized in Panel B. There are substantial variation in size as well as timing of oil discovery across countries.

Figure 2 presents the time series of the average democracy score for four groups of countries: (i) nondemocratic government which discovered oil, (ii) nondemocratic government which did not discover oil, (iii) democratic government which discovered oil, and (iv) democratic government which did not discover oil. For nondemocracies, the time series of democracy score for oil and nonoil countries have been diverging since the early sixties, when

[25]Some countries discovered oil before the sixties. However, the Maddison dataset does not provide a full panel of income and population for all countries. Some countires have data only in the year 1950 and 1990, in which case I impute the values in other years assuming constant growth. Income data for Bahrain, Iraq, Kuwait, and Qatar are imputed using the regional average, because oil was discovered way before 1950.

[26]Results for alternative specifications will be shown in the sensitivity analysis.

global oil discovery peaked.[27] For democracies, however, oil essentially has no effect. Using the most recent data, I plot the raw relationship between oil reserves and democracy for the four most oil-rich regions in Figure 3.[28] There is a strong and clear negative relationship between oil reserves and democracy in Middle East and Africa. The negative relationship is somewhat weaker statistically in Eurasia, due to the outlier Russia, where the status of democracy is the most controversial.[29] These three regions account for more than 80 percent of the global oil reserves. The regression line is essentially flat in the case of Latin America. However, it is well-known that democracy in Venezuela, the most oil-rich country in the region, is problematic.[30] Moreover, Venezuelan oil is less valuable because of lower quality.[31]

[27]The so-called third wave of democratization first began in in Portugual in 1974, then Greece and Spain, another two Southern Europe countries, followed suit. In the late seventies, the wave moved on the Latin America: first Ecuador, then Peru, Argentina, Bolivia, Uruguay, Brazil, Honduras, El Salvador, and Guatemala, and later also Mexico, Chile, Panama, Nicaragua and Haiti in the late eighties. In Asia, the movement swept through India, Turkey, Philippines, South Korea, Taiwan, Pakistan in the eighties. In the nineties, the collapse of the Soviet bloc led to some more or less democratic states include Albania, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Lavtia, Lithuania, Macedonia, Moldova, Poland, Romania, Serbia and Montenegro, Slovakia, Slovenia, and Ukraine. Among all these forty something countries, only Mexico is a major oil producer.

[28]Oil reserves are measured in 2004: Middle East (394 Gb), Eurasia (146Gb), Latin America (71Gb), and Africa (65Gb). The remaining regions, not shown in the figure, are North America (30Gb), Far East (23Gb), and Europe (22Gb).

[29]Human rights record is poor in Russia. There are credible reports, according to the Bureau of Democracy, Human Rights, and Labor, that law enforcement personnel engaged in torture, violence, and other brutal or humiliating treatment, often with impunity. And the government pressure continues to weaken freedom of expression and the independence and freedom of the media. Huge discrepancy exists between the Polity project and the Freedom House in terms of the rating of democracy. Democracy score is 0.85 according to the polity data set, the political rights rating, according to the freedom house is much lower, only 0.33. The negative relationship emerges more significantly in both economic and statistical senses when Russia is excluded.

[30]The human rights record of Venezuela is not much better than that of Russia. According to the Bureau of Democracy, Human Rights, and Labor, serious problems remain regarding politicization of the judiciary and restrictions on electronic media. It is reported that the government conducts illegal wiretapping of private citizens and intimidated political opponents. President Chavez, officials in his administration, and members of his political party consistently attacked the independent media, the political opposition, labor unions, the courts, the Church, and human rights groups. The political rights and civil liberties scores according to the Freedom House are both below the figure from the Polity data. The rating of political rights and civil liberties in 2003 are 0.67 and 0.5 respectively, both in a 0-1 scale.

[31]The remaining three regions, namely North America, Fast East, and Europe, are not reported here. These regions account for only less than 10% of the global reserves. In Far East, the relation is also negative, and it becomes more clear when Australia and India, both had been democratic before oil discovery, are excluded from the sample. The negative relationship fails to hold in North America and Europe. However, all important oil countries in these regions, such as the United States and Norway, had had long experience of democracy before oil discovery.

Descriptive statistics are summarized in Table 1. Countries are classified into three groups, according to their abundance of oil. Democracy is measured as the average of one decade before peak discovery year and three decades after. Change in democracy decreases across the column as oil endowment rises. A simple difference-and-difference calculation suggests that an oil-rich country will be 13 percentage points less democratic than one with no oil.

Heterogeneity in oil is remarkable in all dimensions. While on average, oilfields from large and small oil producers are similar in the fraction of offshore and depth, within-group variations are big. Countries with more oil tend to find oil slightly earlier and to have more giant fields. For wildcat, although on average a larger number of wildcats is needed to find more oil, the difference is not statistically significant due to large variation within-group. For example, 168 wildcats were drilled in Saudi Arabia, while it took 414,979 for the United States to locate a similar amount of oil. Quality is slightly lower for large oil producers, because oil from Mexico and Venezuela are in general more heavy.

There is no systematical difference in observable characteristics of country except in per capital income and population.[32] The differences become less significant after controlling for the number of wildcats. Oil countries tend to be richer and larger, even before oil discovery.[33] The most oil-rich states also have a higher fraction of Muslims. As we shall see, population has no systematic effect on political transition. While income has a positive impact on democratization, any potential omitted variable, such as human capital, which is positively correlated with income will bias my estimates toward zero. Finally, in the sensitivity analysis,

[32]The coefficient on the dummy variable Independent Before Discovery is also significant. However, this is more due to the classifcation of oil and nonoil countries. If I regress this variable on oil discovered, the t-statistic is 1.48.

[33]However, if regressing per capita income on oil discovered, the coefficient is not statistically different from zero.

I will check if my result is robust when dropping all Muslim countries from my sample.

3. Empirical Evidence from Oil Discovery: Before-After Comparison

3.1. Timing of Oil Discovery

Before presenting the regression results, I plot in Figure 4 the trends of democracy when countries are lined up according to their year of peak discovery.[34] Figure 4 looks similar to Figure 2. It indicates that a nondemocratic country which found oil is about 10 percentage points less democratic than one who did not three decades after the year of peak discovery. The raw relationship between the amount of oil discovered and political transition before and after the peak discovery for nondemocratic countries is shown in Figure 5. The slope of the regression line from the simple plot is -0.001, suggesting a discovery of 100 billion barrels of oil will make a country 10 percentage points less democratic than one with no oil.

I consider the following simple before-after empirical strategy:

$$\triangle DEMOC_i = \beta_1 OIL_i + \beta_2 DEMOC_{i,before} + \beta_3 OIL_i * DEMOC_{i,before} + X_i\Theta + \lambda_t + \varepsilon_i, \tag{1}$$

where i and t index countries and time respectively. The variable oil is the total amount of oil discovered. For the democracy score, I compute decade averages for each country from one decade before discovery to three decades after. The idea of conditional convergence in democracy is formulated by controlling for the initial democracy score. The oil-democracy interaction term is used to test the hypothesis that oil discovery has differential effect for democratic and nondemocratic countries. X is a vector of country-level controls that include per capita income and population before oil discovery,[35] the fraction of Muslim population,

[34] For each country, I compute the average democracy score for each decade from two decades before the peak discovery to four decades after that.

[35] Income and population are measured a decade before the peak discovery year.

ethnic fractionalization, a dummy for British legal origin, a dummy for Communist, and a dummy for whether a country is independent before oil discovery. λ_t represents decade fixed effect, which tries to capture any time effect such as fluctuation of oil price over time and waves of democratization. Other oil quality and cost characteristics will be considered in the next section.

Several remarks are in order. First, I use total oil discovered to reduce measurement error because reliable year-by-year oil reserves data are not available for various reasons I have discussed. Moreover, the total oil found is arguably more exogenous than annual oil reserves since the latter also depends on production which is likely to be endogenous. Second, for each country, I aggregate the total amount of oil founded over time to one number as if it was all discovered in the peak discovery year. Strictly speaking, this assumption only holds for a few countries. However, this is a very good approximation for most oil producers, especially major ones.[36] Finally, I average democracy scores by decade because I am interested in the long term effect of oil on political transition, instead of year by year change which may depend on other factors such as natural death of dictators.

