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DOCTORAL THESIS

Essays on the local socio-economic and political impacts of natural resources: Evidence from Ghana's offshore oil and gas

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Declaration of Authorship

I declare that this thesis titled, *"Essays on the local socioeconomic and political impacts of natural resources: Evidence from Ghana's offshore oil and gas"* and the work presented in it are my own. I declare that:

- This thesis represents my own research efforts and has not been submitted for any other degree or qualification.
- All sources used in this thesis have been appropriately acknowledged and cited.
- Any assistance received in the preparation of this thesis, from individuals or organizations, has been duly acknowledged.
- Any opinions, findings, conclusions, or recommendations expressed in this thesis are solely those of the author and do not necessarily reflect the views of the university or any other organization.
- I accept full responsibility for any errors or omissions contained in this thesis.

Signed:

Date:

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Chapter 1

Introduction

Natural resources present a multifaceted dilemma for resource-rich economies. While they can be crucial drivers of economic development, they are often linked with economic, social and political challenges. Resources have the potential to create wealth through revenue generation from exports, increased income for resource workers, job creation, infrastructure development, industrial diversification, and human capital development. However, this wealth, if not effectively managed, can lead to negative consequences such as underdevelopment, limited economic diversification, social inequalities, and political instability. To address these challenges, it is important that resource-rich countries understand the potential effects of their natural resources and the mechanisms through which these resources affect the local economy. This thesis, in three essays, performs a difference-in-differences analysis to examine the socio-economic and political effects of natural resources, with a specific focus on Ghana's discovery of high-grade offshore oil in 2007.

The first essay, titled *"Natural Resources and Local Communities: Evidence from Ghana's offshore oil and gas,"* focuses on the socio-economic impacts at the local level. Using geocoded household data, I compare the living standards of households near the oil fields to those further away before and after the oil and gas discovery. Additionally, I investigate how the gains from resource extraction are distributed among various subgroups. The chapter finds that oil and gas discovery increased real income for households close to the fields, with the benefits being larger for households in districts with a high proportion of skilled workers and limited to non-poor districts. The increase in real income is accompanied by a rise in food and housing expenditure respectively. However, there is no apparent effect on employment, total consumption expenditure and poverty.

These findings raise questions about how resource abundance translates into broader economic growth. They suggest that Ghana, like many resource-rich countries, may not be maximizing the benefits of resource extraction. To address this issue, recent literature has focused on exploring alternative channels through which resource extraction can stimulate economic growth. Ramdoo (2015) suggests that one such channel is the development of linkages between the resource sectors and the rest of the economy. The second essay this thesis, titled *"Natural-resource-driven structural transformation and economic growth: exploring the roles of forward and backward linkages,"* examines how resource discovery can stimulate broader economic development. I use night-time light data to analyze input-output linkages between industries. By comparing districts heavily linked to the petroleum industry with others, the chapter shows that oil and gas discovery increased economic activity in these dependent districts. Highly dependent districts are districts in which industries with strong linkages with the oil and gas industry make up a large share of employment. An industry's linkage with the oil and gas industry is measured by the proportion of inputs it purchases from or output it sells to the oil and gas industry.

Interestingly, these districts also experienced a shift in employment from agriculture to services, bypassing manufacturing. Additionally, the chapter utilizes domar weights to offer new insights into the interaction between the mining sector and the rest of the Ghanaian economy. The analysis shows that most of the mining sector's impact on GDP is through its effect on exports, with little integration into the domestic economy. These findings suggest that resource extraction has the potential to stimulate economic development through the creation of input-output linkages. However, the development of these linkages may rely on effective policies aimed at integrating the extractive sector with the rest of the economy.

Apart from its economic effects, resource extraction also impacts aspects of the political economy. Shifting the focus from economic development to political trust, the third essay, titled *"Natural Resources and the Public's Political Trust,"* investigates the effects of oil and gas discovery on public trust in political leaders and systems. In this chapter, I use data on public attitudes to compare the political trust of individuals living near oil fields with those living farther away. The effect of natural resources on public political trust stems from the expectations following a resource boom. The extent to which these expectations are met shapes citizens' trust in their leaders and political system (Miller, 2015). I find that individuals living near the oil fields became less trusting of political leaders after the oil discovery. This decline in trust is limited to districts with high levels of education, districts with high media exposure and districts with high levels of unemployment. Furthermore, individuals near the oil fields reported more negative views about Ghana's democracy, corruption, government performance, and economic conditions. The results suggest a potential link between increased bribe payments in these locations and declining trust.

This thesis extends the existing literature on how natural resources affect the local economy (Aragón & Rud, 2013; Gollin et al., 2016; Knutsen et al., 2017; Kolstad & Wiig, 2012; Ross, 2001; Valentinyi, 2021; Weber, 2012). It sheds light on the within-country variations of these effects and the mechanisms through which they occur, offering a more nuanced understanding of this intricate relationship. The thesis makes four main contributions. First, it exploits spatial variations to shed light on the heterogeneous effects of resource extraction within an economy. Second, it adopts a relatively unexplored identification strategy that exploits the variation in industrial composition across districts. This approach helps identify alternative channels through which natural resources can stimulate economic growth. Third, it uses domar weights to provide novel insights into how the extractive sector interacts with the broader Ghanaian economy. These are relevant not just to Ghana but to other resource-rich economies. Fourth, it improves our understanding of how resource extraction shapes the public's trust in political leaders and systems.

Chapter 2

Natural Resources and Local Communities: Evidence from Ghana's offshore oil and gas

1.1 Introduction

Natural resource has the potential to stimulate economic development. Exports of natural resource generate fiscal revenue which can be used to make investments that further economic growth. Nevertheless, it is often seen that resource abundance results in low economic performance, corruption, conflict, and inequality (Sachs & Warner, 1997). This could be due to the Dutch disease[1], civil war, volatility in commodity prices or poor institutions. While the cross-country effects are well explored, there is little evidence of how resources interact with the local economies. Resource extraction tends to stimulate local demand for labour, increase the revenue of the local government and induce agglomeration effects. On the other hand, natural resources could have adverse effects on the local population by increasing the incidence of conflict, violence and corruption, raising local prices and causing environmental pollution.

This chapter addresses the question of how natural resources affect income, consumption expenditure, employment and poverty status of the local population. Additionally, I investigate how the gains from resource extraction are distributed among various subgroups. These are important for understanding the mechanisms through which resource abundance impacts local communities and to develop policies that will address potential effects on a local scope. In this chapter, I use the Ghana Living Standard Survey (GLSS) dataset to analyse the effect of a significant offshore oil and gas discovery in 2007 in Ghana. I perform two quasi-experimental analyses (difference-in-differences and synthetic control) to investigate the effect of the oil and gas discovery. The identification strategy exploits spatial and temporal variations in oil extraction and compares households living near the oil fields to households located farther away before and after the oil and gas discovery. I proxy the distance to the offshore oil and gas with the distance to the nearest city. The offshore oil field is located near the Takoradi city in the Western region. Takoradi's proximity to the oil and gas field facilitates my analysis because of the increase in its economic activities since the oil was discovered.

[1] The Dutch disease refers to the causal relationship that exists between natural resource boom and the decline of sectors like the manufacturing sector or agriculture

I find that the offshore oil and gas discovery increased real income. Specifically, the oil discovery led to a 45% increase in the real income of households located close to Takoradi. The results show that the rise in income is higher among households whose heads are skilled workers and only significant for non-poor households. The increase in income did not translate into a rise in total consumption expenditure or a poverty reduction. However, households living close to Takoradi experienced a rise in food and housing expenditure after the oil and gas discovery. The results are robust to using other measures of distance such as continuous distance and including region fixed effects. Finally, I provide evidence that there is a heterogeneous exposure (by distance) to the effects of the oil and gas discovery and that these effects are insignificant beyond 80km from Takoradi.

The chapter contributes to an emerging literature on the effect of natural resources on local community development. The impact of natural resources is unlikely to be evenly distributed across a country. Various effects, including pollution, population displacement, and labor demand shocks, often have a localized geographical scope. The impact or its degree may vary depending on factors such as the location of the resource or labour mobility. Resource boom in a community can draw labour and capital from surrounding areas which results in economic and geographical disparities (Weber, 2014). The findings from Fleming and Measham (2015), Marchand (2012), and Weber (2012) show that regions where gas is produced have higher gains in total earnings and employment.

This research is closely related to Aragón and Rud (2013), Knutsen et al. (2017), and Kotsadam and Tolonen (2016). They study the local impact of natural resources by exploiting spatial and temporal variations in extractive activities. They found that the effect of resource abundance diminishes with distance to the extractive areas. Households located close to these areas had a comparative advantage in job acquisition. However, they had a higher risk of exposure to pollution, emissions and injuries associated with resource extraction. Following this methodology, I adopt an identification strategy that exploits distance to the oil field, comparing households living close to the oil field to those living farther away. The empirical results from my research are consistent with the findings from Adofo et al. (2019), Black et al. (2005), Fleming and Measham (2015), and Weber (2012) who found that activities associated with natural resource extraction increase the income of the local population.

In Ghana, Adofo et al. (2019) compared households in oil districts with those in other districts and found that oil exploration was associated with increased real income and employment. My research differs from the work of Adofo et al. (2019) in two ways: First, I adopt a different identification strategy that exploits distance to the oil field. The findings from Aragón and Rud (2013) suggests that resource extraction increases the local demand for input which results in a positive effect on real income. However, these effects are only present in the supply market and surrounding areas, diminish with distance and are close to zero at 100km from the mine. Second, I complement my results by conducting a synthetic control analysis.

1.2 Overview of oil in Ghana

There are four petroleum basins in Ghana[2] (see Figure 1.1). These are the Saltpond basin/Central basin, the Tano - Cape three point basin/Western basin, the Voltaian basin and the Accra or Keta basin/Eastern basin [3]. Oil was first discovered in 1896 in the onshore Tano basin in the Western region (GNPC, 2009). Onshore oil continued until 1970 when the first offshore oil was discovered and drilled in Saltpond[4]. In subsequent years, exploration for oil and gas was intensified and several wells were drilled but production and commercialization were on a small scale until 2007 when the Jubilee field was discovered.

In June 2007, Kosmos Energy and Tullow Oil found Ghana's most significant column of high-grade offshore oil in the Mahogany-1 (M-1) and Hyedua-1 (H-1) exploration wells. The site, named Jubilee Field, commenced oil production in December 2010[5]. The field's total reserves are 3 billion barrels and daily production was approximately 150,000 barrels in 2019

[2] Eni, 2018.

[3] The Western, Eastern and Central basins are offshore. The Voltaian basin is onshore

[4] In 2018, the government gave a directive to decommission the Saltpond oil field due to safety and environmental concerns

[5] A Floating, Production, Storage, and Offloading (FPSO) vessel capable of processing 120,000 barrels of crude oil per day was approved as part of the Phase 1 development project by the Minister of Energy in July 2009

(Tullow Oil, 2019).

Figure 1.1: Ghana petroleum basins

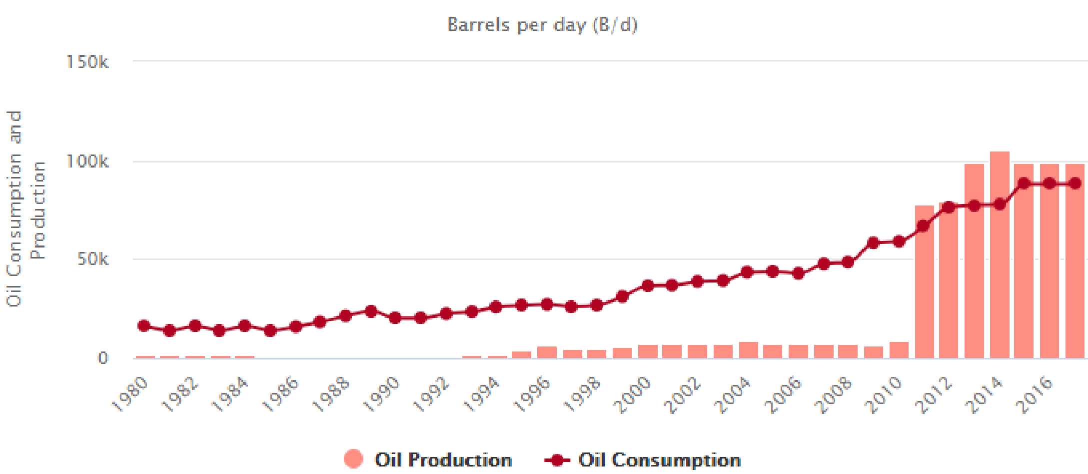


Figure 1.2: Ghana oil consumption and production (barrels per day)

Figure 1.2 shows the history of oil production and consumption in Ghana. It shows how significant the Jubilee field discovery is in the country's history of petroleum exploration[6]. From 2007 to 2013, follow-up appraisals have made 23 additional discoveries in the Deepwater Tano (The Petroleum Commision, 2022). The offshore oil fields are situated between the Deepwater Tano and West Cape Three Points blocks, approximately 60 kilometers from Ghana's Western coast[7]. This region is predominantly rural, with 57.6% of the population residing in rural areas (GSS, 2012). Takoradi, the region's capital, has the largest population share (23.5%), with approximately 445,205 inhabitants. Most of the basic infrastructure required for the oil and gas industry is obtained in Takoradi as it is the city closest to the Jubilee field.

The port of Takoradi was selected as the location for the support base for offshore service vessels[8]. Its proximity to the oil fields and its existing capacity made it the nearest port suitable for the demands of the industry (Tullow Oil, 2019). It serves as the main export channel for oil from the Western Region, and has recently been expanded to accommodate the rise in its business volume since the oil discovery [9]. Here, oil supply vessels store and collect chemicals, equipment, and other supplies. Additionally, Takoradi houses the onshore logistics base facilities for office space warehousing, storage, and logistical support for offshore operations (ADB, 2009).

Takoradi's proximity to the oil fields facilitates my analysis because of the increase in its economic activities since the oil was discovered. I will implement a geographic difference–in-difference analysis using the offshore oil discovery as treatment and comparing households living near Takoradi to those farther away before and after the oil discovery.

The oil fields are owned collectively by Tullow Oil, Kosmos Energy, Ghana National Petroleum Corporation (GNPC), EO Group and Anadarko Petroleum Corporation. The government receives 35% as petroleum income tax[10] and 5% as royalty[11] from the oil industry (PIAC, 2019).

[6] *Source: https://www.worldometers.info/oil/ghana-oil/*

[7] A region is the largest sub-national administrative division in Ghana. It is divided into districts, municipalities, metropolitan and towns/cities. Ghana has 16 regions, 216 districts and 260 Metropolitan and Municipal Assemblies

[8] The Takoradi port is Ghana's second-largest and oldest seaport

[9] *Source::/african.business/2012/11/energy-resources/china-deal-to-rescue-takoradi-port/*

[10] Profit-related revenue received by the government

[11] Royalties are levied on the gross production of oil regardless of the operation's profitability

There is no windfall allocation from the government to the local authorities or households. The only mechanism through which local communities benefit from government revenue is through the provision of infrastructure (Adofo et al., 2019).

1.3 Local impact of natural resources

Natural resource interacts with the local economies in several ways. The main mechanism is through income (Adofo et al., 2019; Allcott & Keniston, 2018; Michaels, 2011). The extraction and processing of natural resources often creates job opportunities. This can lead to increased employment and wages, especially in regions where the resource is produced. Additionally, resource industries may increase the procurement of inputs from local suppliers which can increase income. The increase in income or employment can spill over to workers in non-mining sectors or it could be concentrated among workers in the extractive industry, causing a decline in other sectors. The decline of other sectors illustrates how the natural resource boom might lead to the Dutch disease within a country.

Resource extraction can also impact the local economy by influencing conflict, corruption, and illegal activities. The inflow of income from extractive industries can increase rent-seeking behaviour, political corruption and violence (Berman et al., 2017; Knutsen et al., 2017). Resource abundance provides financial opportunities for insurgent groups through the changes in employment opportunities. According to Angrist and Kugler (2008), coca growing areas in Columbia experienced a high incidence of violent deaths because coca production increased labour supply and self-employment income of boys. On the other hand, changes in employment opportunities can lead to less crime because a rise in employment increases the opportunity cost of criminal activities (Axbard et al., 2021). In addition to providing financial opportunities for individuals, resource abundance also increases local government revenue. This increase in revenue can boost the incentive to stay in power at all costs hence, threatening democracy (Graham et al., 2020). Brollo et al. (2013), Caselli and Michaels (2009), and Vicente (2010) found that larger transfer of windfall revenue to local authorities increases vote buying and decreases the quality of the mayoral candidate, especially in regions with weak institutions.

Additionally, resource extraction can negatively impact local health through pollution, environmental degradation, and occupational hazards. These factors can potentially offset the income benefits. Von der Goltz and Barnwal (2019) found that mineral mining increased asset gains. However, these gains are offset by the high incidence of anaemia in women and stunted growth in children. Potential environmental impact of oil extraction such as emissions and spillage of waste into water and soil resources exposes residents to higher a prevalence of cancer, skin irritation, liver damage and diarrhoea (Johnston et al., 2019). Despite pollution risks, resource abundance can lead to a reduction in infant mortality and incidence of diarrhoea and cough by providing an opportunity for households to afford better healthcare and have access to the media for health information (Benshaul-Tolonen, 2019; Benshaul-Tolonen et al., 2019).

1.4 Data and Method

1.4.1 Data

This analysis uses micro-data from the Ghana Living Standard Survey (GLSS) for the years 1999, 2006 and 2013. The data is repeated cross-section. I link the households with their geographic identifiers (GPS coordinates) obtained from the Ghana Statistical Service (GSS) [12]. GPS coordinates are available on the cluster level. A cluster includes 10 to 15 households located geographically close to each other. I use the GPS coordinates to calculate the measure of distance. Distance is calculated as the length of the shortest path between a household's location and the Takoradi city. I focus on households living less than 300km from Takoradi. Moreover, I restrict my analysis to households in which the household head is less than 50 years old [13]. My sample consists of 7,327 households.

The main outcome variable is income. This includes wages, agricultural income, income

[12] The data on the geographic identifiers was shared by Benshaul-Tolonen et al. (2019)

[13] This is because they are young enough to respond to the shock from the oil discovery

from non-agricultural enterprises and rental income. I deflate the income variable with the regional price index[14]. The summary statistics for the household data are presented in Table 1.1.

Table 1.1: Summary Statistics I

Variables	Observation	Mean	Std. dev.
Household head			
Age	7,327	35.980	8.130
Years of Education	7,327	3.032	2.490
Proportion Male	7,327	0.722	0.448
Proportion in Agriculture	4,381	0.320	0.467
Proportion in Manufacturing	4,381	0.185	0.388
Proportion in Services	4,381	0.495	0.500
Household			
Nominal income	7,327	5,637.664	19,040.98
Nominal expenditure	7,327	3,000.13	4,658.927
Number of household members	7,327	3.836	2.304
Proportion Urban	7,327	0.526	0.500
Proportion Poor	7,327	0.484	0.500
Distance to Takoradi (km)	7,327	172.091	67.672

Notes: Income and expenditure are measured in Ghana cedis.

