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IDENTIFYING OIL EXTRACTION EFFECTS IN DEVELOPING COUNTRIES: EVIDENCE FROM GHANA

a thesis

by

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Abstract

Over the last few decades, the role of natural resources to the development of economies has gained considerable attention. Empirical studies establishing the link between natural resources and development have largely resorted to aggregated country level studies with most finding little to no development in developing economies. The underlying reasons for such findings are the absence of infrastructure, stable government and presence of corruption.

In recent years, there has been a switch in examining natural resource effect. Studies have focused on moving away from macro-level analysis to understanding how extraction of the resource lead to development at the micro-level of countries. This focus allows for heterogeneous study at the lowest administrative level. However, the current literature is largely centered on developed economies with little attention on developing countries, like Ghana that discovered one of the largest oil reserve in West Africa in over a decade in 2007 and started extraction in 2010.

This thesis comprises of three chapters and each examines the effects of oil extraction in Ghana and various economic decisions that resulted from it. The thesis uses data from the Ghana Living Standard Survey which is a nationwide survey conducted by the Ghana Statistical Service in collaboration with the World Bank. The first chapter examines how oil extraction made it possible for the government of Ghana to implement a new wage policy -the Single Spine Pay Policy- for public sector workers. By adopting a novel unconditional quantile estimation within a difference-in-differences framework, the chapter examines the significance and effectiveness of this policy in addressing wage disparities and more importantly productivity of public sector workers. The study finds that the policy largely affected public sector workers at the lower tail of the earnings distribution. Female workers in the education and health sub-sectors and male workers in the administration sub-sector were the largest beneficiaries. However, there was a reduction in the level

of productivity for public sector workers largely from the beneficiaries of the gains in earnings.

The second chapter examines spillover effects of oil extraction on income, employment and migration in Ghana. To capture the spillover effects, individuals living in districts closer to the oil extraction area are used as treated group and those living further away (about 250km) are used as control group. The study employs a difference-in-differences strategy and finds that there is, on average, a positive spillover effect on the income of individuals living closest to the oil extraction area. These effects decrease for income and migration but increase for employment, the further away an individual is from the oil extraction area. Moreover, the spillover effects are heterogeneous and vary by gender and sector. The positive effect on income observed is largely for men and workers in the agricultural and retail sectors. Migrants are mostly women and workers in retail and other services. There is a significant reduction in agriculture and service sectors employment but an increase in the manufacturing sector. The findings suggest that oil extraction in the south of Ghana deepens the economic disparities that exist between the north and south of Ghana.

The third chapter examines the effect of oil extraction on the well being of households. Existing empirical literature examining impact of natural resources at the micro level, undertake a partial analysis of the well being with most focused on average estimation with no consideration for changes along the distribution of these outcomes. This study employs an unconditional quantile technique using the Recentered Influence Function (RIF) in a difference-in-differences framework. Examining oil effect along the distribution of expenditure, the study uses households in close proximity to the oil extraction area as treated group and households further away as control group. The study finds that oil extraction has a positive effect at low expenditure levels or on poor households, but negative effects at high expenditure or on rich households. These results are broadly consistent with microeconomic theory predictions given a downward sloping oil extraction effect on households' expenditure share on food and an upward slope on non-food expenditure share.

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Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Akwasi Ampofo

SIGNATURE .... DATE ....

Dedication

To My Mum, Agnes Akua Pokuaa

Chapter 1

Introduction

Natural resource extraction contributes to the development and growth of economies. These resources serve as inputs and in return generate fiscal revenues and exports for governments and earnings for individuals associated with the extraction. Data from the World Bank have shown that resource-rich countries in Sub-Saharan Africa, grew at an annual average of 2.75 per cent from 1996 to 2014 and one-third of this growth is attributed to natural resources (World Bank 2018). With increasing discoveries, the contribution of natural resources like oil stands a greater chance of ensuring development in the region.

Empirical studies examining the role of natural resources have focused on the increasing dependence of the resource and their inability to transform lives in low to middle-income economies (Sachs & Warner 1995, Auty et al. 2001, Gylfason 2006). The limitation of most of these studies is the aggregation of various heterogeneous developed and developing economies and importantly the focus at the macro level of these economies. Such aggregation may result in insignificant estimates. However, there has been an increase in the focus of micro-level studies but most are largely on developed economies (Black et al. 2005, Michaels 2010, Marchand 2012, Kumar 2017).

