INFLUENCE OF OIL FIELD DISCOVERIES ON SECTORAL ALLOCATION OF GOVERNMENT EXPENDITURE

by

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How do governments respond to an oil field discovery which can sometimes be worth as much as the nation's gross domestic product? This paper studies the potential effect of oil field discoveries on sectoral allocation of government expenditure ("expenditure share") both in the short run (i.e., before the production of oil from the discovered oil field) and in the long run (i.e., after the production of oil from the discovered oil field). I used econometrics methodologies of Difference-in-Differences to estimate the potential long-run effect as well as Event Study Design to examine the potential short-run effect on the expenditure share. Through examining, I found no evidence of the potential effects of oil field discoveries on government educational expenditure share, neither in the short-run nor in the long run. In terms of government military expenditure share, I did find evidence of such share increasing following an oil field discovery in the short run, yet I found no evidence of any potential effects in such share in the long run.

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Introduction

The Catalyst: Oil Field Discoveries Increases Default Risks

Esquivel (2021) found that oil field discoveries increase the default risk in the nation in which the oil fields were discovered. The logic follows this: Esquivel (2021) shows that higher income from investment in the oil fields improves borrowing terms, yet higher volatility and borrowing deteriorate such improved borrowing terms. With an impatient government, the latter effect dominates, and default risk increases. This finding inspired me to question the relationship between oil field discoveries and government behavior. How does a government respond to such a "lottery win" (oil field discoveries can sometimes be worth as much as the nation's GDP according to Arezki et. al. (2017)) in terms of allocating their budget? I decided to explore whether governments change their budget allocation given giant oil field discoveries, and if so, to what extent.

Overview of the Paper

The aim of this paper is to investigate how the discoveries of giant petroleum reservoirs such as oil and gas fields ("oil field discoveries") within a country influence the sectoral allocation of its government expenditure. Oil field discoveries can affect a nation's economy significantly in multiple ways, and those effects in the long run have been widely studied. For instance, Cavalcanti et. al. (2019) found that investment increases in the long run in Brazilian municipalities that produce oil compared to Brazilian municipalities that do not. However, it appears that the potential short-run

consequences of the news of discovery itself ("short-run effect") have not been studied much yet. In addition, the relationship between the sectoral allocation of government expenditure and oil field discoveries, either in the long run or the short run, has not been studied as much as, for example, national investment and oil field discoveries (Arezki et. al. (2017)). My paper contributes to the literature by providing insight on how governments allocate their resources vis-à-vis extravagant wealth that can sometimes be worth as much as or even the multiple of their annual GDP, according to Arezki et. al. (2017). Ultimately, this thesis is projected to shed light on how the government attempts to make the nation better off by allocating resources facing an exogenous, extravagant "lottery win," oil field discoveries.

This paper focuses on military and educational expenditure as a share of total government expenditure ("educational expenditure share" and "military expenditure share," respectively). This is because, in general, governments are reluctant in sharing their sectoral expenditure for national security reasons. However, a successful econometric analysis requires holistic panel data for each country for each year. These two sorts of share are chosen to be the interest of the paper because of the data available to the public online. The World Bank has rich panel data on the government expenditures on education by year for each country. Military expenditure, which may seem something that the government is the most hesitant in sharing, turns out to have rich data because Stockholm International Peace Research Institute has been estimating it for decades for each country.

In assessing the influence of oil field discoveries on sectoral government expenditure, I will be focusing on the changes in educational and military expenditure

share, expressed as percentages of the total government expenditure of a country as the nation discovers a giant oil field. According to Arezki et. al. (2017), it takes 4 to 6 years for a nation to start the production of oil since the discovery. Hence, I will be using a 5-year time frame to assess the potential net impact of what the discovery news shock ("short-run effect") has on educational and military expenditure share. To assess the potential short-run effect, I will be using the econometric methodology of Event Study Design (which will be discussed in detail in the methodology section below) to assess the discoveries that took place in different years among different nations. For the potential long-run effect, I will be using the econometric methodology of Difference-in-Difference regression, which will also be discussed in detail in the methodology section below. As the ultimate conclusion, I will assess the influence of the oil field discoveries in terms of the percent change in educational and military expenditure share.

Hence, my research question is: what are the potential short-run and the long-run effect of oil fields discoveries on educational and military expenditure share? My hypothesis is that military expenditure share is going to increase both in the short run and in the long run. This is to secure the resource from external forces as oil fields are often found off-shore and to establish domestic order as evidence shows that the intensive export of natural resources amplify the nation's risk of internal conflict (Bannon and Collier (2003)). For the educational expenditure share, I predict that it will decrease in the short run, as educational expenditure may be crowded out by other sectors of the government expenditure that are going to be increased, for example, the military expenditure share. However, I predict that the educational expenditure share will increase in the long run. This is because the nation expects an influx of income

from the production of oil and gas. This enables the government to allocate more of their budget to their investment in human capital, rather than that in physical capital like infrastructure.

Literature Review

Dutch Disease and the Resource Curse

As early as the 1980s, it came to many economists' attention that the Dutch economy was experiencing an intense recession due to the export of the oil discovered in the North Sea. The Dutch had soon realized that their oil plants in the North Sea did not help to stabilize their economy but rather worsened their economy. While contributing to a massive portion of their income, the oil export also caused their currency to appreciate which made their other export sectors less competitive. This paradoxical notion, that natural resources hurt the nation's economy rather than benefit it, is today well-known as the Dutch Disease or resource curse and has been widely studied by economists all around the globe. Note that the resource curse will not be observed all the time as there are a handful of nations that has managed their oil reserves as a key to economic success today, e.g., Norway, the United Arab Emirates, Bahrain, and Qatar. However, economists have shown that, collectively, natural resources hurt the economy rather than benefit it.

Firstly, I would like to briefly review the development of the theory in resource curse. The term resource curse was first advocated by Auty in his work Sustaining Development in Mineral Economies: The Resource Curse Thesis (1993), which illustrates the negative consequences of a nation having abundant natural resources. Auty (1993) studied six ore-exporting then-developing countries and found that the export of ore was responsible for draining out the competitiveness of agriculture and manufacturing sectors and therefore the economic development was severely damaged. The work is considered to be one of the foundations of the field of the natural resource

curse. However, the idea itself has already caught much attention during the 1980s when the Netherlands suffered from a severe recession. Many economists attributed the economy's heavy reliance on the massive export of oil found in the North Sea that made the economy vulnerable. Following this, Gylfason (2000) has discovered that there is no positive relationship between having been endowed with natural resources and an increase in the per capita GDP. This result strengthens the validity of the natural resource curse advocated by Auty (1993) and the other economists by showing that natural resources do not aid the nation's economic development in the long run, on average.

Consequences of Exporting Natural Resource

Next, I would like to review the literature on trade, more specifically, export within the field of the natural resource curse. In theory, by engaging in trade, countries always get bettered off with increased income. Exporting natural resources is no exception, at least in the short run. However, in reality, Hardin et. al. (2020) has recently shown that giant resource discoveries lead to a substantial appreciation of the real exchange rate. Appreciation of the real exchange rate of the country hurts the nation's other sectors in exports, resulting in the underdevelopment of those sectors, hence damaging the nation's economic development. Also, there is another work by Bannon and Collier (2003) explaining that developing countries face substantially higher risks of violent conflict, and poor governance if highly dependent on primary commodities. While there still exists a huge space for discussion regarding the extent of natural resources discoveries and/or their export affect an economy, it is mostly agreed

by the scholars that, although the consequences differ among cases, often (though not always) natural resources discoveries and/or their export negatively affects the country's economic development, for example, case of Netherlands.