Regression results are reported in Table 2. I consider two political transitions: from a decade before discovery to two and three decades after. For each transition, three different specifications are reported. The top row of the table presents the coefficients on the oil variable. In all specifications, the oil coefficient is negative, suggesting that more oil discovered is associated with less democratization. Moreover, the oil-democracy interaction term is always positive and statistically significant, implying that the negative impact of oil discovery

[36]Because larger oil fields are more easy to locate, they are more likely to be found first, even technology has been improving over time. A typical oil discovery profile is therefore highly skew to the right. To measure oil wealth, it seems more reasonable to attribute the total oil discovery to the peak discovery year, instead of the first oil discovery year or the first year of commercial production for example, because in some cases only a very small amount of oil was found in the first oil discovery year and then it took many years before substantial amount was located, and there is in general in a time lag between oil discovery and production.

is bigger the less democratic the country was before it found oil.[37] The magnitude implied by the coefficients is moderate, and is broadly consistent with those suggested by Figure 4 and 5. Also, the oil effect becomes more significant over time. For instance, discovering100 billion barrels of oil (countries like Iran or Iraq), which is worth 280 billion dollars of oil revenue[38] at an average price of $28 per barrel[39] and 10 percent royalty rate, pushes the democracy score about 15 percentage points[40] below the trend for nonoil countries three decades after the discovery.

Other coefficients also seem to be plausibly estimated. A negative coefficient between -1 and 0 for the initial democracy score implies democracy converges gradually over time. A positive coefficient on income is consistent with the Lipset hypothesis. Muslim country is about 20 percent less democratic than non-Muslim one. Communist countries are also less democratic. Ethnic fractionalization seems to hurt democracy, but the effect is only marginally significant. Population, legal origin, and whether a country was independent before oil discovery do not have systematic effect on political development.

3.2. Heterogeneities in Oil Quality and Exploration and Extraction Costs

The preceding has treated crude oil as a homogeneous commodity. I explore in this section to what extent heterogeneity in quality and cost of oil matter. This exercise serves two purposes. First, it improves the measurement of oil wealth. Second, it provides a more direct test of the hypothesis that oil wealth impedes democracy.

The basic specification here is identical to the one in the previous section, except that I

[37]Indeed, since in all cases the magnitude of the coefficient of the interaction term is larger than the oil coefficient, oil discovery may encourage further political liberalization for semi-democratic countries.

[38]I assume interest rate is zero for simplicity, or that oil price is increasing over time at the rate of interest. Indeed, the Hotelling Valuation Principle says that the value of any exhaustible resource equals its current price, net of extraction cost, times the total reserves. See Miller and Upton (1985).

[39]This price is a weighted average over 1930-2003, at 2003 US dollars.

[40]This is similar to the difference between Bahrain and Saudi Arabia.

now also include other oil characteristics as controls. Because these quality and cost data are not reported for some small oil producers, I have to restrict my sample to a smaller subset. All regressions are run under the full set of other controls. For simplicity, I present only the result for change in democracy three decades after peak oil discovery.

The first set regression results is reported in Table 3A, where oil discovery is decomposed into those from giant fields and non-giant fields, and also onshore versus offshore. Giant fields are in general easier to locate and hence tend to have lower average cost.[41] The negative impact of oil from giant fields on democracy is bigger. Indeed, controlling for giant oilfield, effect of oil from nongiant field becomes insignificant. Nonetheless, offshore oil has a bigger anti-democratic effect than onshore oil, even though the former is in general more costly. This is perhaps because it is Saudi Arabia and the United Arab Emirates which have the biggest endowment of oil offshore,[42] even though North Sea and the Gulf of Mexico are more well-known.

Table 3B shows the estimates with various quality and cost of oil as controls. The top row of the table presents the effect of oil from an average oilfield, as the oil characteristics are measured as deviation from their means. Adding controls for oil quality and cost increases the oil coefficient, suggesting the presence of attenuation bias otherwise. On average, discovering 100 billion barrels now pushes a country's democracy level more than 30 percentage points[43] below trend. The coefficients on the oil-democracy interaction term are positive in most cases, though they are not statistically significant in this smaller sample. Moreover, the magnitude of the estimates are getting smaller as more controls are included. This suggests part of the reason why democratic oil countries remain democratic is because their oil

[41] Average is also lower to the extent that there is other fixed cost such as oil platform set up.
[42] Safaniya, the world largest offshore oil field, is located in Saudi Arabia.
[43] This is similar to the difference between Jordan and Saudi Arabia.

resources are in general less profitable.

The coefficients on the oil quality variable are negative, whereas the coefficients on the oil cost proxy variables, namely depth and wildcat, are all positive. These imply the anti-democratic effect of oil is larger the higher the oil quality or the lower the exploration and extraction cost. For example, the anti-democratic effect of oil becomes more than 50 percentage points[44] if an oilfield depth is one standard deviation below the average and the quality of oil is light rather than medium. The magnitude of the impact of wildcat, which provides a measure of exploration cost, is also consistent with the oil wealth story. A reduction in the number of wildcats by ten thousand (a difference between USSR and Saudi Arabia) to find a given amount of oil will make a country more than 15 percentage points less democratic. Because it costs about 10 million dollars per wildcat drilling, it implies a 15 percentage points lower in democracy from a saving of 100 billion dollars in exploration cost. This is roughly consistent with the effect of increase in quantity of oil.[45]

A range of sensitivity checks are performed. The oil coefficients for the baseline specification, with and without controls for oil characteristics, are reproduced on the top row of Table 4. All regressions are run with the full set of other controls, and the dependent variables are change in democracy from a decade before to three decades after oil discovery. The sensitivity of the results to the countries with the largest oil endowment is examined first. Removing any of the largest oil producers such as the USSR,[46] Saudi Arabia, or the US does not seem to affect the magnitude of the estimates systematically, especially after

[44]This is similar to the difference between Turkey and Algeria.

[45]Note that other than some minor oil producers, the United States is also not included here because oil quality data are missing. When the United States is included in the specifications (2) and (3), the magnitude of the coefficient on wildcat reduces to about 0.001, because the United States is an extreme outlier in the number of wildcats. However, it is still highly statistically significant and the magnitude of the oil coefficient also remains approximately unchanged.

[46]The case of the Soviet Union is special not only becasue its largest oil endowment, but also of its collapse in the early 90s.

controlling for quality and cost of oil. Excluding the entire Middle East region reduces the coefficient by almost half in the first specification. However, the effect is more robust when adding oil characteristics as controls. Eliminating Muslim countries also does not affect the result much, and indeed increases the coefficient in the second specification.

Instead of imputing the missing democracy score for the post-colony countries as being the least democratic, I reestimate the model with an alternative imputation scheme. Using the earliest observed democracy score, the estimates become smaller. Eliminating these post-colony countries, the effect lies between the baseline and the alternative specifications. Because the magnitude is more closer to the former, baseline specification may be a better fit. Another check is to use the regional peak discovery year so that changes in democracy are observed at the same time for countries in the same geographical region. The oil effects become smaller, but still statistically significant.

Most other natural resources are uncorrelated with the abundance of oil. Gas is an exception because the geological conditions of the formation of oil and gas are very similar. A positive correlation between oil and gas will tend to bias the oil coefficient upward. Using a crude measure of gas discovery as control does reduce the impact of oil.[47] The change is, however, small. This is consistent with the fact that value of gas is only about half of that of oil. Because oil wealth is highly geographical concentrated, including region dummies also reduces the coefficients, especially in the smaller sample with oil quality and cost proxies as controls. However, if I impute the missing quality data using the sample average, the coefficient increases back to -0.310.

Finally, I try to address the potential problem of endogeneity of wildcat and the size of

[47]Gas fields data are taken from the AAPG data set. This measure is kind of crude because the data include only giant gas fields for a smaller set of counties. I also impute zero to those countries who have no gas reserves and production from the public data.

oil discovered.[48] Among other things, exploratory effort depends on the actual size of oil endowment and perhaps the area of the country, which are arguably exogenous. Using them as instrument almost does not change the estimates, suggesting endogeneity may not be a problem.[49]

4. Case Studies of Oil Depletion

Decline in production lowers oil profit exponentially because of decreasing revenue as well as increasing cost.[50] Therefore, we expect oil depleting countries are less resistant to have political reform than their oil-rich neighbors.

4.1. Middle East Non-Swing Producers

The case of Bahrain versus Qatar provides a useful matched pair sample. The two countries are very similar, except for their oil history.[51] Bahrain is the first Arab Gulf state to discover oil; the Awali field, a giant field and also the only oilfield in Bahrain, was discovered in 1932.[52] Bahrain's proven oil reserves are however limited in comparison with that of its neighbors, and it is expected to be the first Persian Gulf nation to run dry of oil.[53]

[48]Bohn and Deacon (2001) argue that nondemocracy slows resource use because of ownership risk.