This thesis examines oil extraction effect on developing economies with specific attention on Ghana. The thesis uses data largely from the Ghana Living Standard Survey (GLSS) and the Demographic Health Survey (DHS) for empirical analysis, and supporting data from district level nightlight luminosity gathered from the National

Oceanic and Atmospheric Administration (NOAA) economy indicators from the World Bank and country statistics from the Ghana Statistical Service and the Bank of Ghana. In 2007, Ghana discovered one of the largest oil deposit in Sub-Saharan Africa off the coast of the Western region and started production in 2010. The area was estimated to have between 600 million and 1.8 billion barrels of oil (Ayelazuno 2014). Extraction of the new oil fields led at an increase in oil export reserve from as low as US$ 0.5 billion prior to 2010 to US$ 3.7 billion in 2013 (EIA 2018). The extraction not only increased the export reserve of the country but also the level of economic activities as national data show an increase in GDP growth from 6% prior to 2010 to 9% between 2011 and 2013 (Ghana Statistical Service 2016). This shows that other non-oil sectors were affected as a results of the oil boom.

Though crude oil has become the recent contributor to the Ghanaian economy, there are other resources that has put Ghana on the international map. Ghana is Africa's second largest producer of Cocoa trailing Cote d'Ivoire and second largest producer of gold trailing South Africa. Ghana generates high levels of export revenue from these products. In 2010 exports value was USD 7.73 billion, gold and cocoa beans made up about 45% and 24% of total exports respectively. This proportion changed the following year with the two products making up 29% and 18%. Crude oil exports made up about 19% of total export overtaking cocoa as the second major export for the Ghanaian economy. In 2014 total exports was valued at USD 10.2 billion and crude petroleum became the largest contributor to total export in Ghana making up 26% against 22% from gold and 23% from cocoa beans (OEC 2018). Imports, on the other hand, have been largely dominated by crude and refined petroleum, food items, machinery and luxurious goods like cars. In 2010, total imports were valued at USD 10.2 billion with crude and refined petroleum making up 4.2% and 2.6% respectively (OEC 2018). Food items made up majority of total imports. In 2014, total import increased to USD 14.8 billion with refined petroleum share of import being at 15%. This was as a result of increased import of machinery and cars (1.9%) (OEC 2018).

The increased net import value is as a result of increased consumption of foreign goods. The increasing trend in import is necessitated by rising levels of income and most importantly stability in the economy. Ghana is mostly seen as a model for other African economies and this has been beneficial to the growth of the Ghanaian economy.

The first chapter of the thesis investigates how the government of Ghana, from 2011, used part of the revenue generated from the oil production to implement a wage policy, Single Spine Pay Policy, for public sector workers. The policy had two (2) objectives: (1) to address existing wage disparities between and among workers in the public sector as compared to private sectors workers, (2) to increase productivity in the public sector. The disparities were widespread from gender to sectoral differences. The existing wage disparities led to instances of strikes and this affected the level of productivity. Baah & Reilly (2009) find that civil servants lost as high as 31 days of work due to strikes. Considering the heterogeneity in the pay disparities, the chapter employs a novel unconditional quantile estimation technique proposed by Powell (2016) within a difference-in-differences framework. The choice of this estimation technique rests on the assumption that the quantiles of the outcomes can be estimated given the limited number of surveys used (3 surveys) and the technical efficiency in estimating quantiles. The approach by Powell estimates a non-additive fixed effect, which means that the fixed effects are absorbed and not estimated at every quantile, giving an accurate estimate of the model. This is contrary to the additive fixed effect estimation by Canay (2011) which takes a difference between the outcome variable and the fixed effects for every quantile specified. As can be inferred from the technique, the approach by Powell makes use of panel data. Given the surveys are repeated cross-section, the chapter employs a pseudo-panel technique proposed by Deaton (1985). This data technique groups the sample into cohorts using individual time-invariant characteristics; year of birth, gender and ethnicity. Averages of each cohorts time-varying variables are used as observations. Discrete time-varying variables are used as reported for the reason that they are rid of errors (Deaton 1985). The cohorts created from the time-invariant characteristics are then used as cohort fixed effects. The thesis finds that the government achieved its objective of reducing the wage disparities but this was only at lower end of the earning distribution where majority were women and workers in education and health sectors. On the other hand, the governments objective of increasing productivity fell short with a reduction largely from the beneficiaries of the earnings gain.