National Investment Following Oil Field Discoveries

What has been studied about the relationship between natural resource export and the national investment behavior in the country? In addition, how does a country, collectively, allocate its scarce resource when it has discovered oil fields? Developed upon the comprehensive studies on the natural resource curse described in the previous subsections, there are studies on investment behavior of the country with oil field discoveries and the export of oil therefrom.

For the literature on how the investment of the country shifts followed by a discovery of a massive amount of natural resources, Arezki et. al. (2017) found that national investment rises robustly soon after the news arrives, while GDP does not increase until after 5 years. This means that the investment was done to the sector that does not immediately affect the GDP of the nation. With this result as the foundation, Esquivel (2021) showed that the discovery of oil has diverted national investment toward the infrastructure needed to obtain that oil, hence it distracts investment in other sectors. Because it takes a country 4 to 6 years to extract oil, Arezki et. al. (2017) makes sense that the GDP did not increase until after around 5 years. Esquivel (2021) has shown that the nation's manufacturing sector has a reduction in capital allocation since capital was reallocated for oil extraction. In summary, a country, as a collective body,

diverted their capital from non-oil-related sectors to sectors that have to do with oil extraction.

As described above, there have been many studies on how a country as a collective body responds and reallocates its capital. However, there are few studies done that takes a look at how the nation's government reallocates their capital. From the next sections forward, I will be exploring how the nation's government reallocates its budget in terms of the sectors, instead of the nation as a collective body.

Research Questions and Hypotheses

Research Questions

This thesis examines the potential impact of oil field discoveries on the educational and military expenditure share of the nation in which the discovery took place. What kind of potential effects are there in the short run (up to 5 years after the discovery, which is generally when the extraction starts)? How about in the long run, (after the production of oil starts)?

Hypothesis

As stated above, this paper explores the potential effects of oil field discoveries on the educational and military expenditure share in order to gain further insight on how the government responds to oil field discoveries in terms of the sectoral allocation of their expenditure. Such potential effects will be examined in the short-run as well as in the long run.

I hypothesize that educational expenditure share will decrease in the short run. I hypothesized as such because education has nothing to do with oil extraction, and hence more of the government's budget will be directed to other sorts of expenditures that have to do with oil extraction, and therefore cause the government to decrease educational expenditure share following an oil field discovery. However, I predict that educational expenditure share will increase in the long run, as there is an influx of income for the country which yields space for the government to invest more in human capital rather than in physical capital like infrastructure.

In addition, I hypothesize that military expenditure share will increase in the long run. I hypothesized as such because there is an urgent need for the government to protect its natural resources from neighboring countries as oil and gas fields can be found beneath the sea. Also, as Bannon and Collier (2003) has found, there is a higher risk of internal conflict following a natural resource discovery, and this factor could also contribute to the government increasing their military expenditure share. I also predict that military expenditure share will increase in the long run because I predict that the risks of external as well as internal violent conflict will not mitigate as time passes since there can be more internal conflict in who benefits from the resource or foreign interference triggered by the production of oil. Therefore, I predict that the short-run increase of military expenditure share would translate to a long-run increase as well.

Methodologies

Theoretical Framework

To assess the influence of oil field discoveries on the educational and military expenditure share of a nation, in the context of econometrics, I will be using the quasi-experimental design. In other words, I will consider the oil field discoveries as random, exogenous "treatments" done to certain countries, and compare their trends in educational and military expenditure share to those of the other countries that did not receive "treatments." The group of countries that did not discover oil fields (i.e., "control group") serves as a counterfactual of the countries that discovered oil fields, meaning, what the treated countries would have been had they never received treatment.

In addition, it is necessary to construct a model that identifies all the relevant variables of a nation that must be controlled to have the result capable of answering the research questions. With all of this being said, I determined two econometric methodologies, namely, Difference-in-Differences and the Events Study Design, are appropriate for my study, which I will use in this paper.

Econometric Model: Difference-in-Difference

Difference-in-Differences ("DID") resolves the classic issue in econometrics that we will never be able to observe the counterfactual (what happens had the treatment group received no treatment or conversely, what happens had the control group received treatment). DID compares the pre-treatment phase for both the treated and the controlled and confirms if the trend is similar between the two groups. If that is the

case, then the parallel trend assumption holds, and we can basically use the trend of the control group post-treatment phase as the counterfactual of the treatment group had they received no treatment. Then, we estimate the causal effect of the treatment by calculating the differences of each group before/after the treatment and calculating the difference of those differences, or, equivalently,

[(outcome of the treated post-treatment phase) – (outcome of the treated pre-treatment phase)] – [(outcome of the untreated post-treatment phase) – (outcome of the untreated pre-treatment phase)].

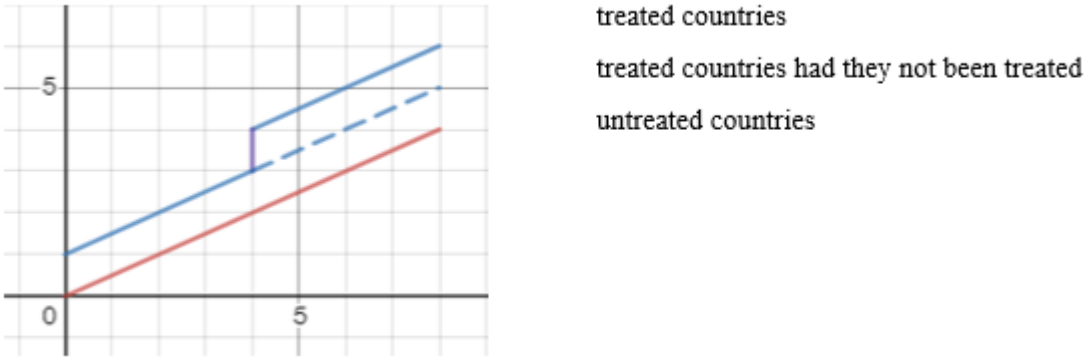

Figure 1: Difference-in-Differences Visualized

For this paper, I will be using the DID methodology to assess the potential long-run effect of oil field discoveries on educational and military expenditure share.

Econometric Model: Event-Study Design

In addition, I will be utilizing the econometric quasi-experimental method of Events Study Design ("ESD") which is constructed on top of the ideas of DID. ESD

works with panel data for multiple individuals (in this case, countries) that had the treatment in different time periods. More specifically, by "lining up" the time period when the individuals had received the treatment, I can basically apply the idea of DID methodology. Note that, similar to the case of DID, ESD requires an assumption that the control group's trend to be the counterfactual of the post-treatment individuals, i.e., the outcome of the treatment group had they not received the treatment. Thus, the identification assumption is that the trend of educational and military expenditure share between nations without oil field discoveries and nations with oil field discoveries before the treatment is the same. With this, I will be able to examine the causal effect of the treatment, controlling for both the time-specific individual-variant characteristics and the time-variant individual-specific characteristics. For this paper, I will be using ESD to assess the potential short-run effect of oil field discoveries on the sectoral allocation of government expenditure. More specifically, I will be quantifying the changes in educational and military expenditure share in a 5-year time frame. According to Arezki et. al. (2017), 5 years is the approximate time needed for a country to start producing oil from the discovered oil fields.