[49]One reason may be because for almost all of the OPEC countries, reserves were discovered and developed by international oil companies, instead of the national oil companies that came to dominate the upstream after the 1970s.

[50]Early in its production life, oil is produced by "natural lift" so that the pressure underground is high enough to force the oil to the surface. After that, the pressure differential is insufficient for the oil to flow naturally and mechanical pumps must be used to bring the oil to the surface. Secondary recovery, or waterflooding as it is commonly known, involves the injection of water into a neighboring well to force out more oil than can be extracted by straight primary pumping. Finally, producers may need to turn to "tertiary" or "enhanced" oil recovery methods, which involve injection of substances such as steam, gases or chemicals into reservoirs to flush out oil that cannot be extracted by either primary or secondary techniques. Enhanced recovery is expensive and hence production cost rises as any oilfield ages.

[51]Both countries are located on the southern side of the Persian Gulf; the island of Bahrain lying to the west of the Qatar peninsula, and each has a number of islands situated close to its coast. Like the rest of the Gulf Emirates, both are Muslim countries. Also, both countries were British protectorates and became independent in 1971. Indeed, until 1868, the Qatar was as a dependency of Bahrain. The two countries are also bonded by ties of kinship: it is said that almost every family in Bahrain has relations in Qatar, and vice-versa. In addition, they have similar per capita income and population.

[52]The Awali field is one of the shallowest reservoirs among all known giant fields in the world, which makes oil in Bahrain easy to locate and produce. Oil exploration brought almost immediate wealth to the Bahrain's ruler.

[53]As early as 1965, Bapco estimated that one-half of the island's total oil had been depleted. Oil production peaked in 1970 and steadily declined thereafter.

Interest in oil prospects in Qatar was aroused by the discovery in Bahrain. The Dukhan field, Qatar 's largest producing oilfield, was discovered in 1939 but commercialization was deferred until after World War II. This oilfield alone is estimated to have 80 percent more oil than the total endowment in Bahrain. During the period 1960-1970, several offshore fields were found, and Qatar's oil output grew steadily.[54] Qatar joined OPEC in 1961 and also became a member of OAPEC.

Table 5A summarizes some key oil and democracy statistics of the two countries. Oman is also included. Countries are ranked according to the size of oil wealth, from the lowest at the top. Bahrain is much more poor in oil than Oman or Qatar; in terms of total oil discovered. Oman is an atypical Persian Gulf oil producers. Although it has similar amount of oil as with Qatar, Oman's oilfields are generally smaller, more widely scattered, less productive, and more costly per barrel than in other Persian Gulf countries.[55] The degree of democracy is negatively correlated with oil wealth.[56]

Some other evidences also support the entry barriers story. Before 1957, Oman was one of the most liberal countries in the region, with a 0.2 democracy score. It dropped to zero

[54]Moreover, the North Gas Field, the largest single non-associated gas reservoir in the world, was discovered in 1971.

[55]Oil was discovered in the late 1950s, decades after most of those of its neighbors. According to the EIA, the average well in Oman produces only around 400 barrels per day, about one-tenth the volume per well of those in neighboring countries. To compensate, Oman uses a variety of enhanced oil recovery (EOR) techniques. While these raise production levels, they increase the cost. Per barrel lifting costs rose from $4.79 in 2002 to $6.35 in 2003. While these figures are low by world standards, they remain substantially higher than in most other Persian Gulf oil fields.

[56]Unlike many of its oil-rich neighbors, Bahrain is a constitutional monarchy. Right after Shaikh Hamad bin Isa Al Khalifa became the ruler in 1999, he established a committee to create a blueprint transform Bahrain from a hereditary emirate to a constitutional monarchy within 2 years. Bahrain held parliamentary elections in 2002 for the first time in 30 years. It also became the first Gulf Cooperation Council (GCC) country to allow the participation of women in national elections, both at the polls and on the ballot, and the second GCC country to allow the establishment of independent labor unions. Indeed, Bahrain is known to be one of the most open society within the region; because it is expected to be the first Persian Gulf nation to deplete its oil reserves, steps have been taken to diversify the nonagricultural sector of the economy. Ship-repair, aluminum-smelting, and banking and financial-services industries have been established, as have oil refineries that largely process Saudi crude. Bahrain is also home to numerous multinational firms, and the government actively encourages foreign investment.

in 1957, which is broadly consistent with the timing of oil discovery. Transition in political leadership was also relatively more peaceful in Bahrain than in Qatar.[57] The barriers to entry theory predicts that nondemocratic countries tend to spend more on defense. According to a report from the United States Arms Control and Disarmament Agency, Qatar recorded the highest per capita military expenditures of any country in the world. Oman ranked fourth, whereas Bahrain listed in twenty-seventh, and had the lowest outlays among the gulf states.

4.2. Former Soviet Union Countries

The collapse of the Soviet bloc provides another interesting case. It led to fifteen new post-Soviet states[58] and another twelve post-communist countries.[59] At about the same time, these countries had to decide the form of their government. Among them, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Slovakia, and Slovenia are perhaps the most democratic nowadays. Except for Hungary, which has been producing an insignificant amount of oil, none of them have significant oil reserves for commercial production.

Oil and democracy statistics for the major former Soviet bloc oil producers are summarized in Table 5B.[60] Albania, Croatia, and Ukraine are relatively poor in oil; each with reserves below 1 billion barrels in 2004. Also, they all had passed their production peak before the late eighties and hence they are expected to be the first group of the post-communist countries to run out of oil. None of them have any giant field either. According to the World

[57]In 1972, the Deputy Ruler and Prime Minister of Qatar, Sheikh Khalifa bin Hamad, deposed his cousin, Emir Ahmad, and assumed power. Again, in 1995, the Deputy Ruler, Sheikh Hamad bin Khalifa, deposed his father Emir Khalifa in a bloodless coup. In contrast, Shaikh Isa bin Sulman Al Khalifa, assumed power in Bahrain in1961 on the death of his father, and the current ruler, Amir Hamad bin Isa Al Khalifa, took over the leadership when his father unexpectedly died of a heart attack.

[58]They are Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

[59]They are Albania, Bosnia, Bulgaria, Croatia, Czech Rep., Hungary, Macedonia, Poland, Romania, Serbia and Montenegro, Slovakia, and Slovenia.

[60]Russia is excluded from the table, because its degree of democracy is controversial. The recent tendency towards state domination in the oil industry is however suggestive.

Energy Council, most Albanian crudes are heavy and the sulfur content is generally high. Kazakhstan and Azerbaijan are by far more oil-rich: larger reserves, more giant fields, and later production peak. Turkmenistan and Uzbekistan fall in between the above two groups, but almost 40 perfect of Turkmenistan's oil comes from giant fields whereas Uzbekistan has none. Once again, more oil-wealthy countries tend to be less democratic. Moreover, oil-rich states are getting less democratic since they became independent, whereas oil poor states are becoming more democratic over time.[61]

5. Concluding Remark

I have argued that insights and tools from the I.O. literature can be applied to understand the government. Elsewhere we show that this approach can be used to analyze problems such as government spending, war, determination of national boundary, party polarization, interest group politics, and discrimination.[62] In this paper, the I.O. approach emphasizes the importance of a more careful measure of oil wealth. My dataset reveals a substantial heterogeneity in effort, timing, size, quality, and cost in oil exploration and extraction.

[61]Kazakhstan, an oil rich state, is still run by its former communist leader, Nursultan Nazarbayev, more than ten years after the Soviet collapse, with his three daughters one is married to the son of the President of neighboring Kyrgyzstan, another to the head of Kazakhstan's oil and gas monopoly, and the third controls state TV. Also, in Kazakhstan, the executive branch has overwhelming power that maintains a nominal existence of opposition capable of mounting only limited political challenges. Azerbaijan is known to be one of the most corrupt nations on earth. Power in the country recently passed from Aliyev-senior, in charge of the republic in Soviet times, to his son, Aliyev-younger. Profits from oil sales strengthen Aliyevs hold on power, and Azeri opposition is also kept in check, even as it tries to vocalize its discontent for the ruling elite. Similarly, Turkmenistan and Uzbekistan are both headed by the men who were in charge of these republics in Soviet times. On the other hand, after Sali Berisha became the first democratically elected President of Albania in 1992, he began a more deliberate program of democratic reform. Durng the late nineties, Albania's democratic structures were strengthened: additional political parties were formed, and media outlets were expanded, and non-governmental organizations and business associations were developed. In particular, in 1998, Albanians ratified a new constitution via popular referendum, guaranteeing the rule of law and the protection of fundamental human rights and religious freedom. In Croatia, following the death of President Tudjman in 1999, the new elected coalition government and President brought significant changes in terms of making progress in implementation of the Dayton Peace Accords, regional cooperation, refugee returns, national reconciliation, and democratization. For Ukraine, shortly after becoming independent, it named a parliamentary commission to prepare a new constitution, adopted a multi-party system, and adopted legislative guarantees of civil and political rights for national minorities. The fact that Ukraine successfully overcame the political crisis in 2004 is a proof that the country has been making progress in the improvement of electoral process, and independent media and judicial framework.