The second chapter examines spillovers from the oil extraction into local labour markets. The oil boom will not only result in revenue to the government but also lead to local effects in other non-oil sectors of the economy. For this reason, the thesis analyses a possible spillover on income and employment for workers in non-oil sectors and migration into areas close to oil extraction sites. A positive effect will ensure development in the locality as a result of the oil extraction and vice versa. To capture the spillovers from the oil extraction, the study assigns treatment status to individuals living in districts closer to the oil extraction area and uses as a control group, individuals in distant districts from the area. The choice of control group is not arbitrary but chosen using the Synthetic Control Approach (SCA) of Abadie et al. (2010). By this approach, the study uses individuals in regions with estimated weights based on similar economic indicators gathered from the three (3) GLSS survey reports. Thus, the study employs a SCA in selecting a control group and a difference-in-differences framework to estimate the mean spillover effect on the outcomes. The study finds positive spillovers on income and migration but a negative spillover on employment. Furthermore, the magnitude of these effects decreases with distance from the oil extraction area. The spillovers are heterogeneous with respect to the gender and sector of the individual. Men and agricultural workers had the largest positive spillover on their income whereas women and retail workers migrated the most. Employment spillover was generally negative for the treated sample but was positive for the manufacturing sector. These estimated effects are robust to different specifications and the possibility of growth in Ghana. They are also immune to missing individual unobserved heterogeneity in the model, which may result in biased estimates. By following Oster (2017), the study finds that the included covariates, districts, region and survey year fixed effects are enough to explain the estimated spillover effects. This solidification of the identification strategy and the confidence in the estimates show that oil extraction has the potential of positively affecting the lives of individuals that live closer to the extraction area.

The third chapter examines the well-being of the individuals in the selected districts. Individuals and households have the tendency to spend the incomes earned from the economic activities differently and this could help explain how beneficial the natural resource has been to them. The chapter investigates this possibility by examining the oil effect on household expenditure. Household expenditure serves as a better proxy to understand household wellbeing, because it shows the households ability to spend from savings and assets. The innovative contribution of this chapter to the literature is not only the focus on a developing economy but the distributional estimation of oil effect. The study follows Firpo et al. (2009)'s unconditional quantile estimation technique which adopts the Recentered Influence Function (RIF) approach. The idea of the approach is to estimate the unconditional quantiles of the model by accounting for the distributional influence of not only the outcome variable but also the explanatory variables. The estimated results are therefore not only from a within-group variation but also between group-variation. Using this approach within a difference-in-differences framework, the study finds that poor households or those at low expenditure had a positive oil impact on their consumption whereas rich households or those at the high distribution had a negative impact. The study further finds that poor households expenditure are mostly on food items but rich households spend more on non-food items in the presence of a shock. Moreover, the gained effects of poor households fade away with increasing regional price levels which are mostly for food items. The study therefore concludes that rich households are major beneficiaries of the oil extraction in Ghana.

The remainder of the thesis is as follows. Chapter 2 investigates the effectiveness of the Single Spine Pay Policy meant to address wage disparities and productivity in the public sector, and made possible by the revenue from the oil extraction. Chapter 3 examines the possibility of spillover effects of oil extraction into local labour market. Chapter 4 analyses the well-being of households in the presence of oil extraction in Ghana. Chapter 5 concludes the thesis. Chapters 2-4 are stand-alone papers, each with a reference and an appendix.

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Chapter 2

Reducing Public-Private sector Pay Differentials: The Single Spine Pay Policy as a Natural Experiment in Ghana

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Overall percentage (%)	70%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the co-author of this paper.		
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By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Please cut and paste additional co-author panels here as required.

Abstract

Empirical studies have documented the existence of the public-private pay differentials in both developed and developing countries. The implementation of policies aiming to reduce this gap has, however, been mitigated or inconclusive. This paper exploits the Single Spine Pay Policy (SSPP) in Ghana as a natural experiment to examine the effectiveness of wage policies in developing countries. The SSPP was implemented in 2010 by the Government of Ghana to address the public-private sector wage gap and improve productivity in the public sector. Using a quantile treatment effect approach based on a difference-in-differences estimation, we show that the SSPP has yet to reduce the wage gap between the public and private sectors across the entire distribution of earnings in Ghana. The improvement observed is only at the lower tail of the distribution of earnings. However, the SSPP has a larger effect on the earnings of female workers than that of males in the education and health services sector, suggesting that the policy was successful in reducing the gender-wage gap in that sector but widened the gap in the administration sub-sector. Moreover, the SSPP has decreased the productivity of workers across the distribution of earnings, mainly due to a decrease in the effort of female public sector workers in the education and health sub-sectors and male workers in the administration sub-sector. Nevertheless, the SSPP has had some successes and could be improved by putting in place a good managerial quality in the government agencies. In addition, it is important that the Government pays much attention to various macroeconomic factors that have challenged the success of the SSPP.