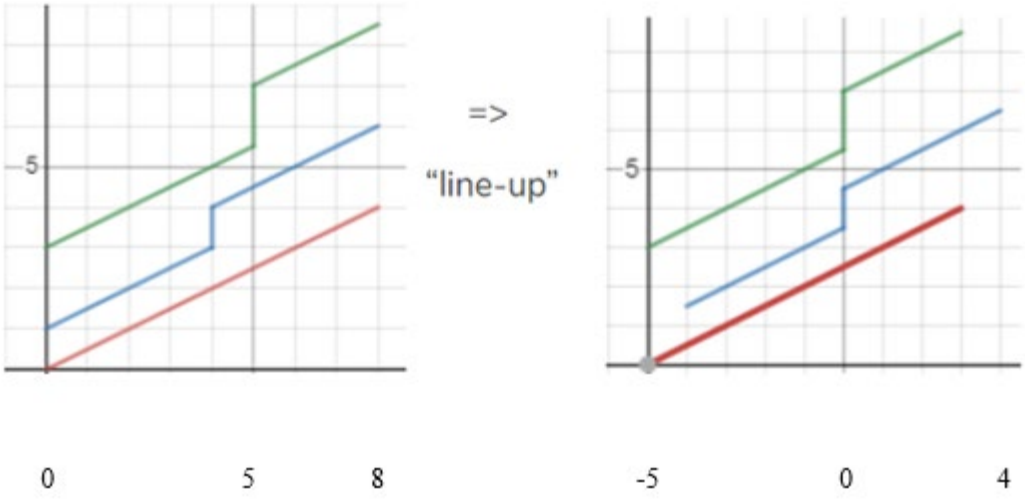

Figure 2: Event Study Design Visualized

In the context of my study, receiving the treatment is equivalent to experiencing oil field discoveries, and the outcome variable is educational and military expenditure share. Since oil field discoveries are exogenous and hence fairly random in the empirical settings, the quasi-experimental methodologies can be applied. This is a strong assumption that is noteworthy, but as past literature like Arezki et. al. (2017) has been constantly holding this assumption, I do not think there will be any problem sticking with this assumption.

Discussion on the Exogeneity of Oil Field Discoveries

I will offer more discussion on the exogeneity of the treatment variable in this context, in other words, why oil field discoveries qualify to be exogenous events, making the quasi-experimental design appropriate. I acknowledge that the decision to extract and export the discovered oil depends on the decision-makers of the nation,

hence are non-random and are endogenous in the economy. However, I would argue that, while not completely random, the news of oil field discovery itself is fairly exogenous hence I can consider the economic activities in the time period between the discovery and the production of oil, which Arezki et. al. (2017) has estimated to be 4 to 6 years. Despite the fact that the researchers can have an estimate of where the oil field lies and countries can choose to purposefully search for oil fields, there are no other scientific ways of confirming the existence of the oil field without actually drilling on the surface (Cavalcanti 2019). Thus, oil discovery is solely based on "luck" and is reasonably analogous to a "lottery win." While this "lottery win" depends on whether the country decides to drill their soil (i.e., deciding to "buy the lottery ticket"), it is almost impossible for anyone to correctly expect the year, the location, and the size of the discovery, which we will be investigating in this paper. Thus, we can treat the oil field discoveries as an exogenous treatment to the economies of countries all over the world.

Data

For the oil field discoveries side of the data, I obtained a comprehensive data file recording the oil field discoveries of each nation from the 1900s to 2019 by geologist Horn (2011) summarized by Arezki et. al (2017). The data file summarizes of all oil and gas fields discoveries and which country they belong to. I have decided to study oil field discoveries that are larger than or as large as "giant" (i.e., giant, supergiant, and megagiant oil fields) so that they do create a lasting effect on the economy, as stated in Arezki et. al. (2017). I have also decided to focus on oil field discoveries from the

1980s to the 2010s, and the reason for choosing this time frame will be discussed in detail in the next section Results. With that being said, there are 58 countries in the treatment group, 95 countries in the control group, with total 153 countries (note that I removed some microstates whose expenditure share was entirely unavailable). Figure 3 below summarizes which countries are in the treatment group or the control group.

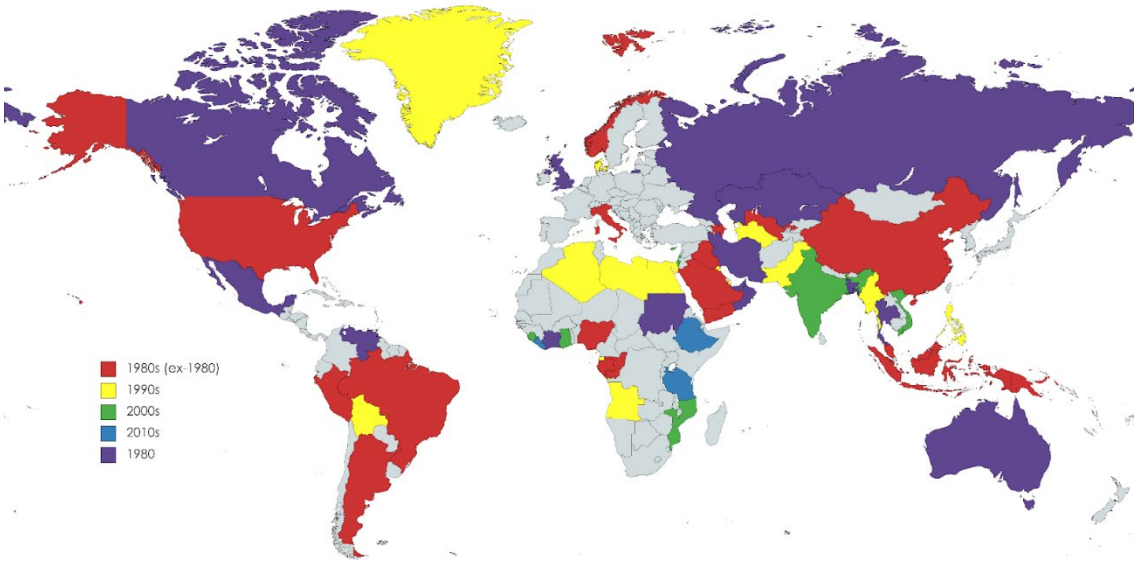

Figure 3: Year of First-ever Oil Field Discovery Since 1980 for Each Country

For the educational and military expenditure share, I predominantly gathered data from the World Bank as it has one of the richest and the most comprehensive datasets. For example, the World Bank has a rich dataset on each nation's military expenditure share from as early as the 1960s, which is provided by Stockholm International Peace Research Institute. Data on government sectoral allocation on education expenditure for each country for each year is also available on World Bank, which will be utilized in this paper. For my paper, I will be merging these two sides'

data in terms of the nation-year hence will have the product of the number of nations and the number of years in the scope as the number of observations.

For the control variables for potential robustness checks, namely, the oil price and the GDP as well as the region of the nations, I utilized what the World Bank has to offer so that I can be consistent in my study. Again, I will be merging this data with the previous data to conduct an analysis.