1.4.2 Identification Strategy

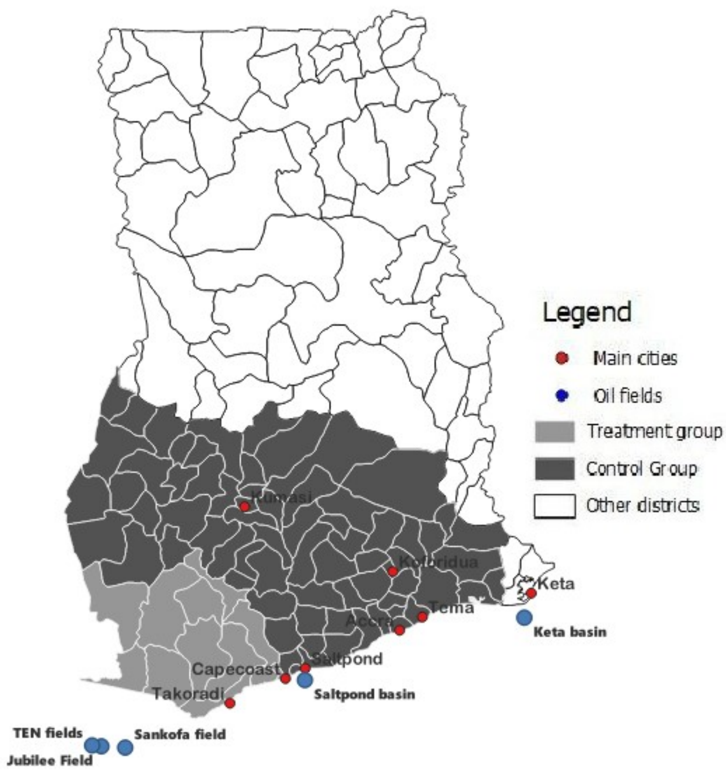
The baseline regression is:

$$Y_{hcdt} = \alpha + \delta_d + \rho D_h + \gamma Post_t + \beta D_h * Post_t + \eta X_{hcdt} + \epsilon_{hcdt} \tag{1.1}$$

where Y_{hcdt} is the outcome variable (income, consumption expenditure, poverty or employment) of household h in cluster c in district d in year t. D_h is a dummy variable that takes the value one if a household is in the treatment group and zero otherwise. The treatment group consist of households located less than 80km from Takoradi (see Figure 1.3). The assignment

[14]The price index is from the Ghana Statistical Service. It is calculated as an average of the relative prices of a given basket of goods in each region for a particular period

Figure 1.3: Districts in my sample: by distance to Takoradi city



of the treatment group was done in 2 ways: First, I split the households into separate distance bands and group them in blocks of 20km. The first group consists of households located less than 20km from Takoradi, the second group consists of households located between 20km to 40km from Takoradi and so on. Second, I estimate the baseline regression to explore spatial heterogeneity. I find that after 80km, the effect of the oil discovery becomes insignificant. The detailed result is presented in Section 1.5.

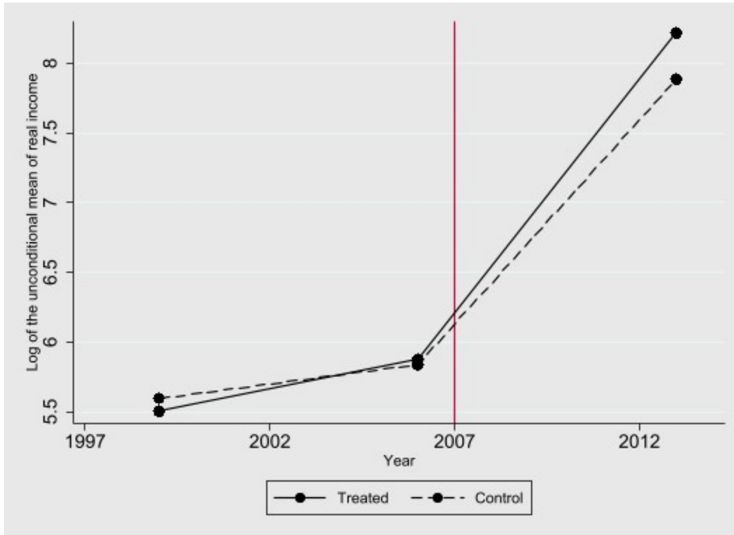
$Post_t$ is a dummy variable that takes the value one in the post oil discovery period (2007). δ_d is district fixed effects[15]. X_{hcdt} is a vector of household- level control variables such as age, gender and years of education of household head, number of household members, and an indicator of urban household [16].

The identification strategy assumes that households in areas both close and far from Tako-

[15]The results are robust to the use of region fixed effects

[16]For robustness, I include controls for distance to old oil fields and the capital city, Accra

Figure 1.4: Mean of real income



radi would experience similar performance in the absence of the oil discovery. I provide support for the validity of the identification strategy in two ways: First, Figure 1.4 plots the log of the mean of real income for the treated and control groups. It shows that the two groups experienced similar trends in real income prior to 2007. After 2007, there was a higher increase in the income of households located close to Takoradi. Second, Table A.1 in the appendix presents the baseline characteristics between the treated and control groups. The table shows that, except for the age of the household head, there are no significant differences in the mean of the covariates between the treated and the control group in the pre-treatment period.

1.5 Main Results

Difference-in-differences analysis at the household level

In this section, I present the empirical results using the differences-in-differences analysis.

1.5.1 Effects on income

able 1.2 shows the estimated impact of offshore oil discovery on real income, measured as the log of real income. Columns 1 and 2 use dummy distance as the treatment indicator. This is the main measure of distance in my analysis. The results show that the offshore oil and gas discovery increased the income of households near Takoradi. The magnitudes of the effects suggest that the oil and gas discovery led to a 45% increase in real income. Columns 2 and 3 include all the control variables while column 1 is without controls. The results remain unchanged irrespective of whether or not I include controls.

Table 1.2: Effect of offshore oil discovery on real income

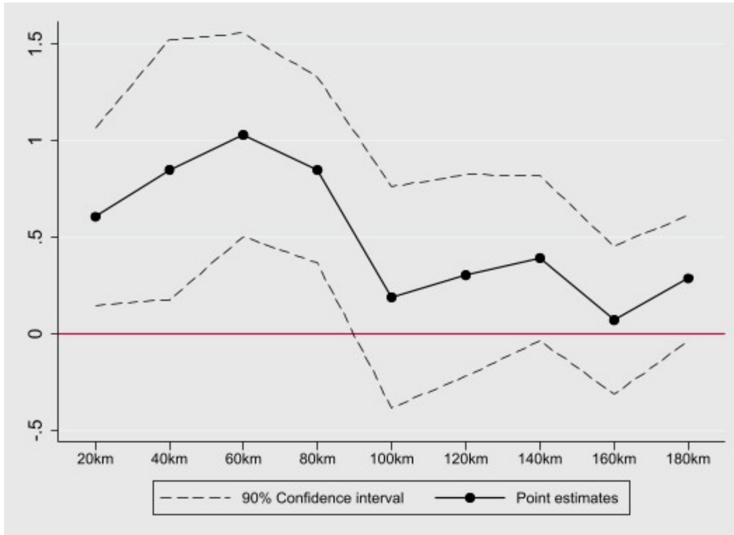
	(1)	(2)	(3)
Post * distance < 80km	0.455***	0.455***	
	(0.163)	(0.156)	
Post * continuous distance			-0.178*
			(0.084)
Includes controls	No	Yes	Yes
Observations	6,886	6,886	6,603
R-Squared	0.385	0.474	0.479

Notes: Column 1 does not include controls. Columns 2 and 3 control for age, gender and years of education of household head, number of household members, an indicator of urban household, distance to old oil fields and the capital city, Accra. Columns 1 and 2 use dummy distance as the measure of distance. Column 3 uses continuous distance measured in hundreds of kilometres. Robust standard errors, clustered at the cluster level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

1.5.2 Heterogeneous effect by distance

The approach I use in this analysis assumes that there is a heterogeneous exposure (by distance) to the shock from the oil discovery. I test this assumption in two ways: First, Column 3 in Table 1.2 uses continuous distance in hundreds of kilometres as the measure of distance. I estimate equation 1.1 using the interaction between the oil discovery and the continuous measure of distance. The estimate is negative and significant. This implies that the closer a household is to Takoradi, the higher their gain in income. Households living 100km closer to Takoradi experienced an 18% rise in their real income after the oil and gas discovery.

Figure 1.5: Effect of offshore oil discovery on real income: by distance to Takoradi



Second, I use spline distance as the measure of distance by splitting the households into 9 separate distance bands and grouping them in blocks of 20km. The first group consists of households located less than 20km from Takoradi, the second group includes households located between 20km to 40km from Takoradi and so on. Then, I estimate equation 1.1 using the interaction between the oil discovery and each distance dummy. Figure 1.5 plots the estimated parameters and the 90 percent confidence interval[17]. They are significant for households living less than 80km from Takoradi. After 80km, the estimates become insignificant. These results provide support for the choice of threshold used for the dummy distance in Table 1.2.

1.5.3 Effects of oil discovery by subgroups

Section 1.5.1 shows evidence of a positive effect of the oil discovery on households near Takoradi. However, these income gains may not be evenly distributed across different subgroups of the local population. I investigate these heterogeneous effects by examining human capital (measured by education) and poverty status at the district level. Since these variables can be influenced by the oil and gas discovery, I use their pre-discovery values to define a district's

[17] The regression results are presented in Table A.2 in Appendix

status. Highly skilled districts are defined as those where a large proportion of household heads had educational attainment above the median level observed across all districts before the discovery. Poor districts are those with poverty levels above the median. The results are presented in table 1.3. I find that the rise in real income is higher for households in districts with a large proportion of skilled workers. Furthermore, the oil and gas discovery significantly increased real income only in non-poor districts.

Table 1.3: Effect of offshore oil discovery on real income (By district-level education and poverty status)

	Education		**Poverty status**	
	Small % skilled	Large % skilled	Small % poor	Large % poor
Post * distance < 80km	0.360**	0.734**	0.419**	0.416
	(0.181)	(0.357)	(0.196)	(0.265)
Observations	3,672	2,540	3,744	2,735
R-squared	0.469	0.288	0.465	0.437

Notes: All regressions control for age, gender and years of education of household head, number of household members, an indicator of urban household, distance to old oil fields and distance to the capital city. Highly skilled districts are defined as those where a large proportion of household heads had educational attainment above the median level observed across all districts before the discovery. Poor districts are those with poverty levels above the median. Robust standard errors, clustered at the cluster level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

1.5.4 Effects on other measures of well being

I replicate equation 1.1 using other measures of standard of living. Table 1.4 displays the results for the effect of oil and gas discovery on household head's employment, household consumption expenditure, household poverty status and access to pipe-borne water. I find that the oil and gas discovery had no apparent effect on household head's employment. This implies that the increase in real income observed in section 1.5.1 may be due to a rise in wages and not through employment.

Panel B shows that the increase in income did not translate into an increase in total consumption expenditure for households located close to Takoradi. However, there is an 18% and a 31% increase in food and housing expenditure respectively [18]. I use household poverty status as the outcome variable and estimate equation 1.1 using a linear probability model. The estimates suggest that there is no significant decrease in poverty associated with the discovery of oil and gas. A possible explanation for this result is that, as discussed in Section 1.5.3, the income of poor households was not significantly affected by the discovery of oil and gas. Finally, I find a rise in access to pipe-borne water for households living close to Takoradi.

Table 1.4: Effect of offshore oil discovery on other measures of well being

	Employment			
Panel A	All workers	Agricultural workers	Manufacturing workers	Service workers
Post * distance < 80km	-0.019	-0.032	0.059	-0.027
	(0.085)	(0.079)	(0.054)	(0.073)
Observations	7,315	4,229	4,229	4,229
R-squared	0.166	0.409	0.073	0.276

Panel B	Ln(Total consumption expenditure)	Ln(Food expenditure)	Ln(Non-food expenditure)	Ln(Housing expenditure)	Poor	Access to pipe-borne water
Post * distance < 80km	0.115	0.180*	0.058	0.310***	-0.084	0.177**
	(0.089)	(0.107)	(0.095)	(0.111)	(0.069)	(0.090)
Observations	7,314	7,297	7,327	7,327	7,327	7,327
R-squared	0.454	0.297	0.508	0.734	0.259	0.532

Notes: All regressions control for age, gender and years of education of household head, number of household members, an indicator of urban household, distance to old oil fields and distance to the capital city. Skilled workers are workers with education higher than the secondary level. Poor households are those with their expenditure below the median level. Robust standard error, clustered at the cluster level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

1.6 Difference-in-differences at the individual level

The baseline estimation strategy captures household level effects. To explore individual level effects of the oil and gas discovery, I re-estimate equation 1.1, only now the treatment group are individuals living less than 80km from Takoradi. On the household level, total income

[18] Housing expenditure includes rent, expenses on fuel used in the house and expenses on maintenance of dwelling

included wages, agricultural income, income from self-employment and rental income. However, on the individual level, there is data on only wages. I use wage as the main outcome variable to investigate heterogeneity at the individual level. I deflate the wage variable with the regional price index. Table 1.5 presents the regression results. I find that the oil and gas discovery led to a 43% increase in real wages of workers living close to Takoradi.

There is a possibility of bias if my results are driven by migration or the compositional changes in the population. For example, if the oil discovery attracts only individuals in their prime years to Takoradi, the increase in income could be a result of this compositional change in population rather than the treatment. I address this concern in two ways: First, I investigate the effect of the oil and gas discovery on migration. I define migrants as people living in villages other than their place of birth[19]. I use migration as the outcome variable and re-estimate the baseline regression using a linear probability model. I find that there is no significant effect on migration to Takoradi and its surrounding areas in the period considered in my analysis.

Second, I investigate changes in workforce characteristics, including educational levels and the proportion of prime-aged workers (20-40 years old). The results indicate no significant changes in the labor force composition. This suggests that migration patterns and demographic factors did not drive the observed increase in real income.

1.7 Robustness Checks

I conduct two robustness checks: First, I explore the sensitivity of the results to the use of region fixed effects rather than district fixed effects. The results are shown in Table A.3 in the appendix. They are similar to the inclusion of district fixed effects.

Second, I perform a synthetic control analysis to complement the results from the difference-in-differences analysis. I construct the synthetic control group as the weighted combination of control districts that closely resemble the treatment districts in terms of selected predictors[20]

[19] The GLSS data includes details on individuals' place of birth and duration of stay in their current residence. Utilizing this information, I construct a variable representing the year of migration. This variable helps identify whether an individual migrated before or after the period of oil and gas discovery

[20] districts with synthetic control weights equal to zero are dropped from the sample

Table 1.5: Effect of offshore oil and gas discovery (Individual level analysis)

	Ln(real wages)	Migration	Years of education	Prime age
Post * distance < 80km	0.433*	-0.047	0.222	-0.007
	(0.237)	(0.037)	(0.213)	(0.029)
Observations	6,829	20,941	21,085	21,085
R-squared	0.237	0.133	0.173	0.033

Notes: All regressions control for age, gender and years of education of household head, number of household members, an indicator of urban household, distance to old oil fields and distance to the capital city. Wages include wages and bonuses. Prime age are individuals between the ages 20 and 40. Robust standard errors, clustered at the cluster level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

(see Table A.5 in the appendix). The predictor variables I use are the age and years of education of the household head, number of household members, real household expenditure and real household income. Figure A.1 in the appendix plots the standardized percentage bias across predictors[21]. It shows a reduction in the bias between the treated and synthetic control group as compared to the bias between the treated and the actual control districts.

Figure A.2 plots the trends in real income for households living in districts close to Takoradi and their synthetic equivalent. Notice that, Figure A.2 shows an improvement in the pre-trends as compared to Figure 1.4. However, both figures show a divergence in real income after the oil and gas discovery. For robustness, I perform the leave-one-out robustness check by iteratively re-estimating the model. In each iteration, I exclude one control unit from the donor pool. The results are displayed in Figure A.3. It shows that irrespective of the districts included in the donor pool, the treatment and synthetic control groups experienced a divergence in real income after the oil and gas discovery.

The empirical analysis replicates equation 1.1 and compares households living close to Takoradi to those in the synthetic control group. The estimated parameters are presented in Table A.4 in the appendix. The results complement those from the difference-in-differences

[21] Bias occurs when there is a covariate imbalance between the treated and control group

analysis.

1.8 Conclusion

This chapter examines the socio-economic effect of offshore oil and gas. Using geocoded data, I perform a difference-in-differences and synthetic control analysis to explore how natural resources interact with the local economy. I find that oil and gas discovery led to an increase in the real income of households located close to the oil and gas fields. These gains in real income are higher for skilled workers and concentrated in non-poor districts.

The results indicate that the impact on real income is driven by an increase in wages rather than employment. This likely explains why the positive effect on real income is more pronounced for skilled workers and is observed exclusively in non-poor districts. Government and policy makers can invest in skills training and education as a tool to increase employment. Investing in education and skills development programs can empower individuals from poor households to participate in the workforce. This can become an important mechanism through which oil extraction benefits poor households, especially if the oil and gas industry requires specific skills that can be developed locally.

The main limitation of this research is that I examine events occurring only a few years after the oil and gas discovery. Findings in this research should be considered as short-term effects. Future research can consider adding a more recent wave of the GLSS data to investigate the long-term effects. Further analysis can also explore alternate mechanisms such as fiscal revenue windfall and prices of goods and services as a channel through which natural resources affect the local population.