Key words: Public sector; Efficiency wage theory; Quantile treatment effect model; DID estimation.

JEL classification: C31, G15, J24, J31, J45.

2.1 Introduction

The implementation of policies aiming to reduce the public-private sector wage gap have received considerable attention in recent years, especially in developed countries (Lausev 2014). Bregn (2013) finds that 80 percent of employers in the OECD economies have either implemented such a wage policy or intended to do so, with the purpose of not only addressing the wage differential but also to increase workers' productivity (Bajorek & Bevan 2015). Their success, however, has been mitigated or inconclusive. While some studies found that adopting a wage policy increases earnings in the public sector (Hasnain & Pierskalla 2012), their effects on productivity have not been addressed. Bryson et al. (2012), Lucifora & Origo (2015) argued that wage policies increase workers' productivity marginally, but their studies remain silent on how such policies correct wage disparities between sectors. Most studies on wage gap often focus on the private sector and little attention is usually paid to the public sector; e.g. (Prentice et al. 2007). Despite the progress made by many countries in recent years to close the public-private sector wage gap, the realisation of this goal remains a challenge especially in developing economies. The few developing countries that implemented wage policies, such as Ghana, have no clear scientific measure of their success.

This study aims to fill this gap by using the Single Spine Pay Policy (SSPP) in Ghana as a natural experiment to examine the effects of wage policies in developing countries. In particular, we investigate whether such a policy reduces the public-private sector wage gap, while achieving maximum productivity. Using the private sector as a control group, we employ a quantile treatment effect approach based on a difference-in-differences (DID) estimation to show that the SSPP has yet to reduce the public-private sector wage gap across the entire distribution of earnings in Ghana. The improvement observed is only at the lower tail of the distribution of earnings. Nevertheless, the SSPP has a larger effect on the earnings of female workers than that of males in the education and health sub-sectors of the public sector, suggesting that the policy was successful in reducing the gender-wage gap in those sub-sectors of the public sector but widened the gender pay gap in favour of male public sector workers in the administration sub-sector. Moreover, the policy has decreased the productivity of workers across the effort distribution, mainly due to a decrease in the effort of female public sector workers in the education and health sub-sectors and male workers in the administration sub sector. Nevertheless, we find the policy effect on earnings to be positive for public sector workers when we estimate our model with self-employed individuals as the control group but highly negative with formal private sector employees. This systematic difference in the effect is as a result of the small scale nature of self employed individuals and the inconsistency in their earnings which is as a result of the general demand for their goods and services.

Our findings are similar to Damiani et al. (2016) who estimate a positive policy effect across the quantiles of earnings and productivity of Italians firms. While, Damiani et al. (2016) find a positive U-shaped curve, we find a (near) U-shaped distributional policy effect on earnings but a downward distributional effect on workers' productivity. When considering gender differences, we find that the SSPP has a positive and near U-shaped effect on earnings of females workers but a downward distributional effect on that of males. In addition, the SSPP has a downward effect on the productivity of female workers, while its effect on that of male workers is an inverted W-shape. Across different sub-sectors, the policy effect on earnings is near W-shaped for education and health services workers but U-shaped for female workers in the sub-sector. Moreover, the effect is downward sloping for administration sub-sector but near W-shaped for both males and females in that sub-sector.

Overall, our findings do not align with the literature on efficiency wage theory that postulates an increase in workers' productivity after the implementation of wage policies. The efficiency wage theory assumes that a higher wage will result in increased effort, thus leading to an increase in productivity. The reasons for such a relationship are that, first, high-paid workers would not shirk knowing the opportunity cost of being fired or losing their wages (Shapiro & Stiglitz 1984, Alexopoulos 2002). Second, as a form of showing appreciation and gratitude to employers, employees will respond positively to an increase in wages with an increase in effort, thus leading to higher productivity (Akerlof 1982, 1984). Lastly, if workers perceive a given wage as fair, there is a high chance they will increase their effort, which in turn will increase their productivity (Akerlof & Yellen 1990).