Results

Estimating the Potential Long-Run Effect Using DID Approach

First of all, I focused on the potential long-run effect of oil field discovery on educational and military expenditure share. In doing so, I have utilized the DID approach as stated above. Now, note that Horn (2011)'s data on world oil field discoveries starts recording oil field discoveries as old as the 1900s. However, there were many significant disturbances that transformed economies and more specifically, the oil and gas markets from the fundamental level, notably World War I, World War II, as well as the two Oil Crises in the 1970s. Not taking into account, these can make the analysis entirely inaccurate as the drastic economic changes caused by these events will marginalize the potential effect of oil field discoveries on the economies. Therefore, it is necessary for this paper to set a time frame for the study. For this paper, I will be focusing on the time frame from the 1980s until the 2010s so that the disturbance created by the two Oil Crises in 1970 is eliminated. With that being said, the "treatment" of this study is reframed as the first-ever oil field discovery since 1980. After that, the country is classified as a treated country (i.e., a country cannot be "treated twice" using this approach even if the country discovers oil fields for the second time after 1980).

Although the treatment (oil field discoveries) is not completely randomly assigned, it is necessary for me to verify that the trends of educational and military expenditure share of the treated and the untreated countries looked as similar as possible before the treatments took place and would have continued to look similar in the absence of the treatment. In other words, I must confirm that the parallel trends

assumption holds so that we can utilize the DID approach. I plotted the evolution of educational and military expenditure share from the 1980s to the 2010s. I confirmed that it is reasonable to assume that the parallel trends assumption holds for both educational and military expenditure share. Please see the Appendix section of this paper for an example of the plots.

I used a two-way fixed effects regression model to assess the potential long-run effect of oil field discoveries. This model enables me to use both the country-fixed effects as well as the year-fixed effects.

$$\mathbf{y_{it}} = \boldsymbol{\alpha_i} + \boldsymbol{\beta_t} + \boldsymbol{\tau D_{it}} + \boldsymbol{\epsilon_{it}}$$

The letter "i" will index different countries (e.g., i=1 for Afghanistan, i=2 for Angola, etc.). The letter "t" will index different years (e.g., t=1 for 1980, t=2 for 1981, etc.). For example, let $\mathbf{y_{it}}$ in the above equation be the educational expenditure share in country i in year t. $\boldsymbol{\alpha_i}$ represents country-fixed effects, in other words, there will be an indicator variable for each country. However, it must be noted that one country is excluded in order to avoid perfect multicollinearity. This controls for any variation across countries that is constant over time (e.g., types of the regimes of the countries, etc.). $\boldsymbol{\beta_t}$ represents the time-fixed effect, in other words, there will be an indicator variable for each year. However, similar to the case of the country-fixed effect, it must be noted that the first year (1980) is excluded in order to avoid perfect multicollinearity. This controls for any global time trends that would affect the sectoral allocation of government education expenditure (e.g., global recessions, etc.). Let $\mathbf{D_{it}}$ in the equation be an indicator variable that equals 1 if the country i has received the treatment by the year t, meaning that the country i experienced oil field discoveries between the year

1980 and the year t. In this case, τ will be the potential effect of oil field discoveries on the educational expenditure share. Note that τ is the average effect after treatment. I will test the significance of τ by performing a t-test with the null hypothesis being $\tau = 0$ and the alternative hypothesis being $\tau > 0$ based on my prediction that both the educational and military expenditure share will increase in the long run. Lastly, ϵ_{it} in the equation represents the error term.

It also must be noted that I clustered standard errors by the country-level to combat potential heteroskedasticity and autocorrelation. Without clustering the standard errors by at least the country-level, the standard errors for the estimation will be unnecessarily lower, which has the potential of declaring statistical significance incorrectly. Also, robustness checks are performed by adding different controls and removing some countries that discover oil fields almost every year, and this will be detailed in the Robustness Checks subsection of this Results section.

Results of Estimating the Potential Long-Run Effects

Here I present the results of estimating the potential long-run effects of oil field discoveries on educational and military expenditure share. As discussed above, each row in the table below represents the regression of the form:

$$y_{it} = \alpha_i + \beta_t + \tau D_{it} + \epsilon_{it}$$

It must be noted that the regression was performed using standard errors clustered by the country-level to accurately estimate the standard error.

y_{it}	τ	standard error	t-statistics	p-value
educational expenditure share	1.94833352	1.62497998	1.1989892	0.11526605
Military expenditure share	0.15604359	0.6251526	0.2496088	0.40144495

Table 1: Potential Long-Run Effects

Here, τ is interpreted as the potential long-run effect of having discovered oil fields since 1980 on the country's sectoral allocation of government expenditure on education and the military. For example, in the case of educational expenditure share as seen in the above table, τ being 1.9483 means that, controlling for the country- and year-fixed effects, the educational expenditure share increases by 1.9483% on average.

Since the p-values for both of the tests are well over 5%, both τ's are not significant at level $\alpha = 0.05$ hence I fail to reject the null hypotheses. In other words, I found no evidence of the potential long-run effect of oil field discoveries on both educational and military expenditure share. These results will be interpreted in the Conclusion section together with the result of the potential short-run effects that are studied below.

Estimating the Potential Short-run Effects by Using ESD Approach

Secondly, I will focus on the potential short-run effect of oil field discoveries on educational and military expenditure share. In doing so, I have utilized the ESD approach as stated above. Now, similar to the case of estimating the potential long-run effects above, it is necessary for me to be aware of the significant disturbance for the economies and the oil markets of the world. Following the similar logic with the above

section, because the two Oil Crises had made fundamental changes to the oil market and the economies all over the world, for this paper, I will be focusing on the time frame from the 1980s until the 2010s. Thus, the disturbance created by the two Oil Crises in 1970 is eliminated. With that being said, the "treatment" of this study is reframed as any oil field discoveries since 1980.

Now, similar to the case of estimating the potential long-run effect of oil field discoveries, I will use a two-way fixed effects regression model to assess the potential short-run effects of oil field discoveries. This model enables me to use both the country-fixed effects as well as the year-fixed effects.

$$\mathbf{y_{it}} = \boldsymbol{\alpha_i} + \boldsymbol{\beta_t} + \boldsymbol{\tau_{-4}}\mathbf{D(r = -4)_{it}} + \ldots + \boldsymbol{\tau_{-1}}\mathbf{D(r = -1)_{it}}$$

$$+ \boldsymbol{\tau_1}\mathbf{D(r = 1)_{it}} + \ldots + \boldsymbol{\tau_4}\mathbf{D(r = 4)_{it}} + \boldsymbol{\epsilon_{it}}$$

Similar to the case of estimating the potential long-run effect, the letter "i" will index different countries (e.g., i=1 for Afghanistan, i=2 for Angola, etc.). The letter "t" will index different years (e.g., t=1 for 1980, t=2, for 1981 etc.). For example, let $\mathbf{y_{it}}$ in the above equation be the military expenditure share in country i in year t. $\boldsymbol{\alpha_i}$ represents country-fixed effects, in other words, there will be an indicator variable for each country. However, it must be noted that one country is excluded in order to avoid perfect multicollinearity. This controls for any variation across countries that is constant over time (e.g., types of the regimes of the countries, etc.). $\boldsymbol{\beta_t}$ represents the time-fixed effect, in other words, there will be an indicator variable for each year. However, similar to the case of country-fixed effect, it must be noted that the first year (1980) is excluded in order to avoid perfect multicollinearity. This controls for any global time trends that would affect the sectoral allocation of government education expenditure

(e.g., global recessions, etc.). Let $\mathbf{D(r = -4)_{it}}$ in the equation be an indicator variable that equals 1 if the country i in year t is five years before an oil field discovery. Similarly, $\mathbf{D(r = -3)_{it}}$, $\mathbf{D(r = -2)_{it}}$, $\mathbf{D(r = -1)_{it}}$, $\mathbf{D(r = 1)_{it}}$, $\mathbf{D(r = 2)_{it}}$, $\mathbf{D(r = 3)_{it}}$, and $\mathbf{D(r = 4)_{it}}$ all represent the same idea, with ones with positive numbers, for example, $\mathbf{D(r = 4)_{it}}$ being an indicator variable that equals 1 if the country i in year t is 4 years after an oil field discovery. In this case, estimating $\boldsymbol{\tau_{-4}}$ to $\boldsymbol{\tau_4}$ will provide us a deeper insight into how much the educational and military expenditure share changes from 4 years before the discovery to 4 years after the discovery. I will test the significance of each τ by performing a t-test with the null hypothesis being $\tau = 0$ and the alternative hypothesis being $\tau < 0$ for the case of educational expenditure share and $\tau > 0$ for the case of military expenditure share. These are based on my hypothesis stated earlier in this paper that the educational expenditure share will decrease in the short run and military expenditure share will increase in the short run. Lastly, $\boldsymbol{\epsilon_{it}}$ in the equation represents the error term.