[62]See Mulligan and Tsui (2005) and Tsui (2005).

All these oil characteristics are important determinants of oil wealth and hence political development. Improving the measurement also alleviate the problem of attenuation bias. This is useful because after controlling for intensity of exploration, oil discovery provides a reasonably exogenous source of variation in wealth within countries over time and also across countries. Such an income shock can be used as an instrument in many applications in public finance and other macro problems. A limitation of my study is the measurement of democracy. The Polity dataset, though widely used, is sometimes criticized for being subjective or not a continuous measure of democracy. We have also seen conflicting measures from other sources in the case of Russia. It is therefore useful to explore other indirect but more accurate measures of barriers to entry such as political prison and military spending.

Although I focus on oil discovery, which is a quantity shock, the analysis can have implication on a permanent change in oil price. Consider Thomas Friedman's claim and suppose that oil price has always been $18 per barrel. Recall that at a price of $28 per barrel, 280 billion dollars of oil profit in a country with 100 billions barrel of oil pushes the country's democracy level 35 percentage points below the trend. A decline in price of $10 per barrel therefore implies a reduction of 100 billion dollars of oil profit and hence an increase in democracy level of about 13 percentage points. Using the same logic, a schedule between oil price and democracy is plotted in Figure 6. Roughly speaking, a permanent increase in oil price by a dollar implies one percentage point decrease in democracy.

My analysis, however, does not necessary imply that there is no hope for democracy in oil-rich countries. Rather, it suggests the importance of establishment of ownership of oil wealth. The experience of the United States, one of the top oil producers, may be insightful. The rule of capture in the United States implies that oil is a private property. Even without private ownership, the government of Norway manages to use its oil wealth to benefit the

whole economy with the help of establishing an oil fund so that the society can monitor the allocation of the oil money. These countries remain the most democratic ones in the world. Several policy implications are as follows. To promote democracy in oil-rich country, it is crucial to establish well-defined property rights over oil wealth to minimize rent-seeking activities in the political sector. Moreover, oil money should not be spent on erecting barriers to political entry. Rather, to the extent that democracy is a normal good, redistributing oil wealth away from political leaders to the society will not only increase the supply of but also stimulate the demand of democracy.

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Appendix: A Theory of Political Transition: An I.O. Approach

In this appendix, I develop a conceptual framework for understanding oil's effects on democracy. The following model extends Mulligan and Tsui (2005).

Political leaders choose barriers to entry policy b, and a political markup rate m to maximize expected political rent PmY, where $P = P(b, m; \alpha)$ denotes probability of staying in power, and $Y = Y(b, m; \alpha)$ denotes national income.[63] Examples of policies that affect barriers to entry are death penalty, military spending, civil liberties, and press freedom.[64] We can interpret the level of barriers to entry b as a measure of the degree of democracy: a society with lower level of b being more democratic.[65] Barriers to entry increase the probability of staying in power, while higher markup rate lower the chance because it hurts popularity (i.e. $P_b > 0$ and $P_m < 0$). Both repression and expropriation are costly and they reduce national output (i.e. $Y_b < 0$ and $Y_m < 0$). α is a parameter that affects income and political survival. In my case, oil discovery increases national income (i.e. $Y_a > 0$). It tends to lower the probability of political survival because the oil wealth serves as bait for potential entrants (i.e. $Y_\alpha \leq 0$). Oil discovery is not likely to affect the deadweight cost of repression or effectiveness of barriers to entry (i.e.$Y_{b\alpha} = 0$ and $Y_{b\alpha} = 0$). Different economies may have different deadweight cost. The supply of oil is rather inelastic, at least in the long run. Moreover, unlike human capital, ownership of oil wealth can be highly concentrated. Oil discovery is therefore likely to lower the deadweight cost of expropriation (i.e. $Y_{m\alpha} > 0$). However, the effect of expropriation on political survival is not affected by oil discovery (i.e. $P_{m\alpha} = 0$).[66]

A dictator chooses b and m to maximize expected political rent:

$$\max_{b,m} P(m, b; \alpha) m Y(m, b; \alpha). \tag{2}$$

The optimal level of barriers to entry satisfies the first-order condition:

$$Y P_b = -P Y_b. \tag{3}$$

The marginal benefit of barriers to entry on the left hand side is proportional to national income; whereas the marginal cost of barriers to entry on the left is proportional to the probability of staying in power. Holding m constant for the moment, we get the following

[63] In Mulligan and Tsui (2005), leaders also choose economic and social policy x. However, they argue that x is likely to be separable with b and m and hence their choices are independent. Moreover, they endogenize the probability function by assuming the hazard of sucessful entry depends on the relative popular support of the incumbent and entrant, which is a functon of all policies chosen.

[64] Mulligan, Gil, and Sala-i-Martin (2004) find that these variables are highly positively correlated with the degree of nondemocracy.

[65] In Mulligan and Tsui (2005), we consider b as an endogeous fixed cost chosen by the incumbent that any political entrant needs to incur upon entry. In that case, b can be interpreted as the cost of war or political conflict in general, where higher cost is associated with higher barriers to entry. Such cost is lower in democratic society because counting heads is cheaper than breaking heads.

[66] Note that the effect of an increase in national income due to more educated and hence productive labor force can be very different. The Lipset's development hypothesis suggests that demand for democracy will increase in this case and hence popular support will be lower under dictatorial rule. (i.e. $P_{b\alpha} < 0$). On the other hand, deadweight costs from repression and expropriation are likely to increase because supply of human capital is relavtively more elastic (i.e. $Y_{b\alpha} < 0$ and $Y_{m\alpha} < 0$).

comparative statics result by differentiating the first-order condition with respect to α:

$$\frac{\partial b}{\partial a} = -\frac{P_b Y_\alpha + Y_b P_\alpha}{YP_{bb} + P_b Y_b + PY_{bb} + Y_b P_b}, \tag{4}$$

which is positive because the denominator is negative from the second-order condition and the numerator is positive according to my assumptions on the effect of oil discovery. Therefore, oil discovery encourages the dictator to run a more repressive political regime. Intuitively, upon oil discovery, national income will rise and hence marginal benefit of barriers to entry will increase; the return is higher for being an oil-wealthy dictator. In contrast, marginal cost of barriers to entry becomes lower because oil wealth attracts entrants and hence lower the chance of political survival. These lead to a higher level of barriers to entry in the new equilibrium.

Similarly, the optimal markup satisfies

$$Y(P + mP_m) = -mPY_m. \tag{5}$$

Though oil discovery increases Y and decreases P, it is unlikely to decrease the left hand side of the above equation because P is bounded below from zero. On the other hand, the marginal cost of the markup on the right hand side will fall, because deadweight cost is lower in expropriating natural resource. Therefore, when the level of barriers to entry is held fixed, the markup is likely to be higher in oil-rich countries. Mathematically,

$$\frac{\partial m}{\partial \alpha} = -\frac{mPY_{m\alpha} + (P + mP_m)Y_\alpha + (Y + mY_m)P_\alpha}{YP_m + PY_m + YmP_{mm} + YP_m + mP_m Y_m + mPY_{mm} + mY_m P_m + PY_m} \tag{6}$$

where the denominator is negative from the second-order condition. Using the first-order conditions, the numerator can be written as $mPY_{m\alpha} - \frac{mPY_m}{Y}Y_\alpha - \frac{YmP_m}{P}P_\alpha$. The first term $mPY_{m\alpha}$ is positive because oil discovery lowers the deadweight cost of expropriation. The second term is also positive and is proportional to the oil wealth. The last term is negative. However, because P is bounded below from zero and Y is not bounded above, the first two terms are likely to dominate the last term.[67] An empirical manifestation is nationalizing the oil industry in many major oil-producing countries. When the markup rate is used as an indicator of the degree of nondemocracy, the theory again predicts that a dictator tends to run a less democratic regime after oil is discovered.