Appendix A

Table A.1: Baseline household characteristics between treatment and control groups

Variables	Mean Control	Mean Treated	Difference
Household head			
Age	35.297	36.199	0.901***
Years of Education	2.882	2.854	-0.028
Proportion Male	0.730	0.767	0.037
Household			
Number of household members	3.804	3.969	0.165
Proportion Urban	0.512	0.484	-0.028
Proportion poor	0.472	0.470	-0.001

Notes: The mean is calculated using sample weights and clustered at cluster level.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table A.2: Effect of offshore oil discovery on real income: by distance to Takoradi

	Ln(real income)	
Variables	Coefficient	Standard error
Post * distance $<$ 20km	0.606**	0.279
Post * 20km to 40km	0.850**	0.409
Post * 40km to 60km	1.03***	0.320
Post * 60km to 80km	0.848***	0.292
Post * 80km to 100km	0.189	0.347
Post * 100km to 120km	0.302	0.317
Post * 120km to 140km	0.393	0.260
Post * 140km to 160km	0.070	0.233
Post * 160km to 180km	0.287	0.198
Observations	4,428	
R-Squared	0.385	

Notes: All regressions includes district fixed effects. Robust standard errors are clustered at the cluster level.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table A.3: Effects of oil and gas discovery on living standards: region fixed effects

Panel A	Employment			
	All workers	Agricultural workers	Manufacturing workers	Service workers
Post * distance < 80km	-0.011	0.051	-0.006	-0.044
	(0.051)	(0.054)	(0.045)	(0.049)
Observations	7,315	4,505	4,505	4,505
R-squared	0.139	0.357	0.032	0.236
Panel B	Ln(real income)	Ln(consumption expenditure)	Poor	Access to pipe-borne water
Post * distance < 80km	0.341***	0.013	-0.011	0.068
	(0.125)	(0.070)	(0.050)	(0.071)
Observations	7,014	7,453	7,467	7,467
R-squared	0.452	0.418	0.222	0.449

Notes: All regressions control for age, gender and years of education of household head, number of household members, an indicator of urban household, distance to old oil fields and distance to the capital city. Poor households are those with their expenditure below the median level. Robust standard errors, clustered at the cluster level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table A.4: Effects of oil and gas discovery on living standards: Synthetic control analysis

Panel A	Employment			
	All workers	Agricultural workers	Manufacturing workers	Service workers
Post * distance < 80km	-0.114	0.026	0.021	-0.047
	(0.121)	(0.002)	(0.072)	(0.083)
Observations	3,616	2,227	2,227	2,227
R-squared	0.196	0.398	0.056	0.252
Panel B	Ln(real income)	Ln(consumption expenditure)	Poor	Access to pipe-borne water
Post * distance < 80km	0.406*	-0.034	0.033	0.215*
	(0.234)	(0.099)	(0.083)	(0.117)
Observations	3,317	3,471	3,478	3,478
R-squared	0.553	0.524	0.260	0.482

Notes: All regressions control for age, gender and years of education of household head, number of household members, an indicator of urban household, distance to old oil fields and distance to the capital city. Poor households are those with their expenditure below the median level. Robust standard errors, clustered at the cluster level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table A.5: Synthetic control weights

Districts	Synthetic control weight
Accra	0.2610
Asunafo North	0.2250
Asutifi	0.0940
Wassa Amenfi East	0.0790
Dormaa Central	0.0360
Asuogyaman	0.0210
Lower Manya Krobo	0.0180
Gomoa East	0.0160
Yilo Krobo	0.0150
Upper West Akim	0.0140
Suhum / Kraboa Coaltar	0.0130
Akwapim North	0.0130
Akyemansa	0.0110
East Akim	0.0110
Birim Central Municipal	0.0110
Ajumanku / Enyan / Essiam	0.0110
Bosumtwi	0.0110
Bosome Freho	0.0110
Atwima - Kwanwoma	0.0100
Akwapim South	0.0100
Birim South	0.0100
Amansie Central	0.0100
Offinso	0.0080
Kwaebibirem	0.0080
Awutu Senya East	0.0080
Ahafo Ano North	0.0080
Jomoro	0.0080
Upper Manya Krobo	0.0080
Wassa West	0.0080
Keta	0.0080
Asunafo South	0.0070
Adenta	0.0070
Dormaa East	0.0060
Amansie West	0.0050

Figure A.1: Predictor balance

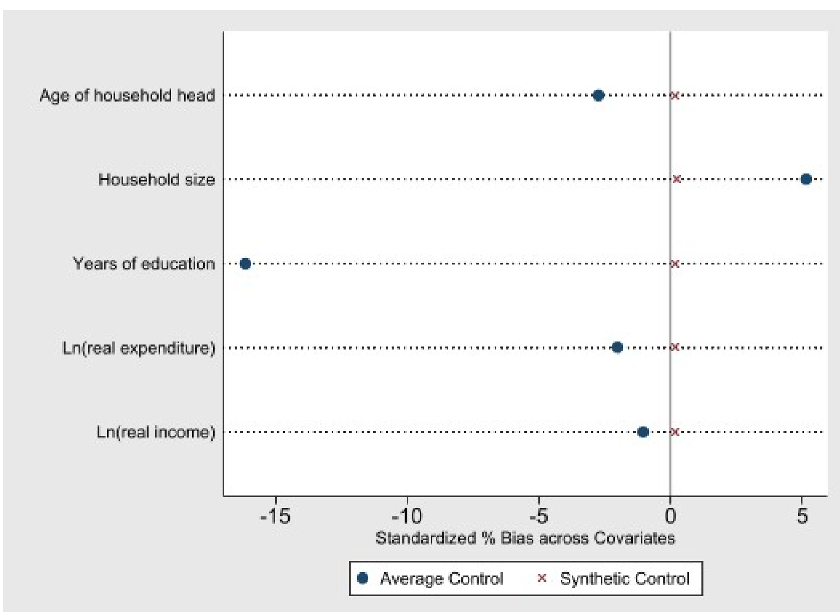


Figure A.2: Actual and predicted outcome

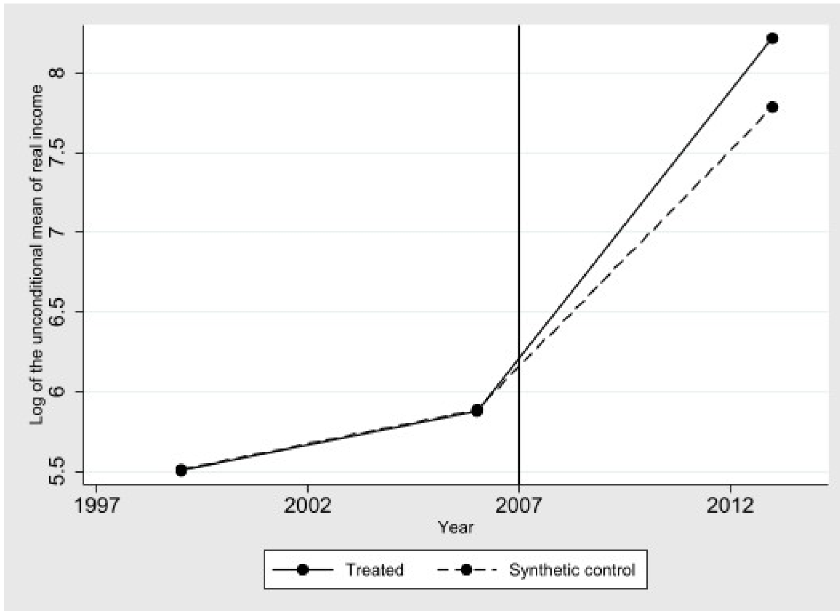
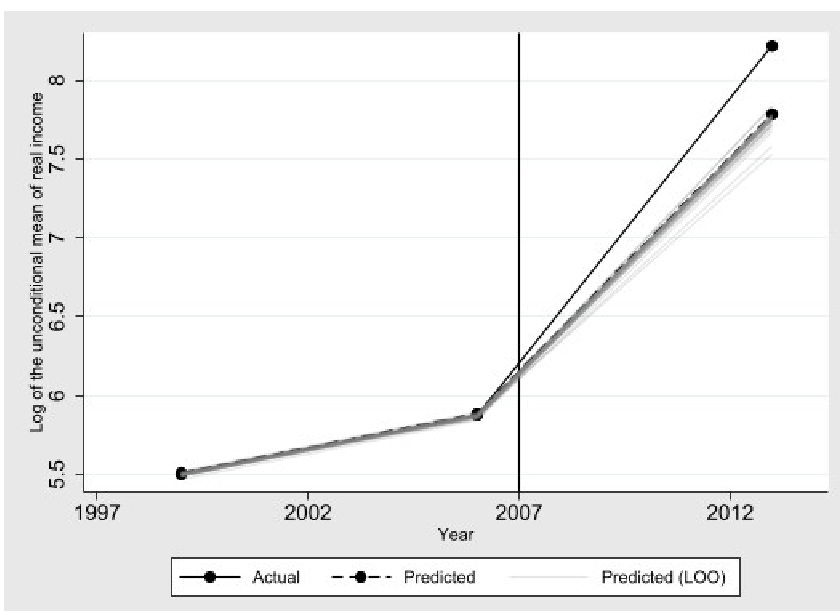


Figure A.3: Leave-one-out robustness test



Chapter 3

Natural-resource-driven structural transformation and economic growth: exploring the roles of forward and backward linkages

2.1 Introduction

There is concern that, despite the significant fiscal revenues generated by the export of natural resources, countries with abundant natural resources often experience lower economic development — a phenomenon referred to as the "natural resource paradox". Studies, including Sachs and Warner (1995) and more recent literature such as Gollin et al. (2016) and Ramdoo (2015), attribute this paradox to the high reliance on resource exports and insufficient economic diversification. Most resource-rich countries tend to have a high reliance on the fiscal revenue generated from commodity export without exploiting other channels through which the extractive sector can stimulate economic growth. This high reliance could limit development because the resource industries in themselves cannot generate much employment to facilitate the shift from low productivity to high productivity activities required for structural transformation and economic growth. Nonetheless, the resource industry may promote this shift through input-output linkages with other sectors, allowing growth in the natural resource sector to positively impact other sectors and overall economic development, thereby mitigating issues such as Dutch disease (Kaplan, 2016).

In this chapter, I perform a difference-in-differences analysis to examine forward and backward linkages as mechanisms through which natural resources drive structural transformation and economic growth. The research questions that I seek to answer are: i) What was the effect of the oil and gas discovery on economic outcomes? ii) What was the effect of the oil and gas discovery on the structure of the economy? The identification strategy exploits the timing of the oil and gas discovery along with variation in industrial composition across districts by comparing districts with high dependence on the oil and gas industry to other districts. Highly dependent districts are districts in which industries with strong linkages with the oil and gas industry make up a large share of employment. An industry's linkage with the oil and gas industry is measured by the proportion of inputs it purchases from or output it sells to the oil and gas industry.

I find that oil and gas discovery increased economic activity in districts that are highly dependent on the oil and gas industry. Economic activity is proxied by night-time light data. A one standard deviation increase in forward and backward linkages led to a 0.099 and 0.155 standard deviation increase in economic activities respectively. The results are robust to several checks such as the inclusion of satellite fixed effects, the inclusion of controls for districts with oil and gas companies present, and utilizing linkage measures from a neighbouring oil-producing country. Additionally, the findings show a structural shift in employment from agriculture to services, bypassing manufacturing. A one standard deviation increase in forward linkages (backward linkages) led to a 0.284 (0.252) standard deviation decrease in the employment share of agriculture and a 0.285 (0.263) standard deviation increase in the employment share of services.

Furthermore, I investigate the effect of oil and gas discovery on firms in industries that are highly dependent on the oil and gas industry. I find that firms with a strong backward linkage with the oil and gas industry experienced an increase in wages, sales and employment after the oil and gas discovery. However, oil and gas discovery did not have any significant effect on firms through the forward linkage channel. The results are robust to the inclusion of firm-level control variables.

This research contributes to the existing literature on how to promote economic diversification in resource-rich economies and the exploitation of linkages created by the extractive sector. Several studies have found that linkages between firms matter for structural transformation and economic growth (Acemoglu et al., 2017; Bigio & La'o, 2020; Carvalho et al., 2021; Chenery et al., 1986; Grobovšek, 2018; Herrendorf & Valentinyi, 2012; Hsieh & Klenow, 2007; Jones, 2011; Lui, 2019; Nchor & Konderla, 2016; Valentinyi, 2021). Other studies have also highlighted the role that the extractive sector plays in the creation of linkages and how countries can exploit them to promote economic diversification (Aroca, 2001; Bloch & Owusu, 2012; Buur et al., 2013; Cappelen & Mjøset, 2009; Leeuw & Mtegha, 2018; Lippert, 2014; Nchor, 2014; Ramdoo, 2015; San Cristóbal & Biezma, 2006; Stilwell et al., 2000; Teka, 2011). In Ghana, Nchor and Konderla (2016) explored the interactions between firms at the aggregate level and found that oil and gas extraction led to changes in sectoral dependence.

This research is closely related to the study by Aragón and Rud (2013), which investigated the local economic impact of a large mine expansion by comparing households located close to the mine to other households. Aragón and Rud (2013) found that, in the presence of backward linkages, the growth of the extractive industries can create positive spillovers in resource-rich economies. This research differs from the study in Aragón and Rud (2013) by adopting an identification strategy that exploits the timing of the oil and gas discovery, along with variation in industrial composition at the district level. To the best of my knowledge, this is the first research to adopt this identification strategy. Additionally, I use domar weights to provide novel insights into the interaction between the mining sector and the rest of the Ghanaian economy.

Findings from this research shed light on the potential economic spill-overs that the extractive sectors can create and their implications for structural transformation and economic growth.

2.2 The role extractive sectors play in the creation of linkages

2.2.1 Extractive sectors and inter-sectoral linkages

Linkages between local industries are key for domestic firm enhancement, skills and knowledge transfer, increased productivity, and economic diversification. They also drive job creation, poverty reduction, and economic development. Through the exchange of sales and purchases, linkages serve as a medium for interaction between sectors, translating shocks in one sector into changes in labour demand, productivity, and wages in another.

Jones (2011) and Valentinyi (2021) analysed intermediate inputs and their role in magnifying sectoral shocks' impact on GDP per capita. The results show that variation in production networks contributes to productivity and growth variation across countries. Just as positive sectoral shocks have positive multiplier effects on GDP, so can distortions in a sector translate into lower economic growth through sectoral dependence. Distortions in industries with strong linkages to the local markets tend to have larger aggregate effects because they propagate along the supply chains affecting consumers and suppliers directly and indirectly. Lui (2019) suggested that industrial policies should prioritize fixing distortions in these industries even if the distortions are relatively smaller.

Extractive industries have unique characteristics which give them an advantage in creating various degrees and types of linkages: they are spatially concentrated which provides an advantage for local suppliers and their projects can last for several years. They vary in size, demand a wide variety of inputs and their outputs have different uses both as intermediate and final goods (Buur et al., 2013; Ramdoo, 2015). Table 2.1 shows an example of the equipment and services needed at the various stages of oil and gas exploration. Additionally, oil and gas output can be used both as finished goods (fuel, gasoline and lubricants) and intermediate input to produce chemicals, plastics, fertilizers, solvents, pesticides, pharmaceuticals, petroleum-based fibres, electronics, health and beauty products as well as hundreds of other end-user products. This affects the degree to which local producers can connect to the extractive sector.

In Norway, growth in the petroleum industry created forward and backward linkages which led to industrial development and an increase in the production of manufacturing goods and capital equipment (Cappelen & Mjøset, 2009). Similar results were observed in copper mining in Zambia (Lippert, 2014). According to Leeuw and Mtegha (2018), the mining industry in South Africa has a strong forward and backward linkage with the manufacturing sector. The mining industry sold about US$ 24.8 billion worth of products to the local manufacturing industries and bought US$ 7.4 billion worth of inputs from them in 2010.

Contrary to the findings of Leeuw and Mtegha (2018) and Lippert (2014), other studies found weak forward and backward linkages between the mining sector and other sectors in Ghana (Bloch & Owusu, 2012; Nchor, 2014), in the Chilean II region (Aroca, 2001) and South

Table 2.1: Oil and gas equipment and supporting services

Activities	Equipment and services
Upstream activities (Backward linkage)	Engineering and architecture, risk assessment, mining equipment and services, laboratory technician, drilling and construction services, geological and related services, information technology and communication services
Midstream activities (Backward linkage)	Transport services, storage and waste disposal services accommodation and catering services, cleaning and maintenance services, platform and rig operations
Downstream activities (Forward linkage)	Insurance and finance services, sales and marketing consultants logistics, distribution services, refinery services

Source: *Author*

Africa (Stilwell et al., 2000). Even though the opportunity exists for the creation of these linkages, local suppliers are often unable to meet the requirements for providing goods and services to the mining industries. Factors that account for the existence of weak linkages include inadequate knowledge networks, weak industrial base and the absence of or ineffective local content practice (Nchor & Konderla, 2016; Teka, 2011).

In Ghana, Nchor and Konderla (2016) examined changes in inter-sectoral linkages after the oil discovery. The findings suggest that the petroleum industry has weak forward linkages with the rest of the economy as compared to other industries because a large proportion of its outputs are exported in their raw state with little local value addition. However, the industry has the potential to create promising economic linkages if it is strengthened with effective industrial policies.

2.2.2 Mechanisms of sectoral shock transmission between sectors

A shock in the natural resource sector can have spillover effects on other sectors and propagate through the economy via several mechanisms. These include:

Dutch disease: This arises when a natural resource boom drives up the local currency's value, making non-resource sectors less competitive, potentially causing job losses in tradable sectors such as manufacturing, and reducing economic diversification as countries become overly reliant on resource exports.

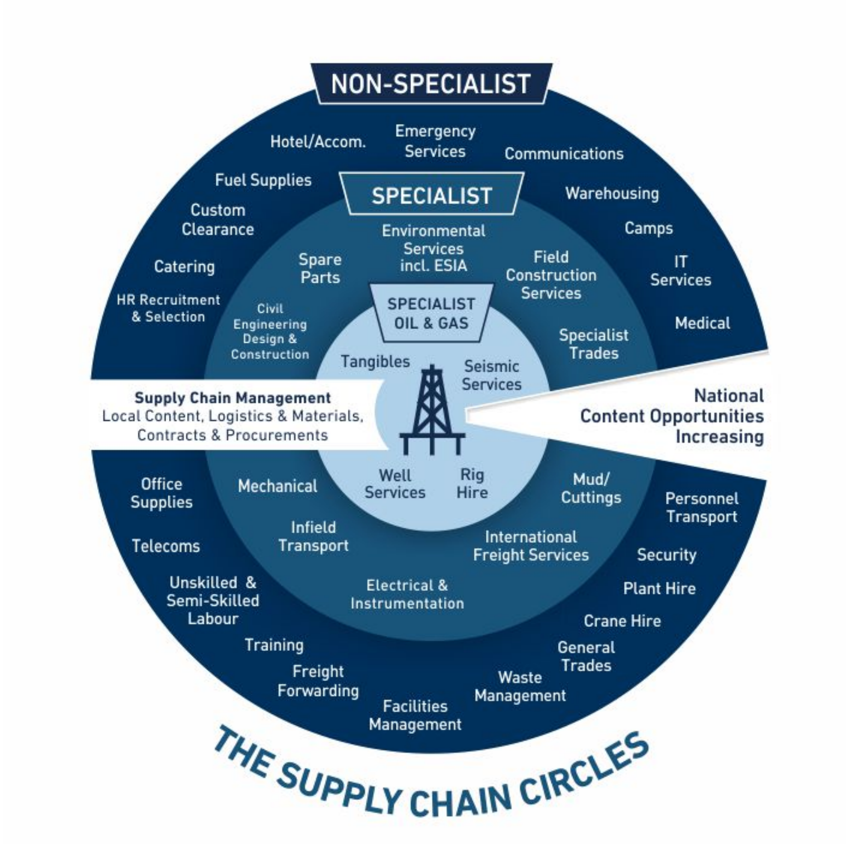
Labour market linkages: Labour market linkages refer to the connections between sectors through labour mobility. In the context of a resource boom, higher wages in the resource sector attract workers with similar skills from other sectors, reducing labour supply and increasing labour costs for non-resource sectors, leading to reduced output and employment. This effect depends on factors such as labour substitutability, mobility, and resource sector job availability.