However, our results are in line with the literature on economics of vocation which states that it is costly to pay more to workers in a vocation-intensive sector like education and health services given they have an internal desire to provide their services (Heyes 2005). However, when workers do not perceive their work as a vocation, their intrinsic motivation for the work is far less than the external incentives in the form of salary given to them (Frey 1993). When workers are motivated by external incentives like surviving and the desire to satisfy their everyday needs, there is less morale to increase their effort even with an increase in earnings.

By emphasizing on identifying the causal effect of wage policies, our study contributes to the existent literature on efficient wage policies, and also shed a new light on the disparity between developed and underdeveloped countries on this topic. To the best of our knowledge, this study is the first to empirically examine the effect of wage policies in sub-Saharan countries using the novel causal quantile treatment effect approach recently proposed by Powell (2016), along with the difference-in-differences estimation. First, by conditioning on workers' unobservable characteristics, we are able to identify the causal effect of the wage policy, despite the presence of other confounding factors which may have contributed to changes in earnings during the period. Second, most studies of wage policies in the public sector have been limited to workers in the health and education sectors (Makinson 2000, Prentice et al. 2007). By contrast, our analysis of the wage policy effectiveness covers the whole public sector. Third, by distinguishing heterogeneous sub-groups of workers, our results show that the effect of the SSPP is not uniform across these sub-groups. In particular, while women and low-income workers benefited from the policy, males and high-income workers did benefit less, which indicates clearly that the mean-type regression analysis, as often done in the literature, may not be an appropriate way to investigate this type of policies. Moreover, from a methodological viewpoint, an interesting contribution of our study is the use of pseudo panels. The absence of genuine panel data covering all areas in Ghana makes it difficult to have individual observations on workers over time. Following Deaton (1985), we construct a panel data with individual time-invariant characteristics such as year of birth, gender, and ethnic composition of workers.

The remainder of the paper is organised as follows. Section 2.2 presents the background and a brief description of the SSPP. Section 2.3 introduces the data and the variables used in the study. Section 2.4 details our empirical strategy. Section 2.5 discusses the findings and we present some robustness checks in Section 2.6. Section 2.7 concludes.

2.2 The Single Spine Pay Policy in Ghana

Ghana is a West African country with a population of about 27.4 million, with around 49.75 percent of the population being men (World Bank 2017). The economy of Ghana was predominantly agrarian but recent developments have seen the services and other sectors contributing largely towards its development. The contribution of the agricultural sector to total GDP (Figure 2.1a) has decreased from 49.92 percent in 1965 to 19.60 percent in 2013, while the share of the services sector has increased from 28.79 to 52.24 percent during the same period (World Bank 2017).

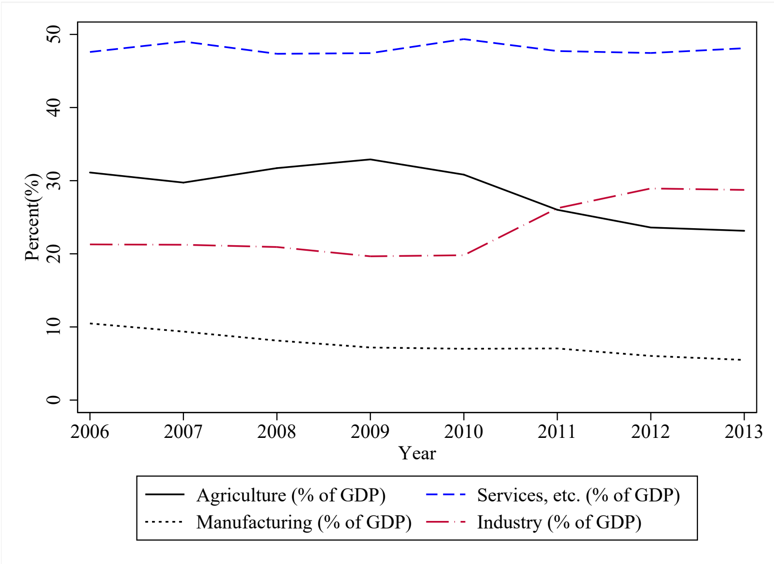
The introduction of democratic rule in 1992, along with subsequent economic reforms, have spurred the expansion of new enterprises, mostly in the private sector. While this rapid development of the private sector has improved earnings for workers, as most private sector employers pay higher wages, the same is yet to be materialized in the public sector. Several studies have found that the public-private pay differential was between 15 to 20 percent prior to 2010 (Glewwe 1991, Verner 1999, Baah & Reilly 2009). This differential was worse for workers on the lower tail of earnings' distribution. Several wage negotiations to address this issue fell through, leading to numerous strikes and a fall in workers hours of work and productivity. Baah & Reilly (2009) evidenced that the hazard rate of strikes is positively related to the strike duration in Ghana. More precisely, their results indicate a higher rate of strikes lasting as long as 30 days (Figure 2.1b). In addition, they also found that between 1980 and 2004, the public sector had lost on average 5.8 days of work per year as a result of strikes compared to 3.3 days per year in the private sector.