If b and m are separable in both the probability and the income functions, the above analysis is complete. Otherwise, the result will also depends on the interaction between the two variables. In general, the total effect is

$$\frac{db}{d\alpha} = (\frac{\Pi_{bb}\Pi_{mm} - \Pi_{bm}^2}{\Pi_{bb}\Pi_{mm}})^{-1}(\frac{\partial b}{\delta \alpha} - \frac{\Pi_{bm}}{\Pi_{bb}}\frac{\partial m}{\delta \alpha}) \tag{7}$$

where $\Pi = PmY$ denotes the expected political rent. The term $\frac{\Pi_{bb}\Pi_{mm} - \Pi_{bm}^2}{\Pi_{bb}\Pi_{mm}}$ is positive from the second-order condition. b and m are complements when Π_{bm} is positive. This is true when

$$YP_{bm} + PY_{bm} > -(P_b Y_m + Y_b P_m). \tag{8}$$

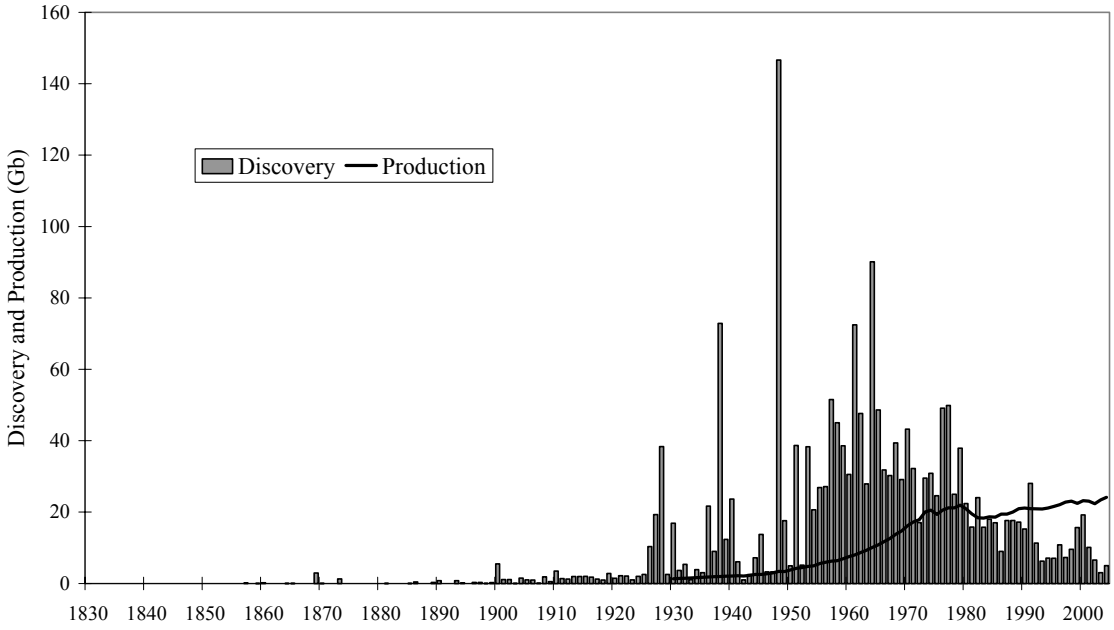
[67] An alternative sufficient condition is that $P_\alpha = 0$ so that the last term vanishes.

It is likely that the conclusion will remain true. First, the first-order effect described above is always at work. Moreover, as Mulligan and Tsui (2005) argue, barriers to entry and political markup are likely to be complements because they share many common determinants, and hence the individual effects tend to reinforce each other.

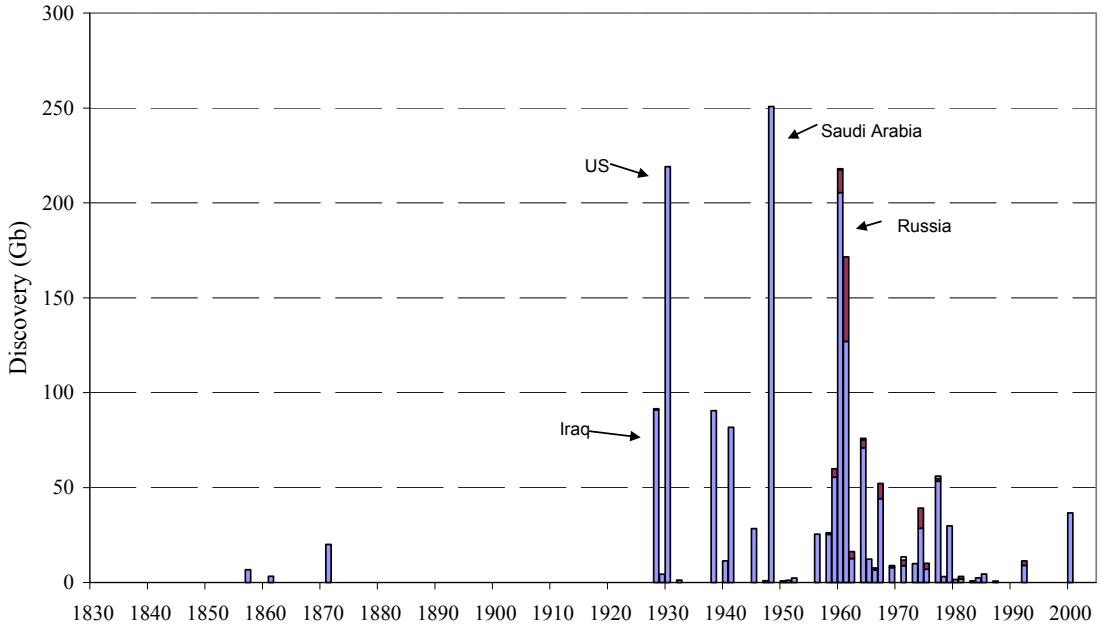
Democratic leaders also aim at maximizing political rent. However, they are generally more constrained in erecting barriers to entries. In addition, in a democratic society where the majority are well-educated, the demand for political freedom will be so high that any slight decrease in it will result in losing significant popular support which threatens political survival. Therefore, the model predicts a negative effect of oil wealth on democratization, but the effect in democratic countries is much weaker.