Consumer spending or income effect: This effect results from changes in the consumption choices of natural resource sector workers. A resource boom increases their income and consumer spending, creating positive spillovers on sectors supplying goods and services to these workers, impacting investment as firms adapt to shifting consumer demand. The extent of this consumer spending effect relies on the income elasticity of goods and services in various sectors.

Input-Output linkages: Input-output linkages are the mutual dependencies between sectors in terms of intermediate input exchange. For instance, the petroleum industry relies on inputs such as machinery, chemicals, transport services, and geological services from sectors such as manufacturing and services (see Figure 2.1). Simultaneously, it supplies intermediate goods to sectors such as transportation, chemical manufacturing, and agriculture. A natural resource sector boom affects other sectors by increasing demand for intermediate goods and input supply to sectors using resource sector outputs as intermediates. The transmission of shocks through input-output linkages depends on inter-sectoral interdependence and input responsiveness to availability and price changes.

This research focuses on the input-output linkages between sectors. Specifically, I explore backward or upstream linkages (the procurement of inputs from non-extractive industries) and forward or downstream linkages (the processing of outputs from the extractive industries) as a mechanism of shock transmission through which oil and gas discovery affects struc-

Figure 2.1: Petroleum industry's supply chain

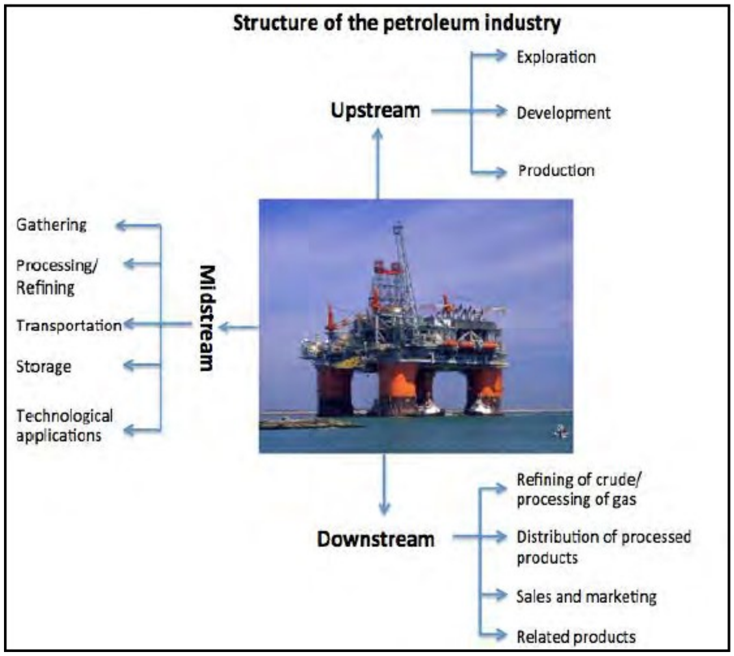


Source: **Tullow Oil**

tural transformation and economic growth. Backward linkages focus on the supply of inputs to extractive industries. An industry's backward linkages are strong if it sells a large proportion of its output to the extractive industry. Forward linkages focus on the demand for outputs from extractive industries. An industry's forward linkages are strong if it purchases a larger proportion of its input is from the extractive industry. Industries with strong forward and backward linkages play an important role in stimulating the local market and promoting economic development (San Cristóbal & Biezma, 2006).

Petroleum industries create several linkage opportunities during their operations (see Figure 2.2). It involves a high demand for inputs from other sectors and the production of goods that are used by other sectors as inputs. This creates an opportunity for countries to cluster

Figure 2.2: Structure of the petroleum industry



Source: *Ramdoo (2015)*

other non-extractive industries around the petroleum industries as a diversification mechanism.

2.2.3 Overview of industrial Domar-weights

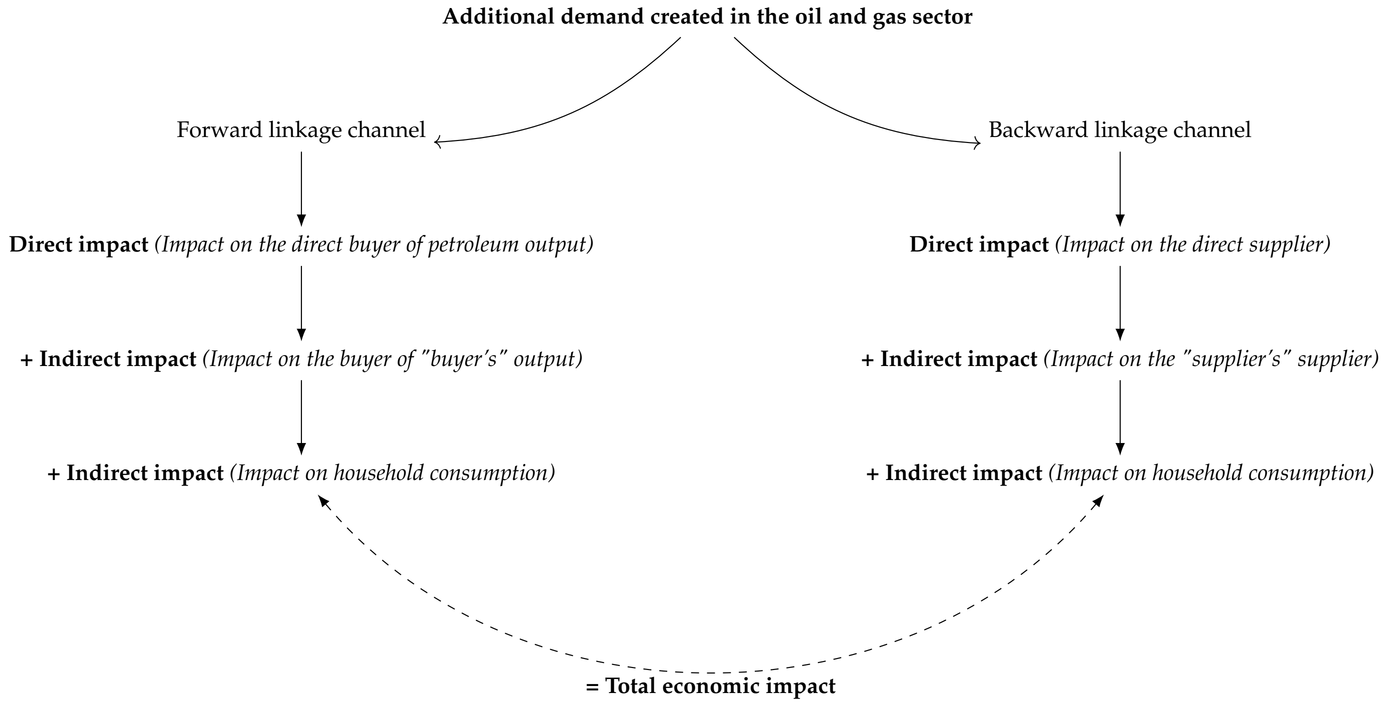
The economic activity in an economy is usually separated into several producing sectors. Sectoral linkages imply that these sectors are interdependent. A product from one sector can be used as intermediate input by another sector in its production process. For example, the extraction and processing of petroleum requires the use of laboratory and geological equipment, transport services and cleaning services. Similarly, oil and gas output can be used as an intermediate input to produce chemicals, electronics and beauty products. When we purchase a petroleum output, we indirectly affect the demand for laboratory equipment, transport and cleaning services as well as the supply of inputs for chemicals and electronic production. Hence, the effect of additional demand created in a sector can propagate to other sectors through the input-output channels.

Valentinyi (2021) provides a model of the economic input-output network and its relevance for structural transformation and productivity growth. The model assumes, among other things, that each sector's output can be used as either an intermediate input or for final consumption. According to Valentinyi (2021), the first-order effect of the sale of a product in a sector is the effect it has on the demand for its intermediate inputs. The second-order effect occurs when the intermediate input supplier in turn uses output from a third sector in its production process. For example, the first-order effect of an additional demand created in the petroleum industry is its effect on the demand for laboratory equipment, transport and cleaning products. The second-order effect is when the increase in demand for transport services leads to a rise in the demand for cars. The total effect of the additional demand for a petroleum product on GDP is the sum of the first-order effect and all subsequent higher order effects. This total effect is also known as the Domar-weight of an industry.

Domar-weights measure the relative importance of a sector in an economy. Valentinyi (2021) shows that the Domar-weight of a sector can be derived as the sum of its direct effect (through final demand or value-added) and its indirect effect (through the flow of intermediate goods between sectors) on GDP (see Figure 2.3). This implies that a sector with a relatively small value added can have a large impact on GDP if additional demand created in the sector has large effects on the demand for output from other sectors.

With this framework in mind, I use supply and use tables obtained from the Ghana Statistical Services (GSS) to calculate the Domar-weights for sectors in Ghana (see Figure 2.4). I do this by first converting the supply and use table into an input-output table following the methodology in Milletler (2018). I then transform the input-output table into a Leontief matrix and use it to calculate the Domar-weights. In the calculation of the Domar-weights, I adopt two approaches: First, I look at a sector's contribution domestically by excluding exports. Second, I include exports to analyse the total contribution of a sector. The Domar-weights calculated with and without exports are shown in Figure 2.4.

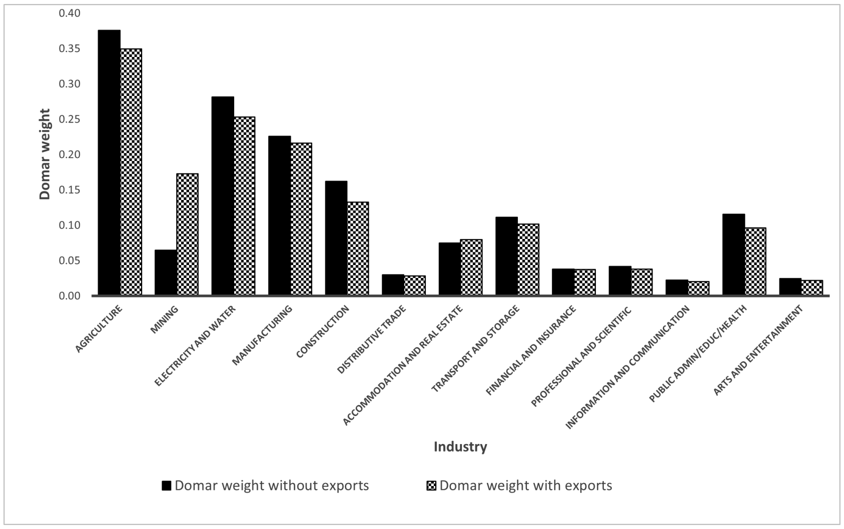
Figure 2.3: Total economic impact of an additional demand created in the petroleum sector



The focus of this research is the mining sector which comprises the oil and gas industry and other extractive industries. Figure 2.4 shows that without exports, the mining sector has a relatively small impact on the economy. However, when exports are included, the mining sector becomes a relatively important sector in the economy. This implies that most of the impact that the mining sector has on GDP is through its effect on exports with little stimulation of the domestic economy. This conclusion complements the findings in Kapstein and Kim (2011) and Nchor and Konderla (2016) which posit that although the mining sector's contribution to GDP is high, its linkage with other sectors of the economy is weak. To some extent, this provides support for the hypothesis that most resource-rich countries have a high-reliance on commodity export without exploiting other channels through which the extractive sector can stimulate the local economy.

Existing literature suggests that there is potential for resource extraction to stimulate economic growth if countries exploit the input-output linkages that exist between sectors (Buur

Figure 2.4: Domar weight for industries in Ghana



Source: *Data obtained from GSS*

et al., 2013). In other words, with the several linkage opportunities created by the oil and gas sector during its operations (see Figure 2.2), the sector has a large untapped potential for stimulating development.

2.3 Data and Method

2.3.1 Data

To conduct the empirical analysis, I use data from the National Oceanic and Atmospheric Administration (NOAA), Ghana Statistical Service (GSS), the World Bank and the Global Trade Analysis project (GTAP). I obtain input-output (IO) tables from GTAP to determine inter-sectoral linkages. The IO tables cover the years 2004 and 2007. The linkage variable I use in my analysis is an average of both years. The forward linkage variable U_i is the share of input purchased from the oil and gas industry by industry i. It can be expressed as:

$$U_i = \frac{U_{pi}}{\sum_j U_{ji}} \tag{2.1}$$

where U_{pi} is the total input purchased from the petroleum industry p by industry i and $\sum_j U_{ji}$ is the total input purchased by industry i from all industries.

The backward linkage variable V_i is the share of output sold to the oil and gas industry by industry i. It can be expressed as:

$$V_i = \frac{V_{pi}}{\sum_j V_{ji}} \tag{2.2}$$

where V_{pi} is the total output sold to the petroleum industry p by industry i and $\sum_j V_{ji}$ is the total output sold by industry i to all industries. The total linkage variable is a sum of the forward and backward linkages.

For the district-level analysis, I use night-time light data from the Defense Meteorological Satellite Program (DMSP) obtained from the National Oceanic and Atmospheric Administration (NOAA). It is an annual dataset covering the years 1992 to 2013. The sample for this analysis consists of 104 districts. The main outcome variable for this analysis is economic activity which is proxied by night-time light intensity. The pixel values vary on a scale from 0 to 63. The higher the pixel value, the more intense the night-time light. I use the average value of all the pixels in a district. The summary statistics are presented in panel A in Table 3.1. Additionally, I use data from the Ghana Housing and Population Census obtained from the Ghana Statistical Service (GSS) covering the years 2000, 2010 and 2020[22]. The main outcome variable for this analysis is the employment share of a sector in a district. The sample for this analysis consists of 110 districts.

To perform the firm-level analysis, I use firm data from the World Bank Enterprise Survey. They are repeated cross-section data covering the years 2007 and 2013. My sample consists of 1,279 firms in 12 industries. The outcome variables are real sales, real wages and total employment[23] of a firm in an industry. I deflate the sales and wage variables with the yearly price index. The summary statistics for the firm data are presented in Panel B in Table 3.1.

[22]Due to COVID-19, the 2020 census had to be conducted in 2021

[23]Total employment includes both permanent and temporary employment

Table 2.2: Summary Statistics II

PANEL A (DISTRICT LEVEL)			
Variables	Obs	Mean	Standard deviation
Light pixel value	3,536	2.403	7.331
District forward linkage	3,536	0.445	0.247
District backward linkage	3,536	0.254	0.192
District total linkage	3,536	0.700	0.400

PANEL B (FIRM LEVEL)			
Variables	Obs	Mean	Standard deviation
Nominal sales	1,279	2,642,174	2.14e+07
Nominal wages	1,160	2,199.704	10464.13
Total employment	1,142	39.090	125.035
Firm forward linkage	1,279	0.046	0.190
Firm backward linkage	1,279	0.021	0.035
Firm total linkage	1,279	0.067	0.188
Manager's years of experience	1,279	14.651	9.722
Part of a larger firm (%)	1,279	7.35	0.261

Notes: The forward linkage variable represents the percentage of inputs purchased from the oil and gas industry by a firm, while the backward linkage variable represents the percentage of output sold to the oil and gas industry by a firm.

2.3.2 Identification Strategy

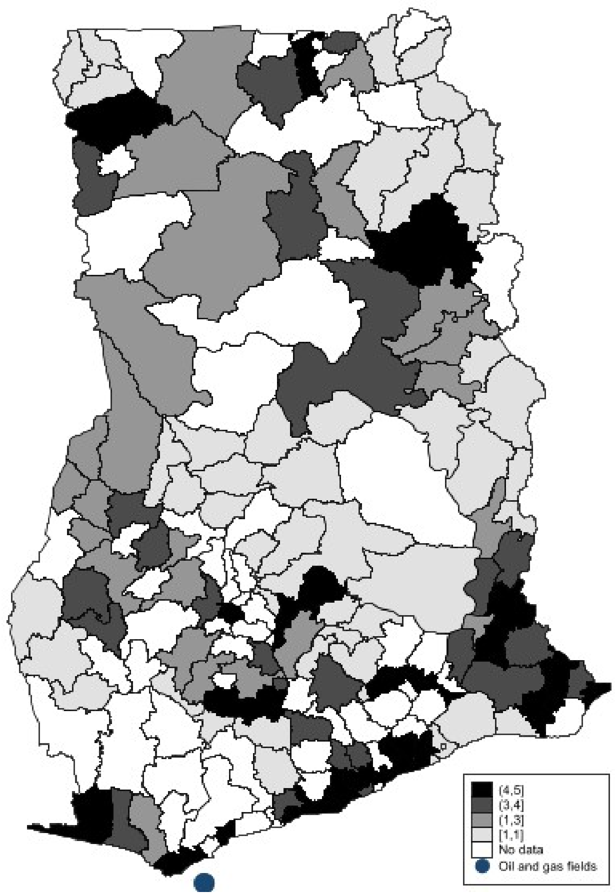
I perform a difference–in-differences analysis using the years after 2007 as the treatment period and compare districts with a strong dependence on the oil and gas industry to other districts before and after the oil discovery. The identification strategy exploits variation in industrial composition across districts. It assumes that, without the discovery of oil and gas, all districts would experience similar trends in their economic activities.

2.3.3 Analysis of economic activity

The baseline regression is:

$$Y_{dts} = \alpha + \delta_d + \rho_t + \mu_s + \beta D_d * Post_t + \epsilon_{dts} \tag{2.3}$$

Figure 2.5: Districts in Ghana (by district dependence)



where Y_{dts} is the outcome variable (economic activity: proxied by night-time light data)[24] in district d in time t by satellite s. ρ_t, δ_d and μ_s are time, district and satellite fixed effects respectively[25]. D_d is a continuous variable representing "District dependence". Following Acemoglu and Linn (2004), Goldsmith-Pinkham et al. (2020), and Greenstone et al. (2020), I construct D_d as a Bartik-like variable[26]. It is the inner product of the industry employment shares in district d and the degree of dependency of an industry on the oil and gas industry:

$$D_d = N_d L = \sum_{i=1}^{I} n_{id} l_i \tag{2.4}$$

[24] The use of night light data as a proxy for economic growth was first introduced by Henderson et al., 2012. Bruederle and Hodler (2018) further highlighted that night-time light data is a good proxy for measuring local-level human development in 29 African countries including Ghana.