Similar to the case of estimating the potential long-run effect, it also must be noted that I clustered standard errors at least by the country-level to combat potential heteroskedasticity and autocorrelation. Without clustering the standard errors by at least the country-level, the standard errors for the estimation will be unnecessarily lower, which has the potential of declaring statistical significance incorrectly. Also, robustness checks are performed by adding different controls and removing some countries that discover oil fields almost every year, and this will be detailed in the Robustness Checks subsection of this Results section.

Results of Estimating the Potential Short-Run Effects

Here I present the results of estimating the potential short-run effects of oil field discoveries on educational and military expenditure share. As discussed above, each row in Table 2 and Table 3 below represents the regression of the form:

$$y_{it} = \alpha_i + \beta_t + \tau_{-4} D(r = -4)_{it} + \ldots + \tau_{-1} D(r = -1)_{it}$$

$$+ \tau_1 D(r = 1)_{it} + \ldots + \tau_4 D(r = 4)_{it} + \epsilon_{it}$$

It must be noted that the regression was performed using standard errors clustered by the country-level to accurately estimate the standard error.

relative year to the discovery	τ of the relative year	standard error	t-statistics	p-value
4 years before	0.411474890	0.48898562	0.841486684	0.799962
3 years before	0.002934609	0.45930748	0.006389203	0.502549
2 years before	-0.146894629	0.61193101	-0.240050964	0.405145
1 year before	0.047587803	0.59970006	0.079352673	0.531624
1 year after	-0.264255991	0.57030756	-0.463356987	0.321554
2 years after	0.295558375	0.51008334	0.579431539	0.718851
3 years after	-0.593036571	0.37908523	-1.564388507	0.058863
4 years after	-0.019598323	0.43523004	-0.045029804	0.517958

Table 2: Potential Short-Run Effects on Educational Expenditure Share

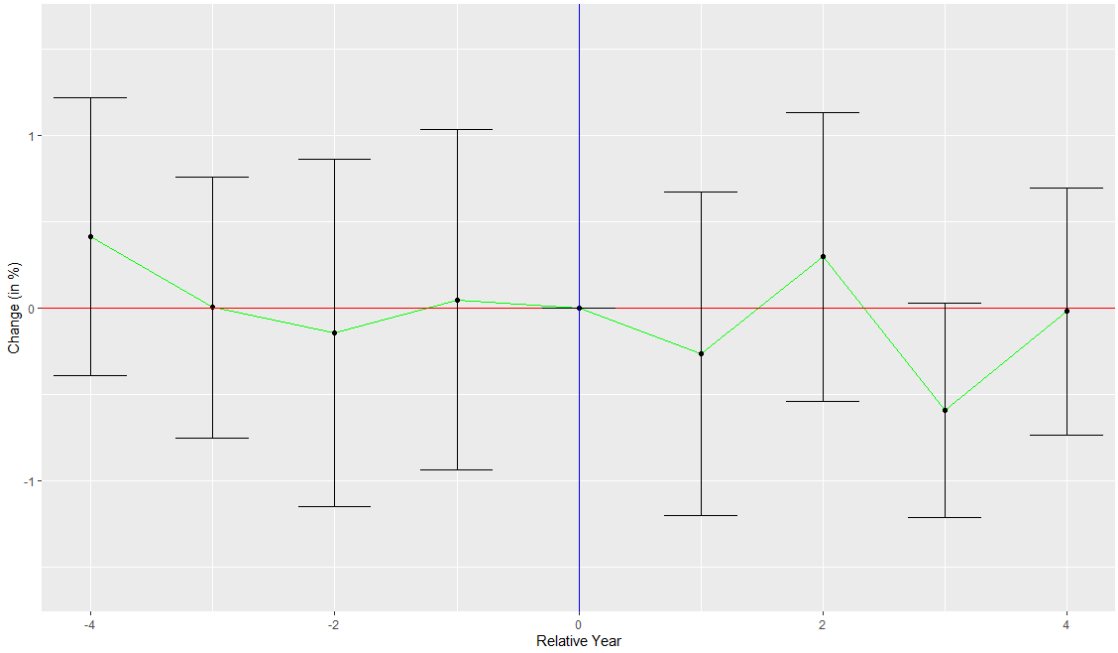

Figure 4: Potential Short-Run Effects on Educational Expenditure Share

relative year to the discovery	τ of the relative year	standard error	t-statistics	p-value
4 years before	0.25835491	0.4596981	0.5620100	0.2870546
3 years before	0.14119286	0.3288483	0.4293556	0.33383225
2 years before	-0.13487970	0.2174617	-0.6202459	0.73245205
1 year before	0.11957238	0.2850044	0.4195458	0.33740865
1 year after	0.79364854	0.4618806	1.718298	0.04287114 *
2 years after	0.36445954	0.2605384	1.398871	0.08092585
3 years after	0.38630451	0.2246152	1.719851	0.042729805 *
4 years after	0.44669221	0.3152923	1.416756	0.07827715