Figure 1: Oil Discovery Time Series

Panel A: Global Oil Discovery and Production

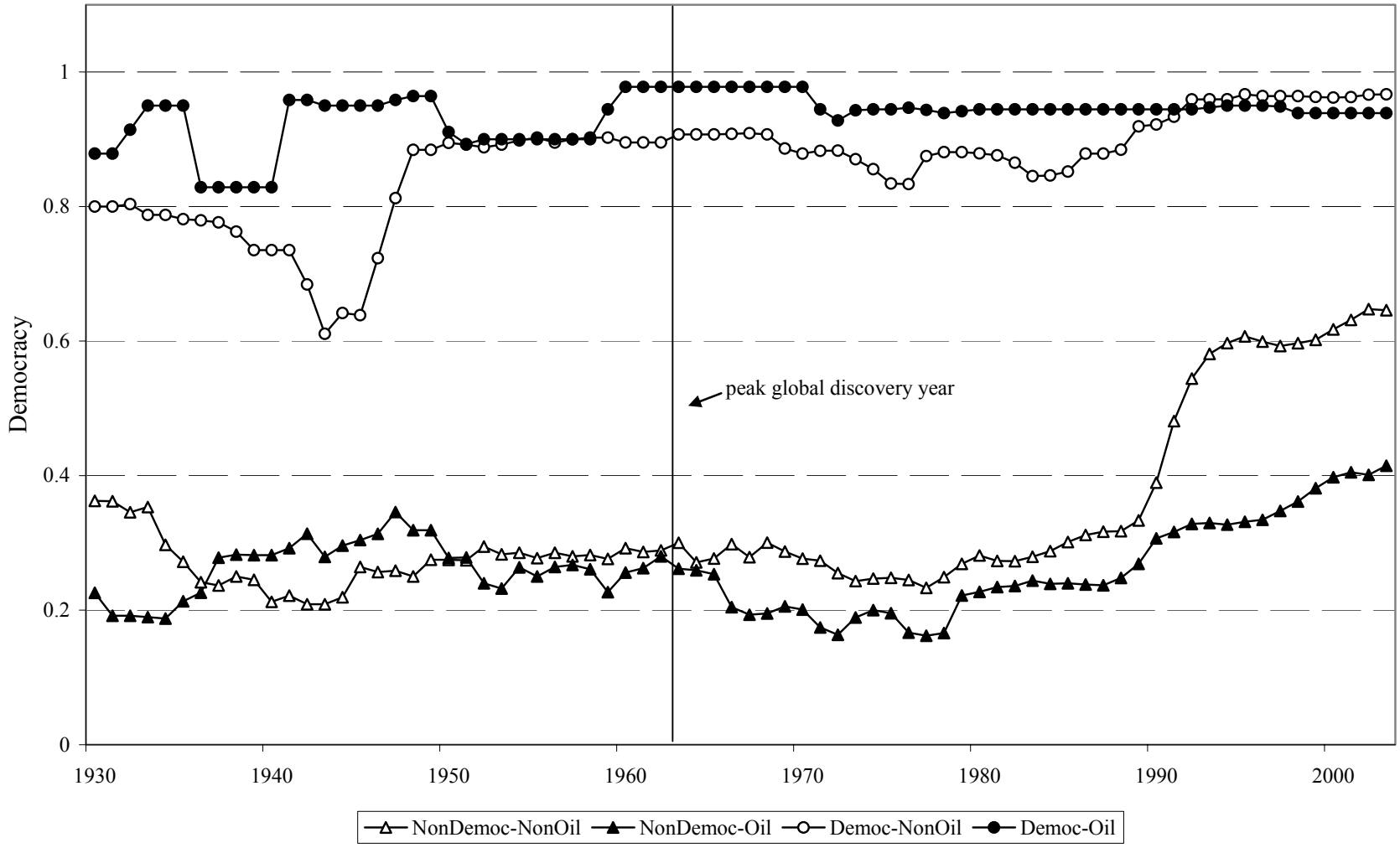


Panel B: Total Amount of Oil Discovered and Peak Discovery Year by Country



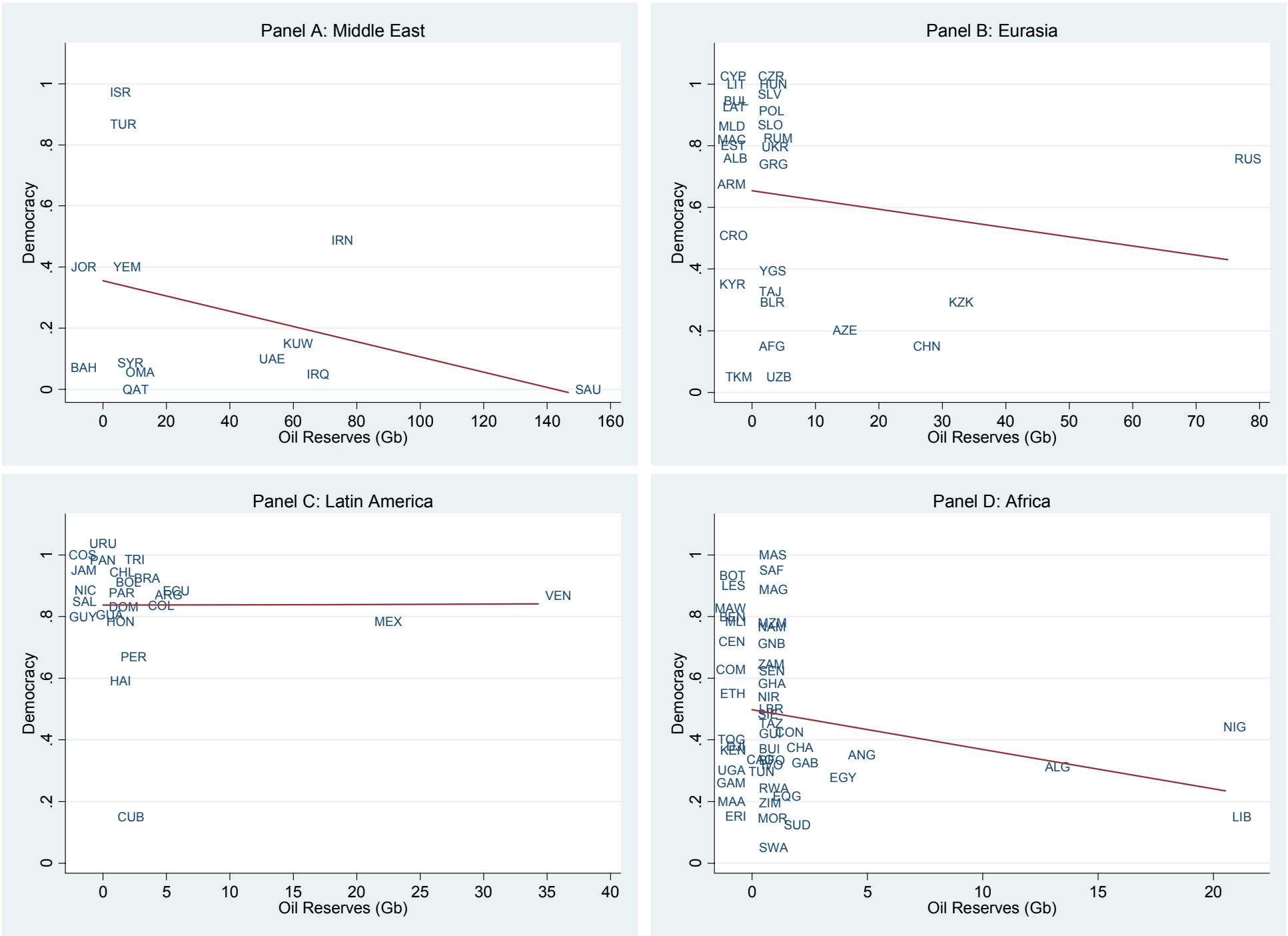
Source: Association for the Study of Peak Oil.

Figure 2: Democracy Time Series by Political Regime Type



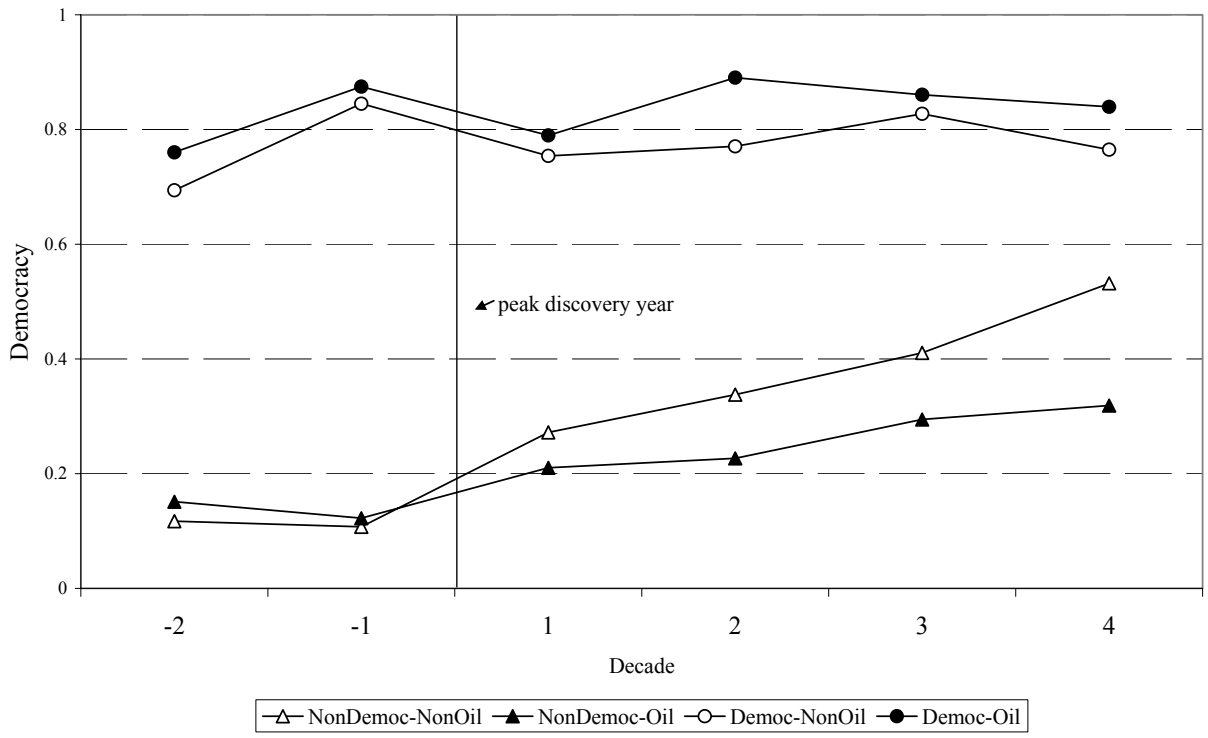
Note: A country is classified as democratic if its democracy score had been above 0.5 for a decade before its peak discovery year. An oil country is one who has a giant field.