[25] Satellite fixed effects are included to address the problem of inter-satellite differences in the DMSP data (Gibson et al., 2020)

[26] The Bartik-like variable typically involves constructing a weighted index that represents the exposure of different regions or areas to an event or policy

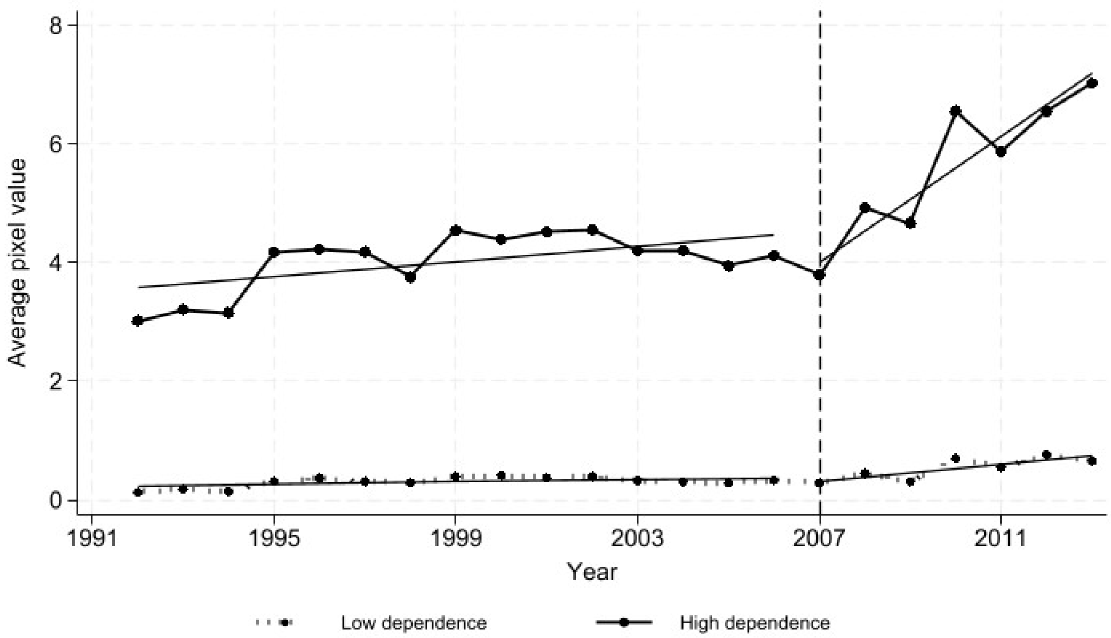
where N_d is a vector of employment shares of an industry in a district. The employment share of an industry is the ratio between the total employment of an industry in a district and the total employment in a district. L is a vector of industry dependence on the oil and gas industry where the i^{th} entry is l_i. Industrial dependence measures the extent of the forward or backward linkage between an industry and the oil and gas industry. In other words, an industry is considered highly dependent on the oil and gas industry if it either provides inputs to the petroleum industry (such as equipment, machinery, raw materials, or services) or processes raw materials from the petroleum industry into intermediate or finished goods.

In equation 2.4, D_d measures the degree of dependency of a district on the oil and gas industry (see Figure 2.5). I fix N_d and L to an initial period prior to the oil and gas discovery to exploit a single cross-sectional difference in district exposure. Hence, changes to the outcome variable may be attributed to the oil and gas discovery and not to changes in N_d and L. $Post_t$ is a dummy that takes the value one in the post oil discovery period (2007). The parameter of interest, β compares economic activities in districts with high dependency on the oil and gas industry to other districts before and after the oil discovery.

This approach exploits variation in industry composition across districts. Even though the oil and gas discovery is a nationwide shock, it may have varying effects on the local labour market because most industries are spatially concentrated. Hence, the spatial location of an industry can be a source of variation in assessing the impact of oil and gas discovery.

Figure 2.6 provides support for the validation of this identification strategy. In figure 2.6, I split the sample into two quantiles based on their district dependence and plot the light intensity recorded in the two groups before and after the oil and gas discovery. The figure shows that prior to the oil discovery, the two groups experienced similar trends in economic activities. However, after the oil and gas discovery, the economic activities in districts with high dependence increased more than in districts in the control group. Note that, this approach assumes a fixed district dependence on the oil and gas industry, which overlooks the potential for low dependent districts becoming high dependent after the oil and gas discovery if new high dependent industries emerge in these districts. While the approach may capture the effect of new highly dependent industries in already dependent districts, it may underestimate the impact if such industries emerge in low dependent districts. To the extent that this occurs, the true effect of the oil and gas discovery could be larger than indicated by this research.

Figure 2.6: Economic activity in a district (by district dependence)



2.3.4 Analysis of the structure of the economy

I also evaluate the effect of the oil and gas discovery on the distribution of employment between the three main sectors (Agriculture, Manufacturing and Service) in the economy. I estimate the following regression:

$$Y_{kdt} = \alpha + \rho_t + \delta_d + \beta D_d * Post_t + \epsilon_{kdt} \tag{2.5}$$

where Y_{kdt} is the outcome variable (employment share) of sector k (Agriculture, Manufacturing and Service) in district d at time t. It is the ratio between the total employment of a sector in a district and the total employment in a district at time t. ρ_t is year fixed effects, δ_d is district fixed effects, D_d is district dependence and $Post_t$ is a dummy variable that takes the value one in the post oil discovery period. The parameter of interest, β compares the distribution of employment between the three main sectors in districts with high dependence to other districts before and after the oil discovery.

2.3.5 Analysis of firm performance

The identification strategy in sections 2.3.3 and 2.3.4 exploits variation based on industrial dependence across districts. In this section, I explore only variation across industries as a mechanism to investigate the effect of the oil and gas discovery on firms. The identification strategy assumes that, without the discovery of oil and gas, all industries would experience similar trends in their performance. A limitation of this approach is that it suffers from the "few" clusters problem because there are 12 industries in my sample[27]. I account for this by using wild cluster bootstrap (Cameron et al., 2008; Cameron & Miller, 2015; Donald & Lang, 2007).

I perform the following estimation:

$$Y_{fit} = \alpha + \rho_t + \lambda_i + \beta Degree_i * Post_t + \eta X_{fit} + \epsilon_{fit} \tag{2.6}$$

where Y_{fit} is the outcome variable (sales, wages, employment share) of firm f in industry i at time t, ρ_t is year fixed effects, λ_i is industry fixed effects, $Degree_i$ is a continuous variable representing the degree of industry dependency on the oil and gas industry. $Post_t$ is a dummy that takes the value one in post oil discovery period (2007), X_{fit} is a vector of firm-level control variables (whether the establishment is part of a larger firm, the manager's experience and the formal training of a worker). In this approach, β compares sales, wages and employment shares of firms in industries with high dependency on the oil and gas industry to other firms

[27] When the number of clusters is small, OLS provides a biased estimation (Cameron & Miller, 2015; Donald & Lang, 2007)

before and after the oil discovery.

2.4 Main Results

2.4.1 Effects on economic activities in a district

Table 2.3 presents the results from estimating the effect of offshore oil and gas discovery on economic activities in districts. Economic activity is measured by the night-time light intensity in a district. I standardized the pixel values as well as the forward, backward and total linkage variables to simplify the interpretation of estimates. In columns 1 to 3, district dependence is a continuous variable. This is the main measure of district dependence in my analysis. These results imply a positive effect of offshore oil and gas discovery on economic activities in districts that are dependent on the oil and gas industry. A one standard deviation increase in forward linkages led to a 0.099 standard deviation increase in economic activity. The effects through the backward and total linkages channels are slightly higher.

Table 2.3: Effect of offshore oil discovery on economic activity (proxied by night-time light data)

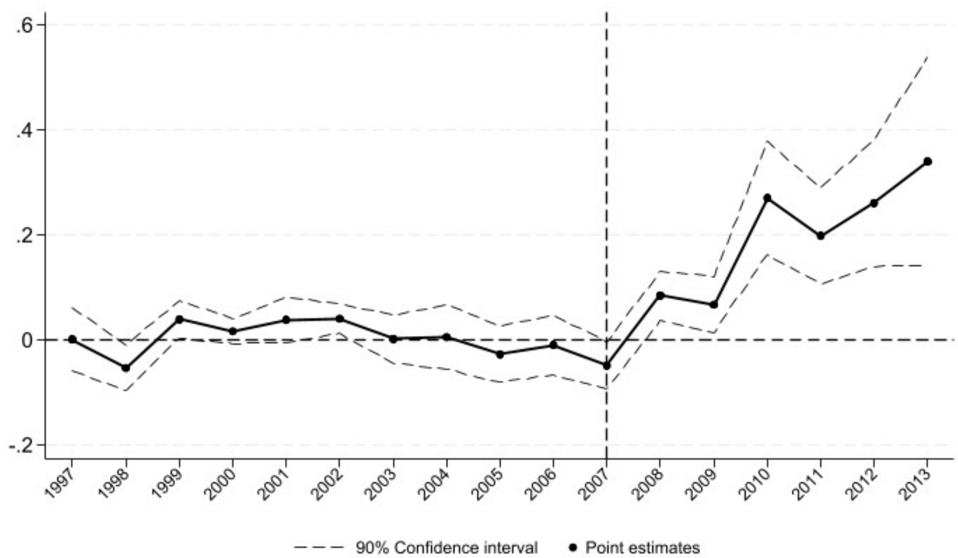
	(1)	(2)	(3)	(4)	(5)	(6)
Post* forward linkage	0.099**			0.142***		
	(0.039)			(0.039)		
Post* backward linkage		0.155***			0.153***	
		(0.046)			(0.039)	
Post* total linkage			0.136***			0.145***
			(0.040)			(0.039)
Measure of district dependence	Continuous	Continuous	Continuous	Dummy	Dummy	Dummy
Observations	3,536	3,536	3,536	3,536	3,536	3,536
R-Squared	0.963	0.966	0.964	0.962	0.962	0.962

Notes: In columns 1 to 3, district dependence is a continuous variable. In Columns 4 to 6, district dependence is a dummy variable. Forward linkage is the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

In Columns 4 to 6, district dependence is a dummy variable. To create the dummy variable, I split the sample into two quantiles based on their district dependence. Districts above the 50th percentile are those that are highly dependent on the oil and gas industry. These are the districts in the treatment group. The results complement the findings in columns 1 to 3. Districts that are highly dependent on the oil and gas industry experienced a rise in their economic activities after the oil and gas discovery. A one standard deviation increase in forward and backward linkages led to a 0.142 and 0.153 standard deviation increase in economic activity respectively.

To provide further support for the results in Table 2.3, I perform an event study to investigate

Figure 2.7: Effect of offshore oil discovery on economic activities (Event study: by district dependence)



the effect of oil and gas discovery flexibly over time. To do this, I re-estimate equation 2.3 using an interaction between the district dependence dummy and each year's dummy. Figure 2.7 presents the results. The estimates for the pre-oil discovery period are close to zero and insignificant. In the period after the oil and gas discovery, there was a steady increase in economic activities in highly dependent districts. This suggests that the oil and gas discovery had a positive effect on economic activities in districts dependent on the oil and gas industry.

2.4.2 Effects on economic activities in a district: controlling for the location of oil and gas companies

In this analysis, industries with a strong linkage with the oil and gas industry make up a large share of employment in highly dependent districts. However, the oil and gas industry itself is located in some of these districts (see Figure B.1 in Appendix B). That is, these districts have either the headquarters of the petroleum industry, an oil and gas refinery, an onshore support base facility or processing plants. The positive effect observed in section 2.4.1 could be a result of growth in the oil and gas industry itself and not growth in highly dependent industries. If this was the case, then the hypothesis of the effect of the oil and gas industry on economic activity through its effect on other industries would be invalidated.

I address this by first performing an event study to explore if districts with oil and gas companies experienced a change in their economic activity after the oil and gas discovery. I do this by creating a location dummy which takes the value one if a district has an oil and gas company (the treated group) and zero otherwise. Then, I estimate equation 2.3 using the interaction between the location dummy and each year dummy. The estimates are plotted in Figure B.2 in Appendix B. It shows that prior to the oil and gas discovery, there were no significant differences in the economic activities in districts with and without oil and gas companies. However, in the periods after the oil and gas discovery, districts with oil and gas companies experienced an increase in their economic activities as compared to other districts. This implies that the oil discovery led to growth in the oil and gas industry itself which translated into growth in districts where these industries are located.

To investigate whether the positive effect of the oil and gas discovery on highly dependent districts observed in section 2.4.1 is not solely driven by the presence of the oil and gas companies in these districts, I include a control variable in equation 2.3 for the location of oil and gas companies and re-estimate the results. This approach is to isolate the relationship between district dependence on the oil and gas industry and district economic activity by holding con-

Table 2.4: Effect of offshore oil discovery on economic activity (proxied by night-time light data: controlling for the location of oil and gas companies)

	(1)	(2)	(3)
Post* forward linkage	0.082***		
	(0.031)		
Post* backward linkage		0.140***	
		(0.036)	
Post* total linkage			0.119***
			(0.030)
Observations	3,536	3,536	3,536
R-Squared	0.963	0.965	0.964

Notes: Forward linkage is the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

stant the effects of the location of the oil and gas companies. The estimates are in Table 2.4. The results still show a positive effect of the oil and gas discovery on economic activity in highly dependent districts[28]. Nevertheless, the magnitudes of the estimates have reduced. A one standard deviation increase in forward and backward linkage led to a 0.082 and 0.140 increase in economic activity respectively. These findings suggest that the positive effect of the oil and gas discovery on economic activity is not solely driven by growth in the oil and gas industry itself but also growth in highly dependent industries.

2.4.3 Effects on the structure of the economy

Table 2.5 shows the results from estimating the effect of the oil and gas discovery on the structure of the economy. The outcome variable is the standardized employment share of the three main sectors (agriculture, manufacturing and services) in a district. Columns 1 to 3 use the employment share of agriculture as the outcome variable. Columns 4 to 6 use employment share of manufacturing as the outcome variable. Columns 7 to 9 use employment share of services

[28]The results are robust to the exclusion of districts with oil and gas companies present

as the outcome variable. Panel A does not control for location of oil and gas companies.

The results suggest that districts that are highly dependent on the oil and gas industry experienced a decrease in the employment share in agriculture and an increase in the employment share in services. A one standard deviation increase in forward (backward) linkages led to a 0.284 (0.252) standard deviation decrease in the employment share of agriculture and a 0.285 (0.263) standard deviation increase in the employment share of services. Note that, the estimates in each row add up to zero. This implies that, in high dependence districts, labour was reallocated from agriculture to services, bypassing manufacturing. Panel B controls for the location of oil and gas companies. The results are similar to those in Panel A.

Table 2.5: Effect of offshore oil discovery on the structure of the economy

PANEL A	Agriculture			Manufacturing			Services		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post* forward linkage	-0.284**			-0.001			0.285**		
	(0.122)			(0.030)			(0.118)		
Post* backward linkage		-0.252**			-0.011			0.263**	
		(0.110)			(0.033)			(0.106)	
Post* total linkage			-0.266**			-0.007			0.273**
			(0.115)			(0.032)			(0.111)
Observations	319	319	319	319	319	319	319	319	319
R-Squared	0.726	0.725	0.726	0.557	0.557	0.557	0.751	0.750	0.750
PANEL B	Agriculture			Manufacturing			Services		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post* forward linkage	-0.320**			0.006			0.314**		
	(0.126)			(0.024)			(0.127)		
Post* backward linkage		-0.287***			-0.004			0.291**	
		(0.108)			(0.027)			(0.111)	
Post* total linkage			-0.302**			-0.0004			0.301**
			(0.115)			(0.025)			(0.118)
Observations	319	319	319	319	319	319	319	319	319
R-Squared	0.730	0.729	0.729	0.559	0.559	0.559	0.754	0.754	0.754

Notes: Columns 1 to 3 show the employment share of agriculture. Columns 4 to 6 show the employment share of manufacturing. Columns 7 to 9 show the employment share of services. Panel A does not control for location of oil and gas companies. Panel B controls for the location of oil and gas companies. Forward linkage represents the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

The results indicate that the service sector exhibits strong linkages with the oil and gas industry, while the manufacturing sector has weak linkages. In Ghana, most manufacturing inputs for the oil and gas industry are imported because they are expensive and cannot be provided by local suppliers, contributing to the weak backward linkage (Nchor, 2014). Furthermore, the manufacturing sector's forward linkage with the oil and gas industry may be weakened because a large portion of petroleum products are exported in their raw state, making manufacturers more reliant on imports for petroleum-based inputs. In contrast, even with raw petroleum product exports, various service industries, including transportation, logistics, engineering, maintenance, and legal and financial services, closely support the oil and gas industry, and these services can be easily provided by local entrepreneurs, resulting in a strong linkage between the service sector and the petroleum industry.

2.4.4 Effects on real sales, real wages and employment share of firms

The results from exploring only variations across industries are presented in Table 2.6. I use the log of wages, sales and employment as the outcome variables. Panel A uses wages as the outcome variable. Panel B uses sales as the outcome variable. Panel C uses employment as the outcome variable. Columns 1 to 3 do not include controls. The results show that firms in industries with strong backward linkage with the oil and gas industry experienced an increase in wages, sales and employment. A one standard deviation increase in backward linkage resulted in a 32% , 53% and 27% increase in wages, sales and employment respectively. However, oil and gas discovery did not have any significant effect on firms through the forward linkage channel. Columns 4 to 5 include firm level control variables. The estimates are similar to those without controls.

2.5 Robustness Checks

In section 2.4.1, the findings show a positive effect of oil and gas discovery on economic activities in districts that are dependent on the oil and gas industry. This section investigates whether alternative approaches could arrive at similar results. I conduct four robustness checks: First, in 12 out of the 22 years covered by the DMSP data, two separate satellites provide different luminosity data. Several studies argue that these inter-satellite differences

Table 2.6: Effect of offshore oil discovery on sales, wages and employment of firms

	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Ln(Wages)	Estimate	[90%	conf. interval]	Estimate	[90%	conf. interval]
Post* forward linkage	-0.077	-1.008	1.104	-0.077	-0.657	1.391
Post* backward linkage	0.322***	0.279	0.478	0.298***	0.261	0.439
Post* total linkage	-0.008	-1.313	2.259	-0.012	-1.230	1.904
Observation	992			992		
Includes controls	No	No	No	Yes	Yes	Yes
PANEL B: Ln(Sales)	Estimate	[90%	conf. interval]	Estimate	[90%	conf. interval]
Post* forward linkage	-0.411	-3.072	3.070	-0.362	-2.272	2.498
Post* backward linkage	0.530*	0.206	1.216	0.412*	0.136	1.011
Post* total linkage	-0.29	-3.109	3.565	-0.273	-2.357	2.961
Observation	1,114			1,114		
Includes controls	No	No	No	Yes	Yes	Yes
PANEL C: Ln(Total employment)	Estimate	[90%	conf. interval]	Estimate	[90%	conf. interval]
Post* forward linkage	-0.219	-1.187	1.172	-0.181	-1.047	1.224
Post* backward linkage	0.266**	0.072	0.524	0.199*	0.078	0.442
Post* total linkage	-0.157	-1.390	1.850	-0.136	-0.982	1.513
Observation	1,141			1,141		
Includes controls	No	No	No	Yes	Yes	Yes

Notes: Panel A uses wages as the outcome variable. Panel B uses sales as the outcome variable. Panel C uses employment as the outcome variable. Columns 1 to 3 do not include controls. Columns 4 to 5 include controls for whether the establishment is part of a larger firm, the manager's experience and formal training of workers. Forward linkage is the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Wages are in thousands of Ghana cedis. Sales are in millions of Ghana cedis. Wild bootstrap standard errors clustered at the industry level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

may affect luminosity values reported within a specific year which may bias the results (Chen & Nordhaus, 2011; Gibson et al., 2020; Liu et al., 2012; Olivia et al., 2018). I account for this problem by including satellite fixed effects in the main analysis. I explore the sensitivity of the results to the exclusion of satellite fixed effects. The results are shown in Table B.1 in Appendix B. They are similar to the inclusion of satellite fixed effects. The oil and gas discovery increased economic activities in highly dependent districts.