Table 3: Potential Short-Run Effects on Military Expenditure Share

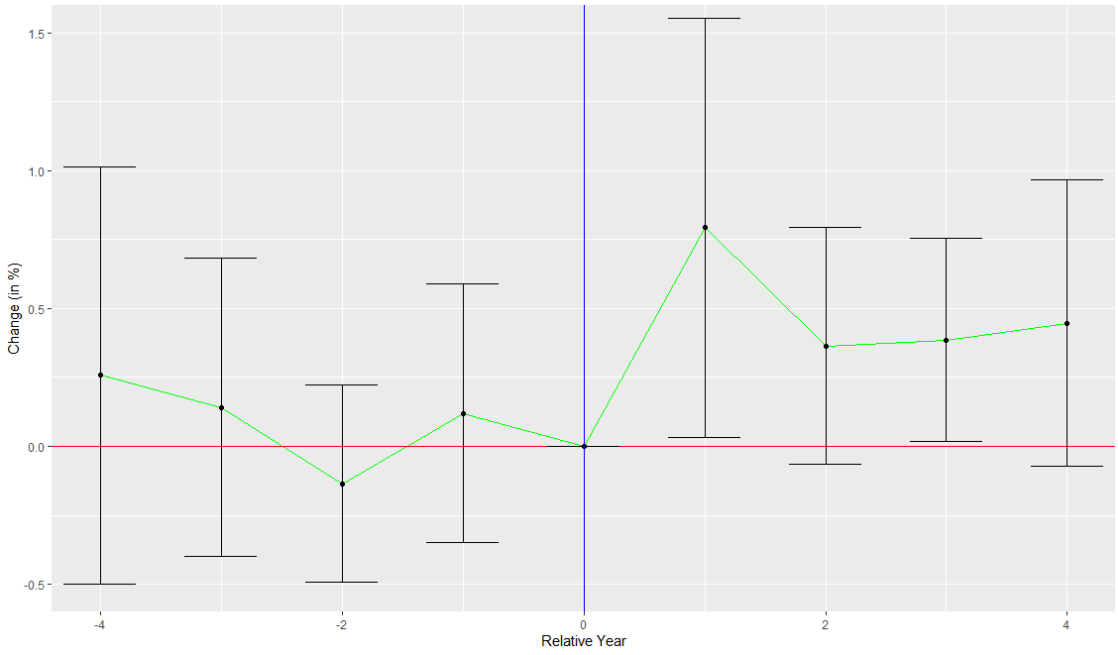

Figure 5: Potential Short-Run Effects on Military Expenditure Share

Here, a series of τ's depending on the relative years to oil field discovery is interpreted as the potential effect of being in that relative year to oil field discovery on the educational and military expenditure share. For example, in the case of military expenditure as seen in Table 3 above, τ of relative year 1 (i.e., $\boldsymbol{\tau_1}$) being 0.7936 means that, controlling for country- and year-fixed effects, the educational expenditure share increases by 0.7936% on average, after a year since an oil field discovery. For Table 2 and 3 as well as Figure 4 and 5 above, it is noteworthy that before the oil field discovery there has been no statistical significance, which is desirable for this study because had there been statistical significance before oil field discovery, that means the government was able to respond to an oil field discovery before it has been actually discovered. It reconfirms the exogeneity of oil field discovery.

The p-values for all of the relative years after the discovery are over 5% for the case of educational expenditure share (see Table 2). However, it must be noted that relative year 3 has a p-value of 0.0589, which is close to the value of 0.05. Nevertheless, I argue that this was by chance, given all other three relative years after the discovery have p-values well over 0.05. With that being said, all of the τ's for the relative years after the discovery are not significant at level $\alpha = 0.05$. Therefore, we fail to reject the null hypothesis. In other words, I found no evidence of the potential long-run effect of oil field discoveries on government educational expenditure as a proportion of the total government expenditure.

In contrast, for the case of military expenditure share on Table 3, τ's for the relative year 1 and 3 are statistically significant at level $\alpha = 0.05$, which can also be seen in Figure 5. In addition, although they are at a lower significance level, τ's for the relative years 2 and 4 are also significant at level $\alpha = 0.10$. In addition, visually, Figure 5 illustrates a general upward trend in military expenditure share after the year of discovery. Therefore, for the case of military expenditure share, I found evidence of the potential short-run effect of oil field discovery. More specifically, government educational expenditure as a proportion of the total government expenditure increases within a 5-year time frame after the discovery, in which the production of oil has not started yet in general according to Arezki et. al. (2017). These results will be interpreted in the Conclusion section below.

Robustness Checks

As I have mentioned before in this Results section, it is important to check the robustness of the results. Here, I will describe in detail the robustness checks that have been performed for validating the robustness of the results presented above. Here I have done three sorts of robustness checks. The first one is adding the oil prices for each country for each year as a control. The second one is adding the gross domestic product for each country for each year as a control, and the third one is removing some countries that discovered oil fields almost every year since their economy might not be affected by oil field discoveries as they are "used to" discovering oil fields. I present that the results do not differ significantly from the results presented above for all the analyses (potential long-run and short-run effects, for both educational and military expenditure share). Therefore, the robustness of all of the results has been confirmed.

Here I will provide an example from the analysis on the potential short-run effect of oil field discoveries on military expenditure share, which is the one I observed statistical significance above. The first robustness check is performed by adding oil prices for each country and each year as an additional control. For example, in the case of analyzing the potential short-run effect of oil field discoveries on sectoral allocation of government military expenditure, the following model is used.

$$\mathbf{y_{it}} = \boldsymbol{\alpha_i} + \boldsymbol{\beta_t} + \boldsymbol{\gamma}\mathbf{OilPrice_{it}} + \boldsymbol{\tau}_{-4}\mathbf{D}(\mathbf{r} = -\mathbf{4})_{\mathbf{it}} + \cdots + \boldsymbol{\tau}_{-1}\mathbf{D}(\mathbf{r} = -\mathbf{1})_{\mathbf{it}} + \boldsymbol{\tau}_{1}\mathbf{D}(\mathbf{r} = \mathbf{1})_{\mathbf{it}} + \ldots + \boldsymbol{\tau}_{4}\mathbf{D}(\mathbf{r} = \mathbf{4})_{\mathbf{it}} + \boldsymbol{\epsilon_{it}}$$

All of the symbols represent the same entity as described in the previous subsection Estimating the Potential Short-run Effects by Using ESD Approach, except **OilPrice$_{it}$** represents the prices of oil of the country i in year t. With everything else analyzed the

exact same way as the previous section (e.g., clustered standard error by the country-level, etc.) except adding prices of oil as an additional control, none of the results presented in the above analyses have significantly changed, and I present the following graph, Figure 6, as an example of the result:

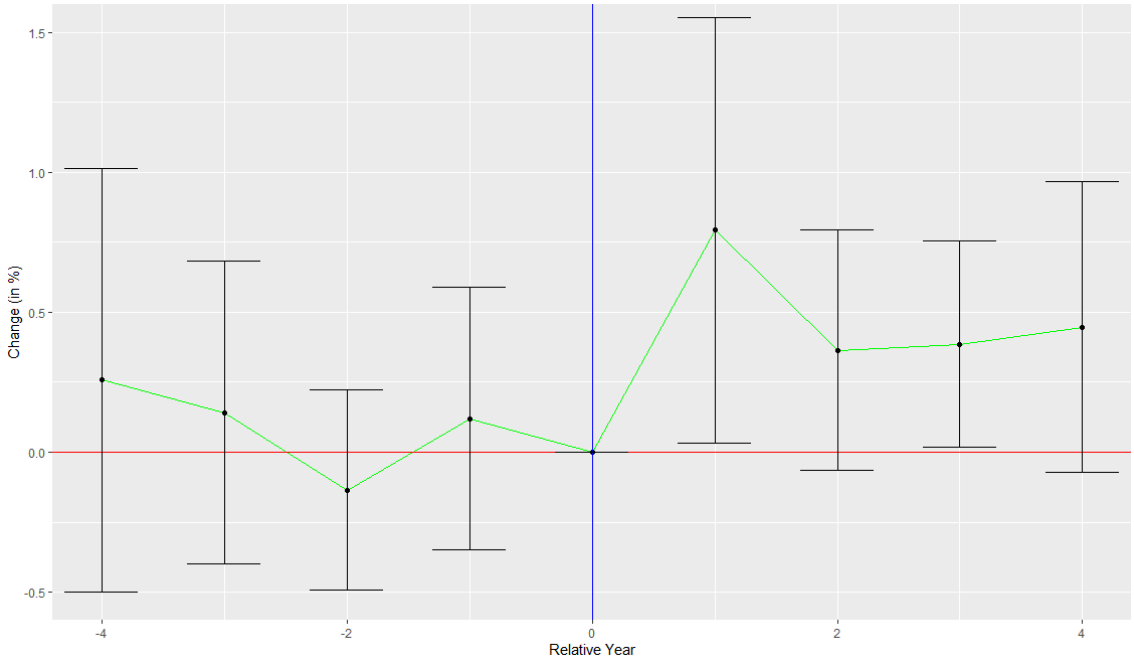

Figure 6: Robustness Check – Controlling for Prices of Oil

As can be seen in Figure 6, τ's for Relative year 1 and Relative year 3 had statistical significance at a 5% significance level just like the analysis done in the previous subsection. There also is a general upward-trend illustrating an increase in military expenditure share similar to the case of the previous subsection. Therefore, the robustness of the result has been shown in this context.