Figure 3: Democracy and Oil Reserves by Region

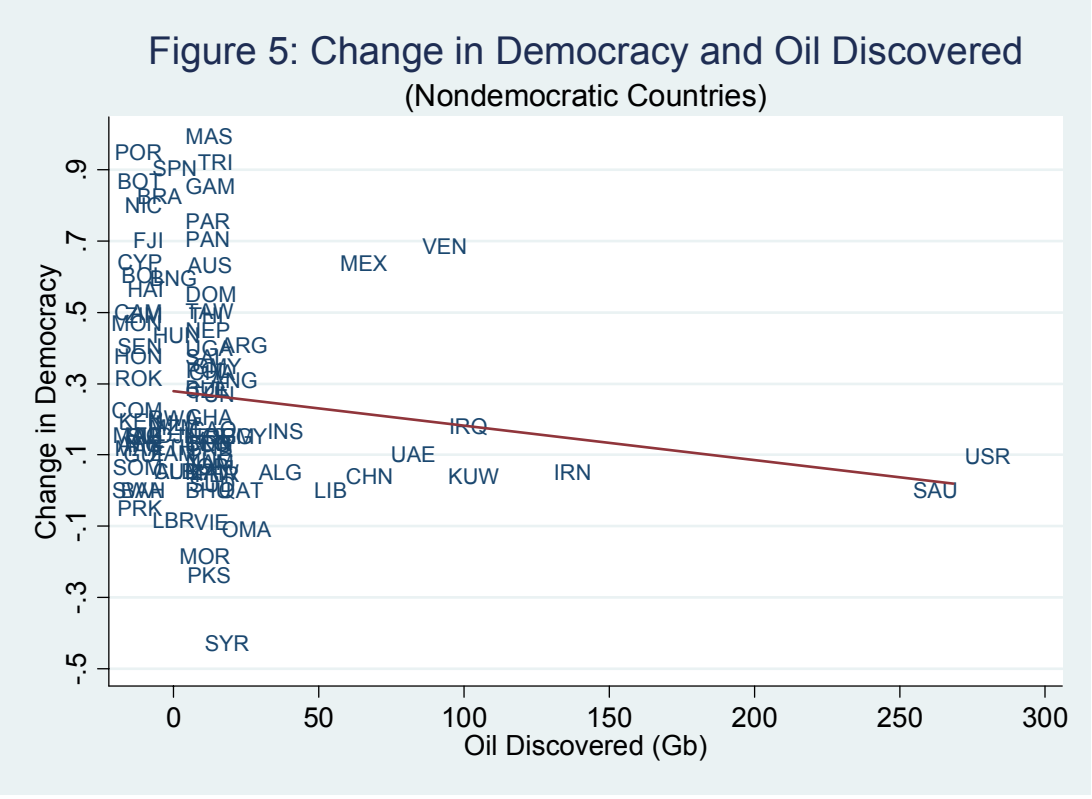


Note: Oil reserves is measured in 2004. Democracy score is averaged over 1994-2003 using the Polity IV index.

Figure 4: Democracy Time Series Before and After Peak Discovery Year

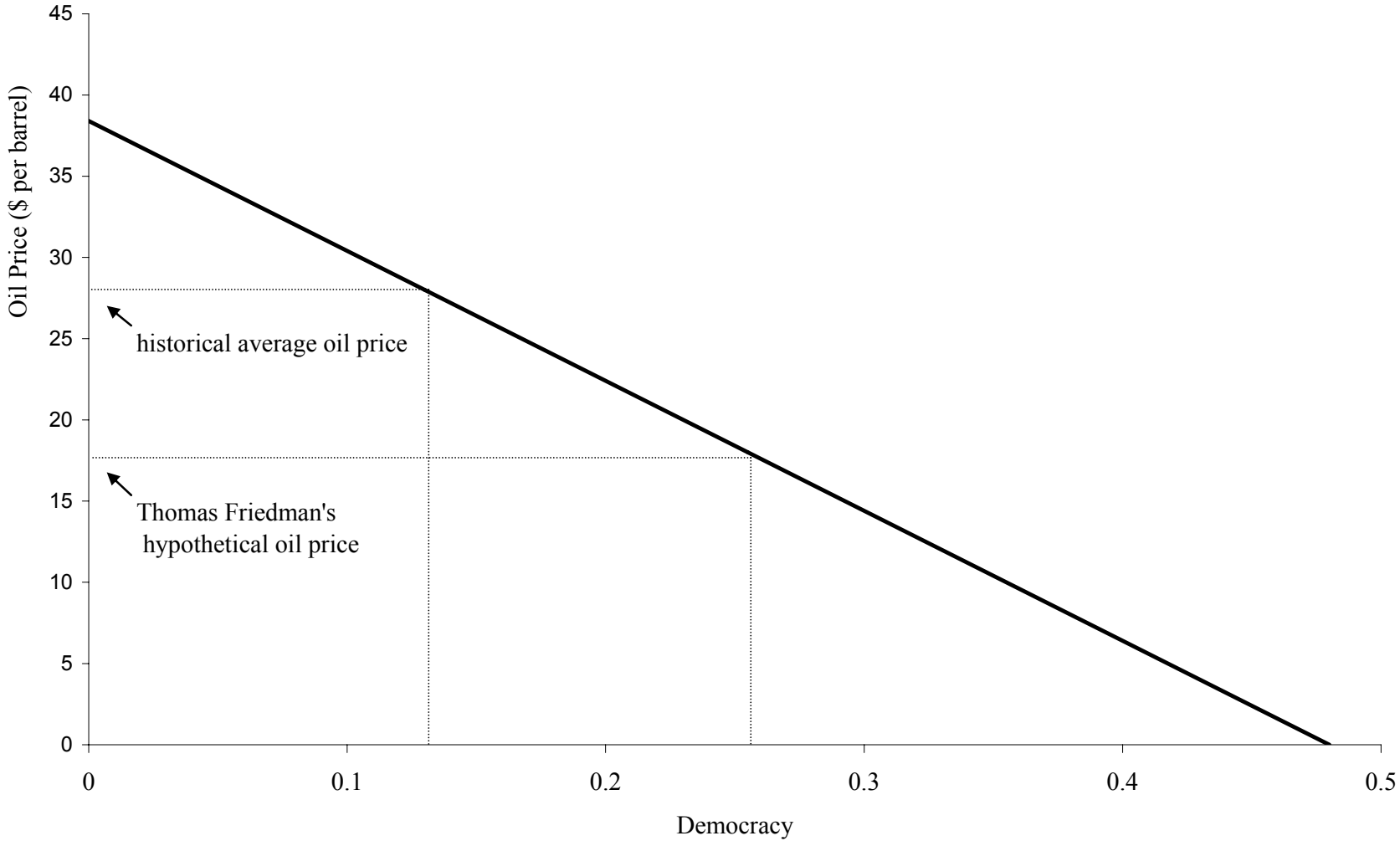


Note: The democracy score is averaged over each decade, using the Polity IV index. A country is classified as democratic if its democracy score had been above 0.5 for a decade before its peak discovery year. An oil country is one who has a giant field.



Note: Change in democracy is measured as the difference between the decade average Polity IV index one decade before and three decades after the peak discovery year. Nondemocratic countries are those with average democracy score below 0.5 a decade before the peak discovery year.

Figure 6: Oil Price and Democracy in a Country with 100 Billion Barrels of Oil



Note: The value of the x-interpret is obtained from the predicted democracy score of an average country with no oil.

Table 1: Summary Statistics

	Oil Discovery			F-statistic Controlling Wildcat	
	No	Small	Large		
	(1)	(2)	(3)	No	Yes
Democracy Variables					
Change in Democracy	0.26	0.16	0.13	2.43*	2.17
	(0.30)	(0.29)	(0.29)		
Democracy Before Discovery	0.22	0.39	0.35	3.19**	2.38*
	(0.33)	(0.36)	(0.39)		
Democracy After Discovery	0.48	0.55	0.48	0.55	0.20
	(0.37)	(0.36)	(0.39)		
Oil Variables					
Oil Discovered	-	0.54	45.11	15.86**	13.67**
(billion barrels)		(0.49)	(68.06)		
Peak Discovery Year	-	1966	1956	4.35**	1.44
		(12)	(27)		
Fraction Giant	-	0.04	0.37	35.68**	9.17**
		(0.18)	(0.27)		
Fraction Offshore	-	0.22	0.32	1.45	2.60
		(0.35)	(0.33)		
Quality	-	6.61	5.96	0.55	0.00
		(2.02)	(2.25)		
Depth	-	6,984	7,022	0.01	2.69
(ft.)		(1,993)	(1,536)		
Wildcat	-	56	1,347	1.25	-
		(55)	(6,891)		
Other Controls					
Income Before Discovery	1,703	2,740	3,403	4.83**	4.02**
	(2,260)	(2,655)	(3,115)		
Population Before Discovery	3.45	16.99	51.37	11.30**	6.02**
(million)	(4)	(20)	(118)		
Fraction Muslims	0.22	0.25	0.35	1.25	1.95
	(0.34)	(0.35)	(0.41)		
Ethnic Fractionalization	0.49	0.42	0.45	0.98	0.62
	(0.27)	(0.26)	(0.26)		
British Legal Origin	0.40	0.25	0.27	1.37	1.11
	(0.49)	(0.44)	(0.45)		
Independent Before Discovery	0.45	0.86	0.68	10.98**	12.32**
	(0.50)	(0.35)	(0.47)		
Communist	0.16	0.22	0.19	0.32	0.04
	(0.37)	(0.42)	(0.40)		
Sample Size	58	36	37	131	108

Note: Oil countries are classified into two groups: those with discovery above 1.62Gb, the median of oil discovered, is classified as "large".* 10% significant, ** 5% significant.