Second, even though the Jubilee Field was discovered in 2007, oil production started in 2010. Between 2007 and 2010, the consortium worked on developing the Jubilee Field for commercial oil production. The development included drilling wells, installing production facilities, and implementing infrastructure for oil extraction and transportation. In the main analysis, I use the year of the oil discovery as the treatment year. For robustness, I investigate how the results are affected by the use of the production year as the treatment year. The results are presented in Table B.2 in Appendix B. I find similar results to those obtained when the treatment year is defined as the year of oil discovery

Third, in sections 2.4.2 and 2.4.3, I control for districts where oil and gas companies are located and find that the effect of the oil and gas discovery is not solely driven by the presence of petroleum companies. To explore this further, I exclude these districts from the analysis and re-estimate equations 2.3 and 2.5. The results are in tables B.3 and B.4. They are similar to those obtained from the inclusion of districts with oil and gas companies present.

Fourth, figure 1.2 shows that, prior to the commercial discovery of oil and gas (2007), the scale of oil production in Ghana was notably small. This suggests that, during that period, the petroleum industry may not have engaged significantly in purchases from or sales to other industries. Because my linkage variable L is fixed to an initial period prior to the oil and gas discovery, it may not fully capture the extent of the dependency between the oil and gas industry and other industries. To address this concern, I use the input-output table for Nigeria spanning the years 2004 and 2007. Notably, Nigeria, having discovered commercial oil in 1956, has since become the foremost oil producer in Africa. In the period before 2007, the petroleum industry in Nigeria is likely to have engaged in substantial transactions with other industries, providing insight into inter-sectoral dependencies. The assumption underlying this approach is that a comparable relationship exists between the petroleum industry and other industries in both Nigeria and Ghana.

I re-estimate equations 2.3 and 2.5 using the input-output table from Nigerian [29]. The results from the analysis of the economic activity and structure in districts are presented in tables B.5 and B.6 in Appendix B. They are similar to the estimates obtained when using the input-

[29] This approach uses linkage measures from Nigerian industries to supplement the understanding of inter-sectoral dependencies in Ghana's petroleum industry before the commercial discovery of oil and gas in 2007

output table from Ghana.

2.6 Conclusion

This chapter investigates forward and backward linkages as mechanisms through which natural resources drive structural transformation and economic growth. I adopt a difference-in-differences analysis using the oil and gas discovery as treatment and compare districts with high dependence on the oil and gas industry to other districts. I find that the oil and gas discovery led to an increase in economic activities in highly dependent districts. These districts also experienced a structural shift in employment from agriculture to services.

Even though natural resource extraction has the potential to stimulate economic growth and structural transformation through the creation of input-output linkages, the development of these linkages relies heavily on industrial policy. In most cases, due to limited local capacity, extractive industries are "forced" to import most of their inputs. Examples of factors that limit local capacity are limited access to tender information, skills mismatch, inadequate infrastructure and limited access to credit. To the extent that policies directed toward promoting capacity building are successful, extractive sectors will be motivated to purchase locally. In addition, host countries need to be active in implementing programs that support local procurement and employment. They can also adopt policies that encourage the resource industries to collaborate with the local authorities in training local suppliers. In helping local suppliers, resource industries will enjoy benefits such as reduced transportation costs from having their suppliers nearby.

One constraint to the development of forward linkage is the lack of local beneficiation and intermediation. Most of the natural resources are exported in their raw state with little local value addition. Industrial policies that aim at supporting local firms to meet the standard in providing local beneficiation and intermediation will promote the development of forward linkages. Moreover, host countries can adopt policies that mandate a minimum percentage of local participation in the value addition process to ensure that a portion of the value chain remains within the country.

The main limitation of this research is that the approach I adopt assumes a fixed district dependence on the oil and gas industry. In the period after the oil and gas discovery, low dependent districts may become high dependent districts if new high dependent firms emerge in these districts. The approach in this research may not capture this possible mechanism. To the extent to which new highly dependent firms emerge in highly dependent districts, my approach will capture that effect. However, insofar as new high dependence firms emerge in low dependence districts, my results will be downward biased. The true effect of the oil and gas discovery will be larger. Future research can consider using an approach that takes into account the fact that the creation of new firms can lead to varying status for some districts before and after the offshore oil and gas discovery.

Appendix B

Table B.1: Effect of offshore oil discovery on economic activity (proxied by night-time light data: without satellite fixed effects)

	(1)	(2)	(3)
Post* forward linkage	0.099**		
	(0.039)		
Post* backward linkage		0.155***	
		(0.046)	
Post* total linkage			0.136***
			(0.040)
Observations	3,536	3,536	3,536
R-Squared	0.962	0.964	0.963

Notes: Forward linkage is the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table B.2: Effect of offshore oil discovery on economic activity (proxied by night-time light data: Treatment date = 2010)

	(1)	(2)	(3)
Post* forward linkage	0.204***		
	(0.074)		
Post* backward linkage		0.318***	
		(0.055)	
Post* total linkage			0.278***
			(0.058)
Observations	3,536	3,536	3,536
R-Squared	0.965	0.970	0.968

Notes: Forward linkage is the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table B.3: Effect of offshore oil discovery on economic activity (proxied by night-time light data: Excluding districts where oil and gas companies are located)

	(1)	(2)	(3)
Post* forward linkage	0.070**		
	(0.029)		
Post* backward linkage		0.126***	
		(0.032)	
Post* total linkage			0.104***
			(0.027)
Observations	3,366	3,366	3,366
R-Squared	0.923	0.927	0.926

Notes: Forward linkage is the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table B.4: Effect of offshore oil discovery on the structure of the economy: Excluding districts where oil and gas companies are located

	Agriculture			Manufacturing			Services		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post* forward linkage	-0.379**			0.025			0.353**		
	(0.167)			(0.020)			(0.160)		
Post* backward linkage		-0.350**			0.016			0.335**	
		(0.148)			(0.018)			(0.147)	
Post* total linkage			-0.363**			0.020			0.343**
			(0.157)			(0.019)			(0.153)
Observations	307	307	307	307	307	307	307	307	307
R-Squared	0.715	0.714	0.715	0.545	0.545	0.545	0.740	0.740	0.740

Notes: Columns 1 to 3 show the employment share of agriculture. Columns 4 to 6 show the employment share of manufacturing. Columns 7 to 9 show the employment share of services. Forward linkage represents the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table B.5: Effect of offshore oil discovery on economic activity (proxied by night-time light data: Linkages from Nigerian industries)

	(1)	(2)	(3)
Post* forward linkage	0.125***		
	(0.036)		
Post* backward linkage		0.177***	
		(0.036)	
Post* total linkage			0.152***
			(0.034)
Observations	3,536	3,536	3,536
R-Squared	0.963	0.965	0.964

Notes: Forward linkage is the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table B.6: Effect of offshore oil discovery on the structure of the economy: Linkages from Nigerian industries

	Agriculture			Manufacturing			Services		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post* forward linkage	-0.320**			0.010			0.309**		
	(0.137)			(0.029)			(0.130)		
Post* backward linkage		-0.264**			-0.007			0.271**	
		(0.114)			(0.032)			(0.110)	
Post* total linkage			-0.294**			-0.002			0.292**
			(0.126)			(0.030)			(0.121)
Observations	319	319	319	319	319	319	319	319	319
R-Squared	0.727	0.726	0.727	0.557	0.557	0.557	0.752	0.750	0.751

Notes: Columns 1 to 3 show the employment share of agriculture. Columns 4 to 6 show the employment share of manufacturing. Columns 7 to 9 show the employment share of services. Forward linkage represents the standardized share of inputs purchased from the oil and gas industry, while backward linkage represents the standardized share of output sold to the oil and gas industry. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Figure B.1: Districts in Ghana (by district dependence and location of oil companies)

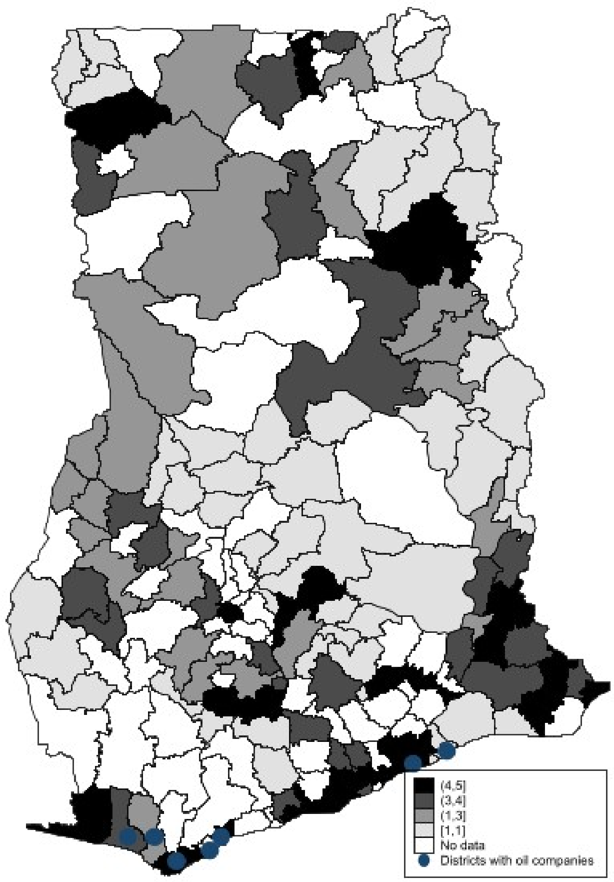
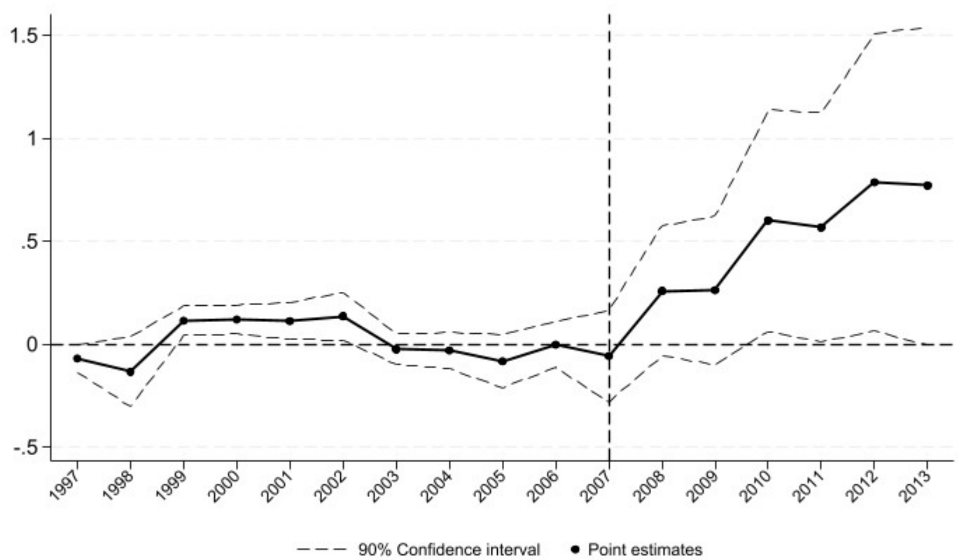


Figure B.2: Effect of offshore oil discovery on economic activities (Event study: by location of oil companies)



Chapter 4

Natural resources and public political trust

3.1 Introduction

Over the years, natural resources have played a complex role in shaping economies. While they can be crucial drivers of social and economic growth, their availability and management are also inextricably linked to a range of challenges, including lower economic development, climate change, conflict, corruption, and authoritarianism. Mehlum et al. (2006) showed that the quality of institutions is the primary factor determining the success or failure of resource management outcomes. Despite the extensive literature on natural resource extraction and its socio-economic and political impacts, there's a gap in understanding how these resources shape trust in political leaders and institutions. Political trust, a key indicator of political legitimacy, impacts public participation, policy support, and social cohesion. In resource-rich countries, citizens often expect benefits from resource extraction, and unmet expectations can lead to discontent and a decline in political trust. Thus, understanding the relationship between resource extraction and political trust is critical for resource-rich economies aiming to build and maintain public confidence in their political systems.

This research seeks to investigate the impact of Ghana's oil and gas discovery on the public's political trust. The research questions that I seek to answer are: i) Did natural resources affect the public's trust in political leaders? ii) Did natural resources affect public opinion about political systems? iii) How did the changes in political trust vary among various subgroups? In this paper, I use data on public attitudes to conduct a difference-in-differences analysis which exploits spatial variations by comparing individuals located close to the oil and gas fields to individuals farther away before and after the oil discovery. I find that after the oil and gas discovery, individuals located near the oil fields experienced a decline in trust towards political leaders (president and parliament), reported more negative views on Ghana's democracy and corruption levels, perceived poorer economic management by the president, and expressed dissatisfaction with the overall economic conditions. The results suggest a potential link between increased bribe payments in these locations and declining trust.

This research contributes to an emerging literature on the effect of natural resources on the political economy. Several studies have investigated the effect of natural resources on political regimes and found that resource wealth can allow governments to become less reliant on public taxation, potentially weakening democratic institutions and accountability. In extreme cases, it can lead to authoritarian regimes that control resource wealth for their benefit (Al-Ubaydli, 2012; Haber & Menaldo, 2011; Ross, 2001; Wantchekon, 2002). Other studies found that resource extraction induces rent-seeking behaviour (Torvik, 2002) and provides an incentive for bribery (Knutsen et al., 2017) and corruption (Busse & Gröning, 2013; Pendergast et al., 2011; Salari & Noghanibehambari, 2021; Vicente, 2010). The level of corruption is influenced by factors such as the abundance of natural resources, government policies, and the centralization of bureaucratic authority (Arezki & Brückner, 2011; Bhattacharyya & Hodler, 2010; Leite & Weidmann, 1999; Zhan, 2017).

Aside from its effect on political regimes and the quality of institutions, natural resources impact other aspects of the political economy that have been relatively unexplored. Natural resource extraction is often accompanied by positive expectations from citizens. This is because most natural resources are publicly owned, hence the residents expect that their management will be in the public's interest (Bright & Manfredo, 1997). When people see tangible benefits from resource wealth, their trust in the government's ability to manage the economy effectively tends to increase. This trust stems from the belief that resource revenues will be used to provide essential services, create jobs, and enhance overall prosperity. However, when people perceive an unequal distribution of resource revenues, whether due to corruption or mismanagement, it can lead to distrust (Miller, 2015).

This paper extends the existing literature by exploring the relationship between natural resources and public political trust. One study closely related to this research is Kolstad and Wiig (2012) which explored the impacts of petroleum and minerals on social trust using cross-country data. While the study found no direct impact of natural resources on social trust, it found a significant effect on trust in intermediate variables like corruption, institutions, civil war, and inequality. This research differs from Kolstad and Wiig (2012) in two ways: First, Kolstad and Wiig (2012) focused on generalized trust which reflects a belief in the trustworthiness of all individuals in a society including friends, family and strangers. This research focuses on public political trust which reflects the level of confidence people have in their political institutions, leaders, and the overall functioning of the political system. It reflects the belief that those in positions of authority will act in the best interests of the public, uphold democratic values, and effectively address the needs and concerns of the citizenry. Political trust has significant implications for the functioning of economies and the overall stability of a country.

Second, Kolstad and Wiig (2012) conducted a cross-country analysis but I employ a within-country analysis in this research. Within-country analysis recognises heterogeneity across local communities and allows for a more comprehensive understanding of specific economies. Even though natural resource discovery is a national shock, some residents may be disproportionally affected which may result in varying views within the economy. Findings from this research provide insight to policy-makers to help them strengthen public political trust in the context of natural resource utilization and management.

3.1.1 Mechanisms through which natural resources might affect public political trust

Oil and gas extraction might influence the public's political trust through several mechanisms. These include:

Economic Impact: If economic gains from resource discovery result in tangible improvements in people's lives, such as job creation, infrastructure development, and increased public services, it can boost citizens' trust in the government.

Bribery and corruption: Resource booms generate significant fiscal revenue for the government and increase the income of workers in the resource sector. This creates incentives for corruption as individuals or groups seek to capture these rents through illicit means. Furthermore, corrupt officials may see this increase in wealth as an opportunity to increase their bribe demands, believing locals can now afford to pay more. This erodes political trust and weakens government legitimacy.

Distribution of Benefits: The allocation and distribution of oil and gas revenues across sectors and regions impact public trust. Unequal distribution, favouring a small elite or specific regions, can worsen inequalities and diminish trust in the government. Governance mechanisms promoting equitable sharing of economic benefits and development opportunities contribute to positive perceptions.

Environmental and Social Concerns: The extraction of natural resources can result in environmental and social impacts, including pollution, community displacement, and threats to biodiversity, thereby affecting political trust. Individuals may lose trust if they perceive that extraction operations harm the environment or pose risks to public health.

Impact on Governance: The influx of resource wealth can concentrate power, weaken checks and balances, and shift governance toward less democracy. Involving the public in formulating oil and gas policies builds trust by ensuring diverse perspectives, and enhancing decision-making legitimacy.

3.2 Data and Method

3.2.1 Data

To conduct the empirical analysis, I use a repeated cross-sectional data on public attitudes from the Afrobarometer survey for the years 2002, 2005, 2008, 2012, 2014, 2019, 2020, and 2022. The main outcome variable is the public's political trust which includes trust in government, political leaders and institutions as well as perceptions about the political system. The summary statistics are presented in Table 3.1.