The second robustness check is performed by adding GDP for each country and each year as an additional control. For example, in the case of analyzing the potential short-run effect of oil field discoveries on military expenditure share, the following model is used.

$$y_{it} = \alpha_i + \beta_t + \zeta GDP_{it} + \tau_{-4} D(r = -4)_{it} + \ldots + \tau_{-1} D(r = -1)_{it}$$

$$+ \tau_1 D(r = 1)_{it} + \ldots + \tau_4 D(r = 4)_{it} + \epsilon_{it}$$

All of the symbols represent the same entity as described in the previous subsection Estimating the Potential Short-run Effects by Using ESD Approach, except **GDP**$_{it}$ represents the gross domestic product of the country i in year t. With everything else analyzed the exact same way as the previous section (e.g., clustered standard error by the country-level, etc.) except adding gross domestic product as an additional control, none of the results presented in the above analyses have significantly changed, and I present the following graph, Figure 7, as an example of the result:

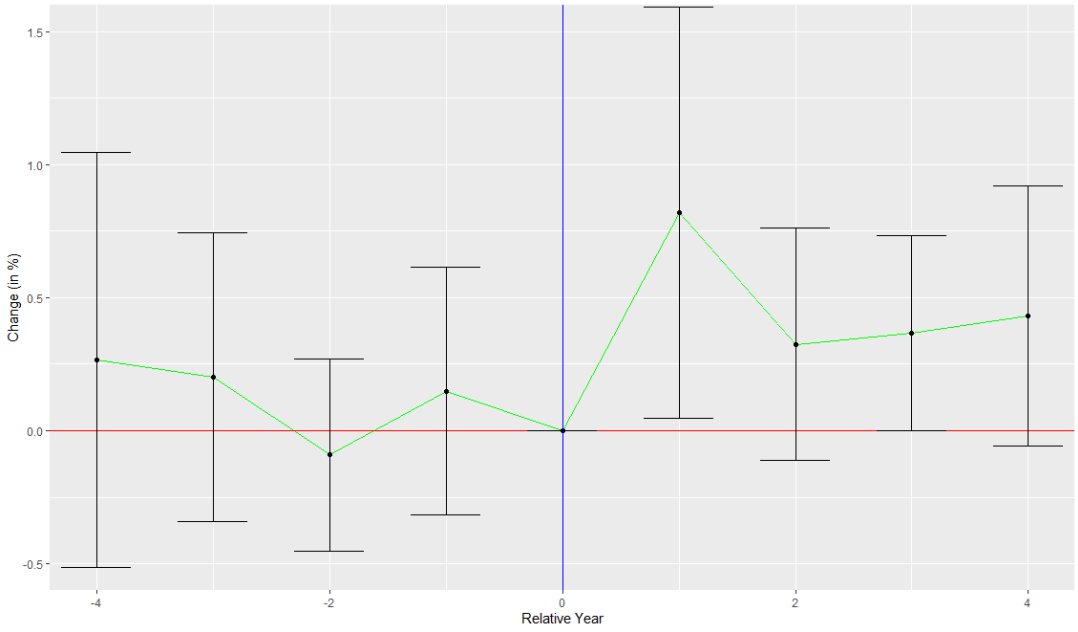

Figure 7: Robustness Check – Controlling for Gross Domestic Product

Similar to the case of the previous robustness check, τ's for Relative year 1 and Relative year 3 had statistical significance at a 5% significance level just like the analysis done in the previous subsection (although it is visually difficult to see, τ for Relative Year 3 has a p-value of 0.0499, meaning it is statistically significant at 5%

significance level). There also is a general upward-trend in Figure 7 illustrating an increase in the sectoral allocation of government military expenditure similar to the case of the previous subsection. Therefore, the robustness of the result has been shown in this context.

The third robustness check is performed by removing some countries that discover oil fields almost every year since their economy might not be affected by oil field discoveries as they are "used to" discovering oil fields. As discussed above, this paper studies the time frame of 1980 to 2010s, and I have observed that there are more countries that have discovered oil fields around the year 1980 than in the later years. This is because there are a certain group of countries that discovered oil fields almost every year, and we consider these countries to have discovered oil fields "for the first time" around the year 1980 for this particular study.

These countries might have been "used to" discover oil fields and therefore their economy might not have been affected by the treatment i.e., oil field discoveries. Therefore, for the sake of robustness checks, I have removed such countries (e.g., Australia, Brazil, China, Iran, Russia, and the USA) and ran the regressions described in the above subsection. In conclusion, none of the results presented in the above analyses have significantly changed, and here is an example of the case of estimating the potential short-run effect of oil field discovery on military expenditure share.

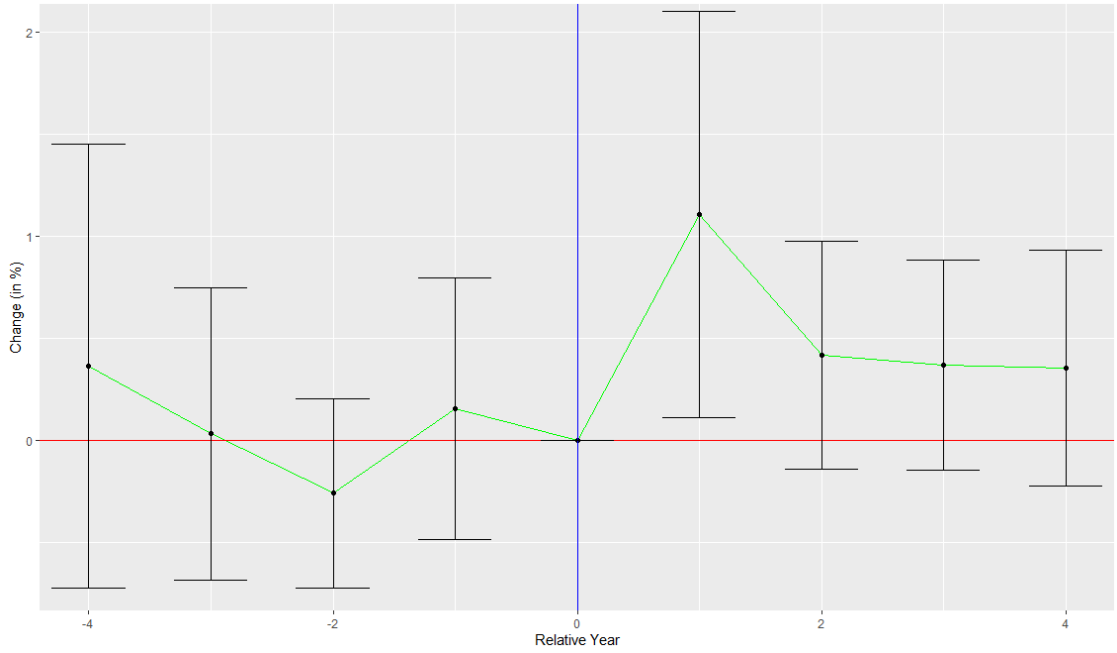

Figure 8: Robustness Check – Removing Some Countries

As can be seen in Figure 8, τ for Relative year 1 had statistical significance at a 5% significance level just like the analysis done in the previous subsection. Although τ for Relative year 3 is no longer statistically significant at a 5% significance level, there still is a general upward-trend describing an increase in the sectoral allocation of government military expenditure similar to the case of the previous subsection. Therefore, I conclude that the robustness of the result has been shown in this context.