Table 2: Effects of Oil Discovery on the Change in Democracy

	Dependent Variable is Change in Democracy					
	Two Decades After Oil Discovery			Three Decades After Oil Discovery		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Oil Discovered	-0.074	-0.069	-0.140	-0.079	-0.087	-0.152
(per 100 Gb)	(0.031)**	(0.049)	(0.053)**	(0.035)**	(0.046)*	(0.043)**
Oil*Democracy	-	-	0.310	-	-	0.282
Before Discovery			(0.093)**			(0.088)**
Democracy Before	-0.284	-0.615	-0.657	-0.309	-0.783	-0.821
Discovery	(0.047)**	(0.091)**	(0.093)**	(0.045)**	(0.076)**	(0.078)**
ln(Income	-	0.1011	0.106	-	0.110	0.114
Before Discovery)		(0.034)**	(0.034)**		(0.032)**	(0.032)**
ln(Population	-	0.007	0.001	-	0.009	0.003
Before Discovery)		(0.014)	(0.015)		(0.015)	(0.016)
Fraction Muslims	-	-0.198	-0.174	-	-0.243	-0.221
		(0.068)**	(0.069)**		(0.077)**	(0.078)**
Ethnic	-	-0.090	-0.108	-	-0.144	-0.160
Fractionalization		(0.079)	(0.079)		(0.093)	(0.093)*
British Legal Origin	-	0.089	0.087	-	0.034	0.032
		(0.049)*	(0.048)*		(0.051)	(0.050)
Communist	-	-0.141	-0.136	-	-0.188	-0.183
		(0.062)**	(0.065)**		(0.063)**	(0.063)**
Independent	-	-0.103	-0.095	-	0.079	0.086
Before Discovery		(0.050)**	(0.050)*		(0.057)	(0.058)
R^2	0.141	0.460	0.480	0.152	0.484	0.499
Sample Size	131	131	131	131	131	131

Note: Democracy is measured by Polity IV index and is averaged over decade. Before Discovery means a decade before the peak discovery year. Specifications (2), (3), (5), and (6) include also fixed decade effect. * 10% significant, and ** 5% significant

Table 3A: Effects of Types of Oil Discovery on the Change in Democracy

	Dependent Variable is Change in Democracy			
Variable	(1)	(2)	(3)	(4)
NonGiant Oil (per 100Gb)	-0.025 (0.117)	0.116 (0.107)	-	-
Giant Oil (per 100Gb)	-	-0.201 (0.061)**	-	-
Onshore Oil (per 100Gb)	-	-	-0.067 (0.048)	0.001 (0.069)
Offshore Oil (per 100Gb)	-	-	-	-0.681 (0.186)**
R^2	0.475	0.494	0.479	0.503
Sample Size	131	131	129	129

Table 3B: Effects of Quality and Cost of Oil on the Change in Democracy

	Dependent Variable is Change in Democracy			
Variable	(1)	(2)	(3)	(4)
Oil Discovered (per 100Gb)	-0.109 (0.053)**	-0.106 (0.052)**	-0.349 (0.111)**	-0.348 (0.112)**
Oil*Democracy Before Discovery	0.244 (0.362)	-0.069 (0.347)	0.142 (0.266)	0.112 (0.272)
Wildcat (per 1000)	-	0.020 (0.008)**	0.016 (0.008)**	0.016 (0.008)**
Oil*Quality	-	-	-0.146 (0.058)**	-0.148 (0.057)**
Oil*Depth (per 1000ft.)	-	-	-	0.016 (0.027)
R^2	0.480	0.489	0.520	0.520
Sample Size	92	92	92	92

Note: All regressions are run under the full set of controls. Democracy is measured by Polity IV index and is averaged over decade. Change in Democracy is measured as the difference between three decades after peak discovery year and one decade before. Giant Oil means oil discovery from giant oilfield, defined as oilfield with reserves above 500 million barrels.

* 10% significant, ** 5% significant

Table 4: Sensitivity of Oil Coefficient to Alternative Specifications

Specification	Oil Coefficient with Oil Characteristics as Controls: No		Yes	
Baseline (N=131 and N=92)	-0.152	(0.043)**	-0.348	(0.112)**
Exclude USSR (N=130 and N=91)	-0.185	(0.061)**	-0.320	(0.130)**
Exculde Saudi Arabia (N=130 and N=91)	-0.131	(0.048)**	-0.383	(0.132)**
Exclude US (N=130 and N=92)	-0.138	(0.054)**	-0.348	(0.112)**
Exclude USSR, Saudi Arabia, and US (N=128, N=90)	-0.134	(0.124)	-0.327	(0.198)
Exclude Middle East (N=119 and N=83)	-0.070	(0.055)	-0.302	(0.124)**
Exclude muslims countries (N=114 and N=79)	-0.144	(0.060)**	-0.571	(0.159)**
Impute Democracy using the beginning value (N=131 and N=92)	-0.108	(0.033)**	-0.250	(0.123)**
Exclude countries that were not independent before discovery (N=82 and N=50)	-0.139	(0.047)**	-0.319	(0.122)**
Use regional discovery peak (N=134 and N=95)	-0.108	(0.033)**	-0.198	(0.079)**
Include control for gas (N=104 and 83)	-0.129	(0.063)**	-0.289	(0.135)**
Include region dummies (N=131 and N=92)	-0.106	(0.047)**	-0.167	(0.080)**
IV using ULTIMATE and AREA (N=131 and N=92)	-0.154	(0.043)**	-0.336	(0.109)**

Note: Change in Democracy is measured in the same way as in Table 3. All regressions are run under the full set of controls.Muslims countries are countries with fraction of Muslims population above 0.9. ULTIMATE is the estimated total amount of oil, including yet to find. AREA is the area of a country. * 10% significant, ** 5% significant

Table 5A: Oil Depletion in Bahrain vs. Other Gulf Emirates Non-Swing Producers

Country	Wildcat	Disc (Gb)	Giant (%)	Reserves 2004 (Gb)	Offshore (%)	Depth (Ft)	Quality	Disc Peak	Prod Peak	Democ 2003	Change in Democ since 1991
Bahrain	20	1.21	94.80	0.21	0	2513	4.0	1932	1970	0.15	0.15
Oman	642	12.57	35.84	5.01	0	5648	4.0	1962	2001	0.10	0.10
Qatar	93	11.37	59.13	4.06	67	5623	7.2	1940	2004	0.00	0.00

Table 5B: Oil Depletion in Albania, Crotia, and Ukraine vs. Other Post-Communist Producers

Country	Wildcat	Disc (Gb)	Giant (%)	Reserves 2004 (Gb)	Offshore (%)	Depth (Ft)	Quality	Disc Peak	Prod Peak	Democ 2003	Change in Democ since 1991
Albania	45	0.73	0.00	0.21	0	8367	--	1928	1983	0.85	0.3
Croatia	159	0.82	0.00	0.31	0	5032	--	1950	1988	0.85	0.5
Ukraine	157	3.71	0.00	0.99	0	6115	--	1962	1970	0.85	0.05
Uzbekistan	340	2.34	0.00	1.19	0	8142	6.9	1992	1998	0.05	0
Turkmenistan	422	4.19	37.27	1.09	0	9203	6.2	1964	1973	0.05	-0.05
Azerbaijan	149	20.00	59.11	11.67	0	5812	5.6	1871	2009	0.15	-0.2
Kazakhstan	402	36.66	46.60	30.00	0	8740	8.3	2000	2030	0.20	-0.15