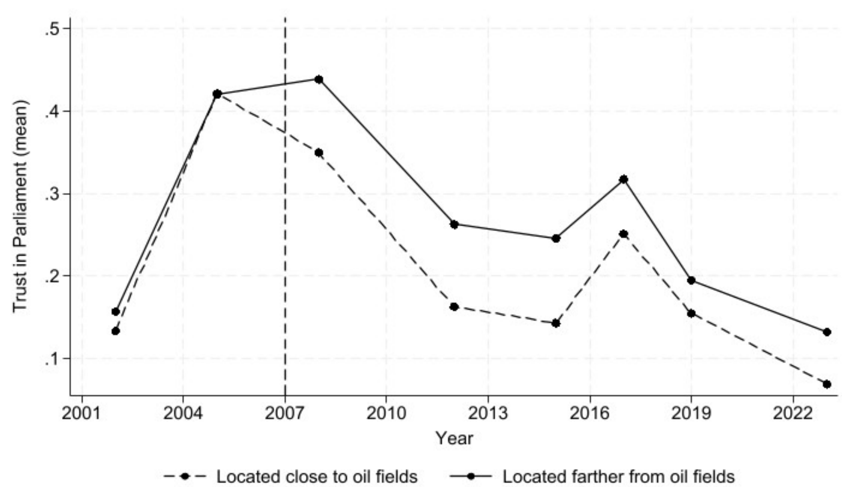
The approach that I use in this analysis compares individuals located close to the oil and gas fields to individuals located farther away. Distance is calculated as the length of the short-

Table 3.1: Summary Statistics III

Variables	Obs	Mean	Std. deviation
Age	15,566	45.114	81.183
Years of education	15,566	3.462	4.448
Proportion male	15,566	0.499	0.500
Proportion urban	15,566	0.520	0.500
Proportion employed	15,566	0.584	0.493
Overall trust	14,440	0.393	0.489
Trust in president	15,197	0.346	0.476
Trust in parliament	15,015	0.200	0.400
Trust in local gov't council	14,760	0.158	0.365
Democracy	15,566	0.756	0.430
Corruption	11,573	0.095	0.294
Present economic conditions	15,327	0.270	0.444
Government performance	15,566	0.508	0.500
Frequency of bribe payments	6,321	0.227	0.419
Distance to Takoradi (km)	15,566	260.672	163.466

est path between an individual's location and the closest main city to the oil and gas fields (Takoradi city).

Figure 3.1: Trends in political trust



3.2.2 Identification Strategy

The baseline regression for this approach is:

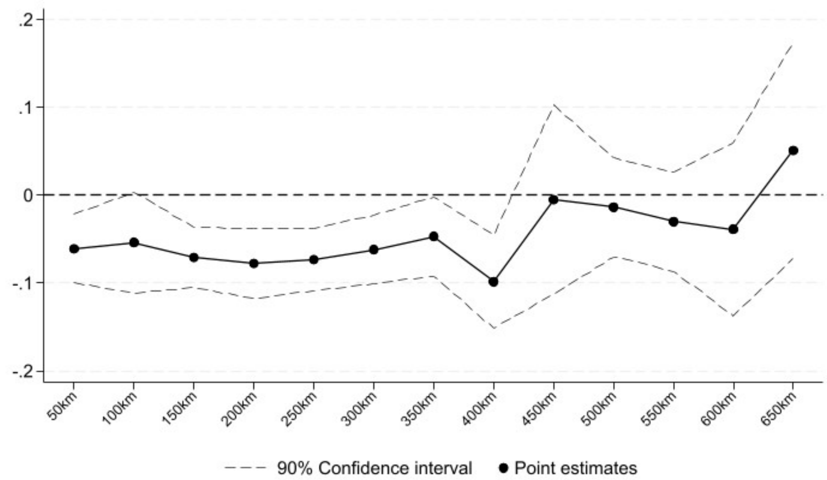
$$Y_{icdt} = \alpha + \rho_t + \delta_d + \beta T_i * Post_t + \eta X_{icdt} + \epsilon_{icdt} \quad (3.1)$$

where Y_{icdt} is the outcome variable (political trust) of individual i in cluster c in district d in year t. T_i is a continuous variable which represents the distance to Takoradi. $Post_t$ is a dummy variable that takes the value one in the post oil discovery period (2007). δ_d and ρ_t are district and time fixed effects respectively. X_{icdt} is a vector of individual level control variables such as age, gender, years of education and an indicator of urban residence.

The identification strategy assumes that individuals in areas both close and far from Takoradi would experience similar trends in political trust in the absence of the oil discovery. Figure 3.1 provides support for the validation of this identification strategy. It shows that the two groups experienced similar trends in political trust prior to 2007. After 2007, there was a divergence in the trends between the two groups. In Figure 3.1, the treatment group comprises those living less than 400km from Takoradi. The main analysis in this paper measures distance as a continuous variable, but the 400km threshold is used solely for constructing the trend graph.

Assigning the treatment group to construct the trend graph was done in two steps: First, I split the households into separate distance bands and grouped them in blocks of 50km. The first group consists of households located less than 50km from Takoradi, the second group consists of households located between 50km to 100km from Takoradi, and so on. Second, I estimate the baseline regression to explore spatial heterogeneity. Figure 3.2 plots the estimated parameters and the 90% confidence interval. The estimates are significant for individuals located near Takoradi. After 400km, they become insignificant (see figure C.1 in appendix C).

Figure 3.2: Effect of oil discovery on political trust: by distance to Takoradi



3.3 Main Results

3.3.1 Effect on public political trust

Table 3.2 shows the effect of the oil and gas discovery on public political trust of individuals located near Takoradi. Distance is measured in hundreds of kilometres. I use negative distance[30] in my analysis for easier interpretation. The results indicate that, after the oil and gas discovery, individuals near Takoradi experienced a decline in overall political trust[31] as well as trust in the president and members of parliament. Individuals located 100km closer to Takoradi experienced a 3.8 % and 1.4 % decrease in their probability of trusting the president and parliament respectively. The coefficients show that trust in the president declined more than trust in members of parliament. This could be because the president is seen as the head of state and thus bears the brunt of public frustration, particularly regarding economic issues.

The effect of the oil and gas discovery may not be uniformly distributed among different subgroups in the local population. I explore these heterogeneous effects by education status, employment status, and the level of media exposure[32] at the district level. Since these vari-

[30]Negative distance is the original distance multiplied by -1

[31]Overall trust is an additive measure of trust in the president, trust in parliament and trust in the local government council

[32]Media exposure is measured by how frequently an individual listens to the radio, watches television or reads the newspaper

Table 3.2: Effect of offshore oil discovery on public political trust

	Overall trust	Trust in president	Trust in parliament	Trust in local government
Post * negative distance	-0.029** (0.011)	-0.038*** (0.009)	-0.014** (0.006)	0.011 (0.008)
Pre-treatment Mean	0.525	0.443	0.281	0.225
Observations	14,440	15,197	15,015	14,760
R - squared	0.112	0.121	0.089	0.087

Notes: Negative distance is the original distance multiplied by -1. All regressions control for age, gender, years of education and an indicator for urban residence. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table 3.3: Effect of offshore oil discovery on overall trust: by proportion of subgroups in a district

	Education		Media exposure		Employment status	
	Small % educated	Large % educated	Low	High	Large % Employed	Small % Employed
Post * negative distance	-0.026 (0.016)	-0.041*** (0.012)	-0.021 (0.013)	-0.034* (0.018)	-0.028 (0.018)	-0.034** (0.017)
Observations	6,525	6,788	6,528	6,785	6,466	6,847
R - squared	0.110	0.094	0.102	0.121	0.112	0.110

Notes: Negative distance is the original distance multiplied by -1. Highly educated districts are districts where a large proportion of the population has educational attainment above the median level observed across all districts before the discovery. Districts with high media exposure are those where the level of media exposure is above the median level. Districts with high employment are those where the employment level is above the median level. All regressions control for age, gender, years of education and an indicator for urban residence. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

ables can be influenced by the oil and gas discovery, I use their values prior to the discovery to define a district's status. Highly educated districts are districts where a large proportion of the population has educational attainment above the median level observed across all districts before the discovery. Districts with high media exposure are those where the level of media exposure is above the median level. Districts with high employment are those where the employment level is above the median level.

The results are presented in Table 3.3. They show that the decrease in political trust after the oil discovery is mostly in highly educated districts and districts with high media exposure.

According to Besley and Burgess (2002), educated individuals are more likely to be aware of their rights and the performance of their government, which in turn can lead to greater political engagement and demand for better governance. This suggests that pre-existing knowledge or higher expectations might have led to greater discontent when those expectations weren't met after the oil discovery. Moreover, high media exposure implies that individuals might be more informed and less disconnected from the political process, leading to heightened awareness of economic and political issues.

Also, the findings indicate that individuals in districts with low employment became less trusting of the political leaders. In these districts, economic hardships may lead to increased dissatisfaction towards the government's ability to address their needs and improve their living conditions. This could be especially true when the oil and gas discovery did not lead to as much job creation as expected (see Table 3.5).

These findings suggest that the oil discovery's impact on political trust may vary depending on pre-existing social and economic conditions. This highlights the importance of considering diverse perspectives when evaluating the effects of resource discoveries.

3.3.2 Effect on public opinion about the political system

Table 3.4 presents the effect of the oil and gas discovery on the public's opinion about Ghana's political system and economic conditions. The results suggest that after the oil and gas discovery, individuals located close to Takoradi were more likely to report that Ghana had become less democratic, identify corruption as one of the top three problems in the country, view the government's performance as poor, and rate economic conditions as bad. This shift in public perception highlights the potential socio-political and economic challenges that resource discoveries can bring to local communities.

Table 3.4: Effect of offshore oil discovery on public opinion

	Democracy	Corruption	Felt unsafe	Government performance	Economic conditions
Post * negative distance	-0.016**	0.011***	-0.004	-0.032***	-0.021***
	(0.006)	(0.004)	(0.008)	(0.009)	(0.007)
Pre-treatment Mean	0.866	0.021	0.307	0.692	0.288
Observations	15,566	11,573	15,566	15,566	15,327
R - squared	0.071	0.068	0.055	0.178	0.085

Notes: Negative distance is the original distance multiplied by -1. All regressions control for age, gender, years of education and an indicator for urban residence. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

3.3.3 Exploring mechanisms

Section 3.1.1 discussed potential mechanisms for how resource discovery can erode public trust in political leaders. This section explores two such mechanisms: employment and bribery. Table 3.5 shows that, after the oil discovery, people near Takoradi reported a higher frequency of bribes paid to government officials for permits and documents. This aligns with the findings by Knutsen et al. (2017) who linked increased mining activity to more frequent bribes. They argue that resource booms create opportunities for officials to demand bribes as they believe locals can now afford to pay more.

Table 3.5: Mechanisms through which resource extraction can affect public political trust

	Employment	Bribe payment
Post * negative distance	-0.008	0.018**
	(0.009)	(0.008)
Pre-treatment Mean	0.573	0.186
Observations	15,566	6,321
R - squared	0.066	0.088

Notes: Negative distance is the original distance multiplied by -1. All regressions control for age, gender, years of education and an indicator for urban residence. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

To investigate the link between economic activity and bribery, I followed the approach inKnutsen et al. (2017) and examine the effect of oil discovery on economic activity in districts near the oil fields. Economic activity is measured by the night-time light intensity in a district[33]. I standardized the pixel values to simplify the interpretation of estimates. The results are shown in table 3.6. I find that, the discovery increased economic activities in districts near the oil fields. Additionally, table C.3 in the appendix shows a positive correlation between economic activity and the frequency of bribe payments at the district level.

Interestingly, despite the increase in economic activities, table 3.5 showed no significant impact on employment. This suggests the increase in economic activities might be due to factors like infrastructure development, wage increases for resource workers, or growth in supporting industries. However, the capital-intensive nature of the oil and gas industry and its need for a specialized workforce might limit direct job creation.

Table 3.6: Effect of offshore oil discovery on economic activities

Post * negative distance	0.030**
	(0.011)
Observations	2,176
R - squared	0.962

Notes: Negative distance is the original distance multiplied by -1. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

3.4 Robustness Checks

I conduct four robustness checks: First, in section 3.3, the results show a negative effect of oil and gas discoveries on the public's political trust and their opinions about political systems. However, these results could be driven by the views of individuals located in capital cities, as

[33] Night-time light data is from the Defense Meteorological Satellite Program (DMSP) obtained from the National Oceanic and Atmospheric Administration (NOAA)

these cities often have unique economic, social, and political dynamics that differ significantly from rural or suburban areas. This can create the impression of a national trend, even if it is primarily concentrated in specific urban centres. I show that the negative effects of oil discoveries on political trust are not solely concentrated in capital cities in two ways: First, I include a control variable for capital cities in equation 3.1 and re-estimate it, using overall trust as the dependent variable. The results are presented in Table C.2 in Appendix C. The estimates still show a negative effect of oil and gas discovery on political trust. Second, I take the analysis a step further and exclude all capital cities from the sample. The estimates, presented in Table C.2, are similar to those obtained when capital cities are included.

The second robustness check I conduct accounts for the differences in the district's economic structure. The distribution of employment across different sectors varies between districts. Some districts have a high employment share in one sector and low employment in another. If the oil and gas discovery had a positive (or negative) effect on a sector, then districts with high employment in that sector may experience a corresponding positive (or negative) effect. This could impact the trust and opinions of the local population in these districts. To account for this, I re-estimate equation 3.1, controlling for districts with high employment in one of the three main sectors (agriculture, manufacturing, and services).

I use the employment share[34] of a sector in a district as a measure of district economic structure. Since employment shares can be influenced by the oil and gas discovery, I use the values prior to the discovery to define a district's economic structure. Agriculture, manufacturing and services are continuous variables measuring a district's percentage of employment in agriculture, manufacturing, and services, respectively. The results are presented in Table C.4 in Appendix C. The estimates show that the effect of the oil and gas discovery on political trust is not driven by differences in district economic structure.

Third, there might be other underlying differences between districts besides their proximity to the oil fields. For instance, the southern districts (closer to the fields) are predominantly

[34]Employment share is calculated as the total employment of a sector in a district divided by the total employment in a district

Christian, while the northern districts are mainly Muslim. To address this concern and confirm that the observed effects are driven by proximity, I perform a placebo test using religion as a source of variation. Since there's no established causal link between religion and political trust in the context of resource discovery, any significant difference in trust levels between Christians and Muslims should not appear after the oil discovery. If the observed decline in trust near the oil fields is truly driven by proximity, we wouldn't expect a significant difference in trust levels between Christians and Muslims after the discovery.

I re-estimate equation 3.1 but substitute religion for proximity to oil fields. This analysis compares the political trust of Christians and Muslims before and after the discovery (results are in Table C.5 in Appendix C). As expected, the results show no significant effect of oil and gas discovery on the political trust of Christians compared to Muslims. This supports the validity of the original analysis, suggesting that the decline in trust is indeed driven by proximity to the oil fields, not by pre-existing differences between the districts.

Fourth, I explore the sensitivity of the results to the inclusion of district-time trends by re-estimating equation 3.1 and including an interaction term between year and district. This approach allows for unique time-specific variations within each district, accounting for factors that change over time and differ across districts. The results, shown in Table C.6 in Appendix C, are similar to those obtained when district-time trends are excluded. This suggests that the observed effect of oil discovery on political trust is not driven by districts being on different trends. Column 2 in Table C.6 includes region-time trends and obtains similar results.

3.5 Conclusion

Natural resources present a multifaceted dilemma for resource-rich economies. While they offer the potential for significant economic growth, they can also have unintended consequences, such as eroding public trust in political leadership. This paper examines the effects of oil and gas discoveries on the public's confidence in their political leaders and systems. This paper examines the effects of oil and gas discovery on the public's confidence in their political leaders and systems. The findings show that individuals living near the oil fields experienced a significant decline in political trust. This decline is linked to more negative perceptions of Ghana's democracy, increased corruption, poor economic management, and overall dissatisfaction with economic conditions. The research suggests that unmet expectations and increased bribe payments in resource-rich areas contribute to this decline in trust, emphasizing the need for better management of natural resource wealth to maintain public confidence.

For resource-rich countries aiming to foster and maintain public trust, several policy recommendations emerge from this study. Governments could prioritize transparency and accountability in the management of natural resources, ensuring that revenues are used for public benefit and development projects that directly impact local communities. Strengthening anti-corruption measures and enhancing communication between the government and citizens can mitigate negative perceptions and build trust. Additionally, investing in social and economic infrastructure in resource-rich regions can address local grievances and improve living standards, thereby reinforcing trust in political institutions and promoting sustainable development. By adopting these strategies, resource-rich countries can better harness their natural wealth to foster economic growth while maintaining public trust and social cohesion.

Appendix C

Table C.1: Description of variables

Variable	Description
Overall trust	Additive measure of trust in the president, trust in parliament, trust in the local government council
Trust in president/parliament /local government	How much do you trust each of the following, or haven't you heard enough about them to say?
Democracy	In your opinion, how much of a democracy is Ghana today?
Corruption	In your opinion, what are the most important problems facing this country that the government should address?
Felt unsafe	Over the past year, how often, if ever, have you or anyone in your family: Felt unsafe walking in your neighbourhood?
Government performance	How well or badly would you say the current government is handling the following matters or haven't you heard enough to say: Managing the economy
Economic conditions	Looking back, how do you rate economic conditions in this country compared to 12 months ago?
Media	How often do you get news from the following sources: Radio, Television or Newspaper
Bribe payment	How often, if ever, did you have to pay a bribe, give a gift, or do a favour for a government official to get the document you needed?