Conclusion

Summary and the Interpretation of the Results

The effects of oil field discoveries have been widely studied by scholars and the nuanced outcome that natural resources can bring to an economy has been well documented. For instance, Esquivel (2021) has discovered how exporting natural resources is in general welfare-improving yet weakens the other exporting sector of the nation (e.g., manufacturing, etc.) by appreciating the nation's currency. However, there has not been much attention on how the government responds to oil field discoveries. In this paper, I have focused on the potential effect of oil field discoveries on educational and military expenditure share.

Firstly, I found no evidence of potential effects of oil fields discoveries on educational expenditure share neither in the short-run nor in the long run. Before conducting the analysis, I predicted that educational expenditure share will decrease in the short run and will increase in the long run. This can be because education is relatively unrelated to the investment in producing oil, and the government might rather reallocate its budget on education to oil-related investment, (e.g., infrastructure to facilitate the production of oil) in the short run.

Given this result, I conclude that there is no noticeable reallocation of the government budget on education to other oil-related sectors. In contrast, my hypothesis that the educational expenditure share will increase in the long run was supported by how the government can invest more in human capital rather than physical capital as an influx of income comes from the production of oil and therefore there is sufficient

infrastructure. Again, given the insignificant result, I conclude that there is no noticeable reallocation of the government budget to education from other sectors.

Secondly, I found evidence of oil field discoveries increasing the military expenditure share in the short run but I found no evidence of any potential effect in the long run. Prior to performing the analysis, I predicted that the military expenditure share will increase both in the short run and in the long run. This is supported by my hypothesis that there is an increased risk of foreign interventions as well as internal conflicts following an oil field discovery, since oil and gas fields can be found underneath the sea and there are groups in the nation that benefit from oil production and those that will be hurt economically. I conjectured that this increased risk will persist both in the short-run (i.e., before the production of oil actually begins, which is usually 4 to 6 years) as well as in the long-run (after the production of oil starts), and therefore the government will put more weight on its military. There does exist past study, Bannon and Collier (2003), that states countries face substantially higher risks of violent conflict if highly dependent on primary commodities like natural resources.

Given the result, there does exist evidence of the government increasing the proportion of military expenditure within the total government expenditure in the short run following an oil field discovery. This can be due to the government immediately responding to the discovery, securing its "lottery win" and establishing a national order to mitigate the risk of violent conflict both internally and externally. However, given that the result was insignificant in the long run, this increased attention of the government on national defense should be understood as non-perpetual. The result can be interpreted that, while the government attempts to combat the potential risk of

violent conflict in the short-run followed by an oil field discovery, in the long run, the government conceives the risk to be lowered, and finds it unworthy to put more weight on its military.

Some limitations of my model include the fact that the time frame of the study could have been relatively short to have the statistical power to detect statistical significance for potential effects of a smaller scale. Other limitations can be attributed to the missing data points in educational and military expenditure. Lastly, there can be some biases in the data of military expenditure share. This is because, following an oil field discovery, a country could be more secretive about their military expenditure to protect its national interest, hence spend more on its military than it appears to the eyes of Stockholm Peace Institute. This results in a downward bias in the institute's data on military expenditure share after a discovery. However, I do not see this as a crucial issue to my conclusion, since I found a significant increase in military expenditure share following oil field discoveries using potentially downward-biased data.

Suggestions for Future Researches

I focused on two sorts of expenditure share for data availability reasons, but I believe that future studies can examine how other sorts of expenditure share (e.g., expenditure on social benefits, etc.) will be affected by oil field discoveries. It is imperative to continue assessing how the government responds to a "lottery win" for the country so that decision-makers all over the world can take the best option to utilize the newly discovered natural resource for the nation's benefit, and not fall into the trap of "natural resource curse".

Notes

Here I detail the data source used in the robustness checks done in the Results section. The data on the average annual price of crude oil in the current (2020) US dollars comes from World Bank Commodity Price Data (The Pink Sheet) (https://www.worldbank.org/en/research/commodity-markets). The data on the annual GDP for about 200 countries and territories of interest comes from World Bank GDP (in 2020 US Dollar) (https://data.worldbank.org/indicator/NY.GDP.MKTP.CD). The data on the 23 regions comes from World Bank Development Indicators (https://datacatalog.worldbank.org/dataset/world-development-indicators). Finally, the data on whether a country discovered an oil field for each year comes from Arezki et. al. (2017) based on geologist Horn (2011)'s data (https://lsheng.weebly.com/research.html).

Appendix

Here is an example plot created in order to confirm that the parallel trends assumption holds in using the DID approach in the Results section of this paper, in which I estimated the potential long-run effect of oil field discoveries on educational and military expenditure.

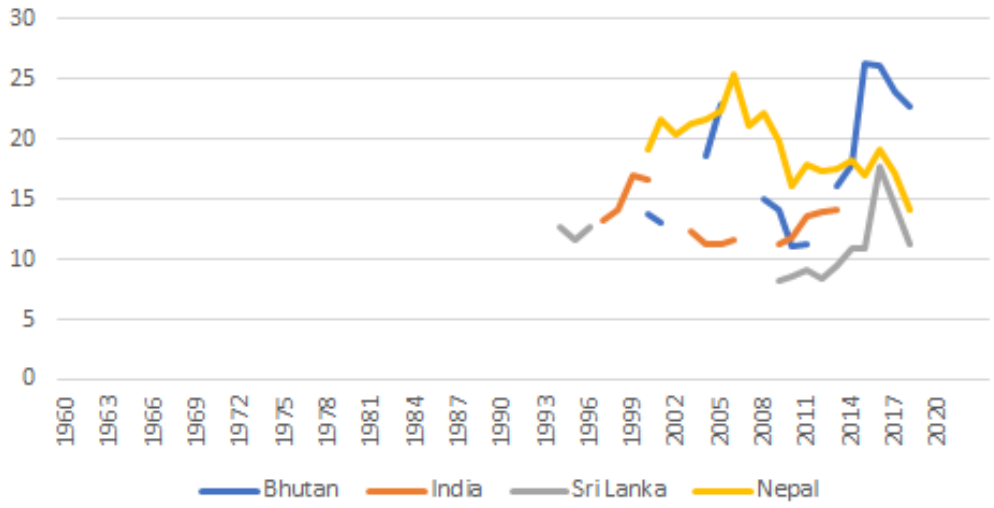

Figure 9: Educational Expenditure Share in Region South Asia

Figure 9 is a graph that plots a selected set of countries in South Asia, for the sake of the graph's visibility. India discovered an oil field in 2002 which was counted as a "treatment" in this paper. All the other three countries (i.e., Bhutan, Sri Lanka, and Nepal) never discovered an oil field in the time frame of this particular study. While there do exist missing data points for this particular example, we do not see a significant dissimilarity in how the trend evolves for India before 2002 and those of India's neighboring countries. I have looked at how the trend evolves for all of the countries and territories studied in this paper, and have come to a conclusion that the parallel

trends assumption holds in general. In other words, there was no significant dissimilarity in how the trend of educational and military expenditure share evolves for the treated countries before the treatment and the controlled countries.

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