Table C.2: Effect of offshore oil discovery on overall trust: controlling for and exclusion of all the capital cities

	(1)	(2)
Post * negative distance	-0.032***	-0.026**
	(0.011)	(0.013)
Control for capital cities	Yes	No
Exclude capital cities	No	Yes
Observations	14,440	11,187
R - squared	0.112	0.119

Notes: Negative distance is the original distance multiplied by -1. All regressions control for age, gender, years of education and an indicator for urban residence. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table C.3: Correlation between economic activity and bribe payment at the district level

	Economic activity	Bribe payment
Economic activity	1.000	
Bribe payment	0.386***	1.000

Notes: Economic activity is measured by the night-time light intensity in a district. Bribe payment is the frequency of bribe payment at the district level.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table C.4: Effect on overall trust: by district economic structure

Post * negative distance	-0.034***
	(0.011)
Post * agriculture	-0.006
	(0.165)
Post * manufacturing	-0.033
	(0.368)
Post * services	0.069
	(0.208)
Observations	13,454
R - squared	0.108

Notes: Agriculture, manufacturing and services are continuous variables measuring a district's percentage of employment in agriculture, manufacturing, and services, respectively. All regressions control for age, gender, years of education and an indicator for urban residence. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table C.5: Effect on overall trust: Using religion as a source of variation

Post * religion	-0.010
	(0.015)
Observations	13,377
R - squared	0.111

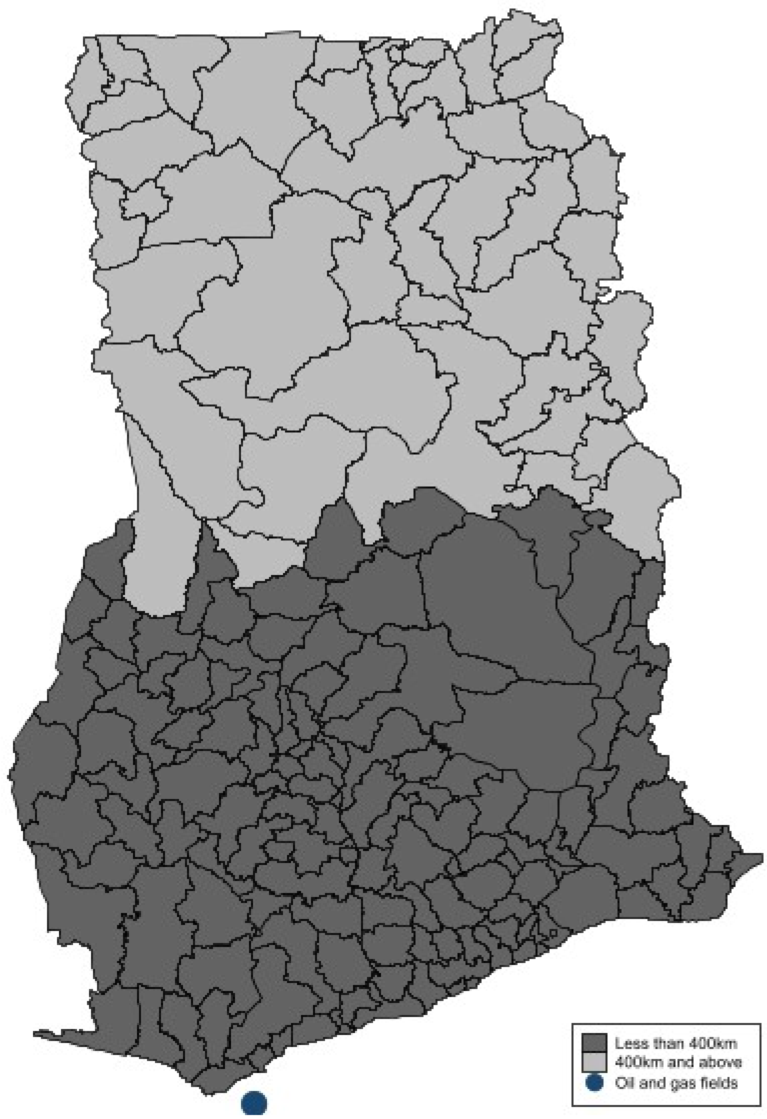
Notes: Religion is a dummy equal to one if an individual is a Christian and zero if an individual is a Muslim.All regressions control for age, gender, years of education and an indicator for urban residence. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table C.6: Effect on overall trust: including district and region-time trends

	(1)	(2)
Post * negative distance	-0.029**	
	(0.011)	
Post * negative distance		-0.031***
		(0.011)
Includes district-time trends	Yes	No
Includes region-time trends	No	Yes
Observations	14,440	14,440
R - squared	0.112	0.112

Notes: Negative distance is the original distance multiplied by -1. All regressions control for age, gender, years of education and an indicator for urban residence. Robust standard errors clustered at the district level are in parenthesis.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Figure C.1: Districts in Ghana: by distance to Takoradi



Chapter 5

Conclusion Remarks

The existing literature on the natural resource paradox shows that resource extraction can yield economic benefits while also presenting significant challenges. While it offers potential for economic growth and improved living standards, the actual outcomes are often more complex. The three essays in this thesis delve into the intricate relationship between natural resources and local economies, offering valuable insights for policy-makers seeking to maximize benefits and tackle the associated challenges effectively.

Chapter 2 uses geocoded household data to examine the socio-economic impacts on local communities, showing that while households near oil fields experienced income growth, this benefit was not evenly distributed across all demographics and did not significantly affect overall employment, consumption, or poverty levels. This essay improves our understanding of the heterogeneous effects of resource extraction within an economy. It suggests that resource-rich economies might consider implementing programs that focus on inclusive growth to ensure that benefits from natural resources reach a wider population. This might involve investing in programs that enhance education, skill development and training to help local communities secure better employment opportunities.

Chapter 3 uses night-time light data to explore forward and backward linkages as mechanisms through which natural resources drive economic development. The findings indicate that oil and gas discovery led to an increase in economic activity and a structural transformation in districts with strong linkage with the petroleum industry. Findings from this essay shed light on the economic spillovers that resource extraction can create and their implications for economic development. It highlights the need for policy interventions such as local supplier development programs, support for and the establishment of downstream industries, and infrastructure investment to create a more diversified economy.

Chapter 4 uses data on public attitudes and examines the political implications of resource extraction. I find that proximity to oil fields led to a decline in public trust in political leaders and systems, likely due to unmet expectations and increases in bribe payments. This essay provides insight into how resource extraction shapes public political trust and suggests a need for policies promoting transparency and accountable governance to rebuild trust and ensure resource wealth benefits the population.

There are still unanswered questions about the socio-economic and political effects of natural resources, as well as the mechanisms through which these effects occur. This thesis explores two key mechanisms by which resource discovery affects local communities: proximity to oil fields and input-output linkages between industries. Further analysis can investigate additional mechanisms, such as the impact of fiscal revenue windfalls, fluctuations in prices of goods and services, and oil revenue sharing policies.

Moreover, the second essay investigates economic linkages as mechanisms through which natural resources drive economic development within an economy. This analysis could be extended to a cross-country level. This would improve our understanding of how different institutional frameworks, governance structures, and economic policies influence the effectiveness of these linkages in promoting sustainable development and structural transformation across various contexts. Furthermore, it could reveal best practices and valuable lessons from countries that have effectively transformed resource wealth to foster inclusive growth, providing valuable insights for policy-makers in resource-rich but underdeveloped regions.

The third essay examines the effects of natural resource discovery on public political trust. While data limitations restricted the analysis to two potential mechanisms – employment and bribe payments – the findings highlight the complex relationship between resource extraction and trust. Future research can delve deeper into other mechanisms, such as corruption, unequal distribution of benefits, and environmental impacts, to provide a more comprehensive understanding.

References

Acemoglu, D., & Linn, J. (2004). Market size in innovation: Theory and evidence from the pharmaceutical industry. *The Quarterly journal of economics*, *119*(3), 1049–1090.

Acemoglu, D., Ozdaglar, A., & Tahbaz-Salehi, A. (2017). Microeconomic origins of macroeconomic tail risks. *American Economic Review*, *107*(1), 54–108.

ADB. (2009). *Africa development bank, jubilee field report*.

Adofo, J. O., Tarui, N., & Tanaka, T. (2019). The local economic effects of natural resources: Evidence from ghana. *World Bank, Washington, DC*.

Allcott, H., & Keniston, D. (2018). Dutch disease or agglomeration? the local economic effects of natural resource booms in modern america. *The Review of Economic Studies*, *85*(2), 695–731.

Al-Ubaydli, O. (2012). Natural resources and the tradeoff between authoritarianism and development. *Journal of Economic Behavior & Organization*, *81*(1), 137–152.

Angrist, J. D., & Kugler, A. D. (2008). Rural windfall or a new resource curse? coca, income, and civil conflict in colombia. *The Review of Economics and Statistics*, *90*(2), 191–215.

Aragón, F. M., & Rud, J. P. (2013). Natural resources and local communities: Evidence from a peruvian gold mine. *American Economic Journal: Economic Policy*, *5*(2), 1–25.

Arezki, R., & Brückner, M. (2011). Oil rents, corruption, and state stability: Evidence from panel data regressions. *European Economic Review*, *55*(7), 955–963.

Aroca, P. (2001). Impacts and development in local economies based on mining:: The case of the chilean ii region. *Resources Policy*, *27*(2), 119–134.

Axbard, S., Benshaul-Tolonen, A., & Poulsen, J. (2021). Natural resource wealth and crime: The role of international price shocks and public policy. *Journal of Environmental Economics and Management*, *110*, 102527.

Benshaul-Tolonen, A. (2019). Local industrial shocks and infant mortality. *The Economic Journal*, *129*(620), 1561–1592.

Benshaul-Tolonen, A., Chuhan-Pole, P., Dabalen, A., Kotsadam, A., & Sanoh, A. (2019). The local socioeconomic effects of gold mining: Evidence from ghana. *The Extractive Industries and Society*, *6*(4), 1234–1255.

Berman, N., Couttenier, M., Rohner, D., & Thoenig, M. (2017). This mine is mine! how minerals fuel conflicts in africa. *American Economic Review*, *107*(6), 1564–1610.

Besley, T., & Burgess, R. (2002). The political economy of government responsiveness: Theory and evidence from india. *The quarterly journal of economics*, *117*(4), 1415–1451.

Bhattacharyya, S., & Hodler, R. (2010). Natural resources, democracy and corruption. *European Economic Review*, *54*(4), 608–621.

Bigio, S., & La'o, J. (2020). Distortions in production networks. *The Quarterly Journal of Economics*, *135*(4), 2187–2253.

Black, D., McKinnish, T., & Sanders, S. (2005). The economic impact of the coal boom and bust. *The Economic Journal*, *115*(503), 449–476.

Bloch, R., & Owusu, G. (2012). Linkages in ghana's gold mining industry: Challenging the enclave thesis. *Resources Policy*, *37*(4), 434–442.

Bright, A. D., & Manfredo, M. J. (1997). The influence of balanced information on attitudes toward natural resource issues. *Society & Natural Resources*, *10*(5), 469–483.

Brollo, F., Nannicini, T., Perotti, R., & Tabellini, G. (2013). The political resource curse. *American Economic Review*, *103*(5), 1759–96.

Bruederle, A., & Hodler, R. (2018). Nighttime lights as a proxy for human development at the local level. *PloS one*, *13*(9), e0202231.

Busse, M., & Gröning, S. (2013). The resource curse revisited: Governance and natural resources. *Public choice*, *154*, 1–20.

Buur, L., Therkildsen, O., Hansen, M. W., & Kjær, M. (2013). *Extractive natural resource development: Governance, linkages and aid*. DIIS Report.

Cameron, A. C., Gelbach, J. B., & Miller, D. L. (2008). Bootstrap-based improvements for inference with clustered errors. *The review of economics and statistics*, *90*(3), 414–427.

Cameron, A. C., & Miller, D. L. (2015). A practitioner's guide to cluster-robust inference. *Journal of human resources*, *50*(2), 317–372.

Cappelen, Å., & Mjøset, L. (2009). Can norway be a role model for natural resource abundant countries? *Canadian Health Policy*, *3*, 44–72.

Carvalho, V. M., Nirei, M., Saito, Y. U., & Tahbaz-Salehi, A. (2021). Supply chain disruptions: Evidence from the great east japan earthquake. *The Quarterly Journal of Economics*, *136*(2), 1255–1321.

Caselli, F., & Michaels, G. (2009). Resource abundance, development, and living standards: Evidence from oil discoveries in brazil. *NBER Working Paper*, *15550*.

Chen, X., & Nordhaus, W. D. (2011). Using luminosity data as a proxy for economic statistics. *Proceedings of the National Academy of Sciences*, *108*(21), 8589–8594.

Chenery, H. B., Robinson, S., Syrquin, M., & Feder, S. (1986). *Industrialization and growth*. Oxford University Press New York.

Donald, S. G., & Lang, K. (2007). Inference with difference-in-differences and other panel data. *The review of Economics and Statistics*, *89*(2), 221–233.

Eni. (2018). *Eni ghana exploration and production limited annual report*.

Fleming, D. A., & Measham, T. G. (2015). Local economic impacts of an unconventional energy boom: The coal seam gas industry in a ustralia. *Australian Journal of Agricultural and Resource Economics*, *59*(1), 78–94.

Gibson, J., Olivia, S., & Boe-Gibson, G. (2020). Night lights in economics: Sources and uses 1. *Journal of Economic Surveys*, *34*(5), 955–980.

GNPC. (2009). *Exploration and production history of ghana*. http://www.gnpcghana.com/

Goldsmith-Pinkham, P., Sorkin, I., & Swift, H. (2020). Bartik instruments: What, when, why, and how. *American Economic Review*, *110*(8), 2586–2624.

Gollin, D., Jedwab, R., & Vollrath, D. (2016). Urbanization with and without industrialization. *Journal of Economic Growth*, *21*, 35–70.

Graham, E., Van Gyampo, R., & Tuokuu, F. X. (2020). A decade of oil discovery in ghana: Implications for politics and democracy. *Ghana Social Science Journal*, *17*(1), 27–27.

Greenstone, M., Mas, A., & Nguyen, H.-L. (2020). Do credit market shocks affect the real economy? quasi-experimental evidence from the great recession and" normal" economic times. *American Economic Journal: Economic Policy*, *12*(1), 200–225.

Grobovšek, J. (2018). Development accounting with intermediate goods. *The BE Journal of Macroeconomics*, *18*(1).

GSS. (2012). *Ghana statistical service,2010 population and housing census final results*.

Haber, S., & Menaldo, V. (2011). Do natural resources fuel authoritarianism? a reappraisal of the resource curse. *American political science Review*, *105*(1), 1–26.

Henderson, J. V., Storeygard, A., & Weil, D. N. (2012). Measuring economic growth from outer space. *American economic review*, *102*(2), 994–1028.

Herrendorf, B., & Valentinyi, A. (2012). Which sectors make poor countries so unproductive? *Journal of the European Economic Association*, *10*(2), 323–341.

Hsieh, C.-T., & Klenow, P. J. (2007). Relative prices and relative prosperity. *American Economic Review*, *97*(3), 562–585.

Johnston, J. E., Lim, E., & Roh, H. (2019). Impact of upstream oil extraction and environmental public health: A review of the evidence. *Science of the Total Environment*, *657*, 187–199.

Jones, C. I. (2011). Intermediate goods and weak links in the theory of economic development. *American Economic Journal: Macroeconomics*, *3*(2), 1–28.

Kaplan, D. (2016). Linkage dynamics and natural resources: Diversification and catch-up. *Sustainable Industrialization in Africa: Toward a New Development Agenda*, 66–84.

Kapstein, E., & Kim, R. (2011). The socio-economic impact of newmont ghana gold limited. *Stratcomm Africa*.

Knutsen, C. H., Kotsadam, A., Olsen, E. H., & Wig, T. (2017). Mining and local corruption in africa. *American Journal of Political Science*, *61*(2), 320–334.

Kolstad, I., & Wiig, A. (2012). Testing the pearl hypothesis: Natural resources and trust. *Resources Policy*, *37*(3), 358–367.

Kotsadam, A., & Tolonen, A. (2016). African mining, gender, and local employment. *World Development*, *83*, 325–339.

Leeuw, P., & Mtegha, H. (2018). The significance of mining backward and forward linkages in reskilling redundant mine workers in south africa. *Resources Policy*, *56*, 31–37.

Leite, M. C., & Weidmann, J. (1999). *Does mother nature corrupt? natural resources, corruption, and economic growth*. International Monetary Fund.

Lippert, A. (2014). Spill-overs of a resource boom: Evidence from zambian copper mines.

Liu, Z., He, C., Zhang, Q., Huang, Q., & Yang, Y. (2012). Extracting the dynamics of urban expansion in china using dmsp-ols nighttime light data from 1992 to 2008. *Landscape and Urban Planning*, *106*(1), 62–72.

Lui, E. (2019). Industrial policies in production networks. *The Quarterly Journal of Economics*, *134*(4), 1883–1948.

Marchand, J. (2012). Local labor market impacts of energy boom-bust-boom in western canada. *Journal of Urban Economics*, *71*(1), 165–174.

Mehlum, H., Moene, K., & Torvik, R. (2006). Cursed by resources or institutions? *World Economy*, *29*(8), 1117–1131.

Michaels, G. (2011). The long term consequences of resource-based specialisation. *The Economic Journal*, *121*(551), 31–57.

Miller, R. (2015). Natural resource extraction and political trust. *Resources Policy*, *45*, 165–172.

Milletler, B. (2018). Handbook on supply and use tables and input output-tables with extentions and applications.

Nchor, D. (2014). Analysis of the structure of the ghanaian economy: Using input-output modelling techniques. *Economic Theories available online at http://dennisnchor. blogspot. ie/2013/04/analysis-of-structure-of-ghanaian. html. Accessed 10th July*.

Nchor, D., & Konderla, T. (2016). Economic multipliers and sectoral linkages: Ghana and the new oil sector. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *64*(2), 635–642.

Olivia, S., Boe-Gibson, G., Stitchbury, G., Brabyn, L., & Gibson, J. (2018). Urban land expansion in indonesia 1992–2012: Evidence from satellite-detected luminosity. *Australian Journal of Agricultural and Resource Economics*, *62*(3), 438–456.

Pendergast, S. M., Clarke, J. A., & Van Kooten, G. C. (2011). Corruption, development and the curse of natural resources. *Canadian Journal of Political Science/Revue canadienne de science politique*, *44*(2), 411–437.

PIAC. (2019). *Annual report on the use and management of petroluem revenues*.

Ramdoo, I. (2015). Resource-based industrialisation in africa: Optimising linkages and value chains in the extractive sector.

Ross, M. L. (2001). Does oil hinder democracy? *World politics*, *53*(3), 325–361.

Sachs, J. D., & Warner, A. (1995). Natural resource abundance and economic growth.

Sachs, J. D., & Warner, A. M. (1997). Sources of slow growth in african economies. *Journal of African economies*, *6*(3), 335–376.

Salari, M., & Noghanibehambari, H. (2021). Natural resources, women and corruption. *Resources Policy*, *74*, 102412.

San Cristóbal, J. R., & Biezma, M. (2006). The mining industry in the european union: Analysis of inter-industry linkages using input–output analysis. *Resources Policy*, *31*(1), 1–6.

Stilwell, L., Minnitt, R., Monson, T., & Kuhn, G. (2000). An input–output analysis of the impact of mining on the south african economy. *Resources policy*, *26*(1), 17–30.

Teka, Z. (2011). Backward linkages in the manufacturing sector in the oil and gas value chain in angola. *pdf], MMCP*.

The Petroleum Commision. (2022). *Exploration history*. https://www.petrocom.gov.gh/exploration-history/

Torvik, R. (2002). Natural resources, rent seeking and welfare. *Journal of development economics*, *67*(2), 455–470.

Tullow Oil. (2019). *Tullow oil ghana annual report*. https://www.tullowoil.com/our-operations/africa/ghana/jubilee-field/

Valentinyi, A. (2021). Structural transformation, input-output networks, and productivity growth. *Structural Transformation and Economic Growth (STEG) Pathfinding paper*.

Vicente, P. C. (2010). Does oil corrupt? evidence from a natural experiment in west africa. *Journal of development Economics*, *92*(1), 28–38.

Von der Goltz, J., & Barnwal, P. (2019). Mines: The local wealth and health effects of mineral mining in developing countries. *Journal of Development Economics*, *139*, 1–16.

Wantchekon, L. (2002). Why do resource dependent countries have authoritarian governments? *Journal of African Finance and Economic Development*, *5*(2), 57–77.

Weber, J. G. (2012). The effects of a natural gas boom on employment and income in colorado, texas, and wyoming. *Energy Economics*, *34*(5), 1580–1588.

Weber, J. G. (2014). A decade of natural gas development: The makings of a resource curse? *Resource and Energy Economics*, *37*, 168–183.

Zhan, J. V. (2017). Do natural resources breed corruption? evidence from china. *Environmental and Resource Economics*, *66*, 237–259.