Over decades of failed attempts to address the public-private pay gap and improve workers' productivity in the public sector, the Government of Ghana introduced the Single Spine Pay Policy (SSPP) and implemented it on January 1, 2010. In addition to addressing the public-private sector wage gap, the SSPP aimed not only to reduce the strikes in the public sector and the frequency of wage negotiations, but also to retain skilled workers in the public sector (FWSC 2009). To the government, achieving these objectives were a probable way of containing the cost of the public sector wage bill and ensuring that public sector workers productively spend 8 hours a day and 40 hours a week.

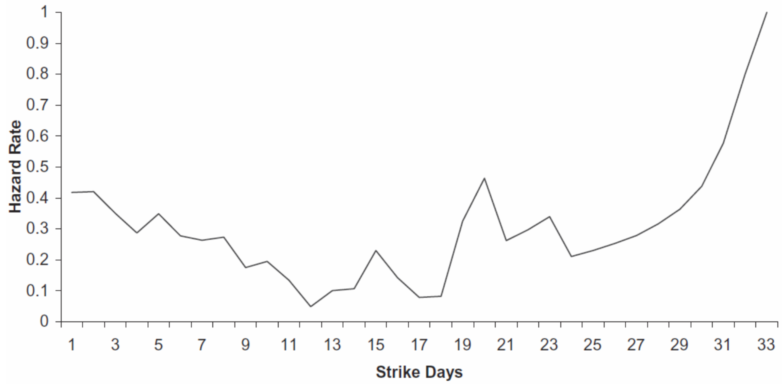
The issue of rising wage bill brings to mind how the Government of Ghana intended to finance the SSPP. In 2007, the Government of Ghana discovered new oil fields on the coast of the Western region. Extraction and large scale sale of the new oil started in 2010 bringing in oil rents for the government. Figure 2.1c shows the GDP growth of Ghana and the share of oil rents to total GDP. The average oil rents share to total GDP was about 0.05 percent during the period 2002 to 2010, but bounced to 4.88 percent in 2011. The late receipt of the rents saw the government paying off arrears to the public sector workers from 2011.

However, while well intentioned, the SSPP may not have a significant impact on the earnings in the public sector due to the expansionary trend in the GDP per capita since 1992 (Figure 2.1d). This increase may be attributed to many factors such as the establishment of new enterprises (as mentioned earlier). Therefore, the rising earnings may be a reflection of the increasing trend in the performance of the economy, rather than the impact of new oil discoveries which facilitated the implementation of the policy. This study aims to clarify this issue by proposing an econometric strategy to identify the causal effect of the SSPP.

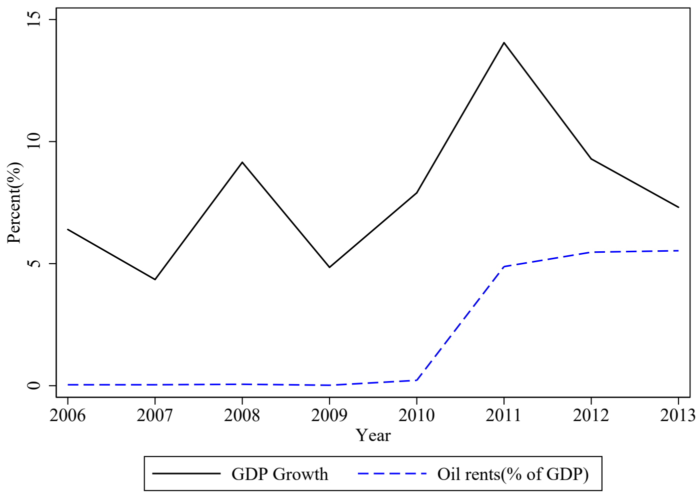
Figure 2.1: Economic Indicators and Strikes Duration in Ghanaian



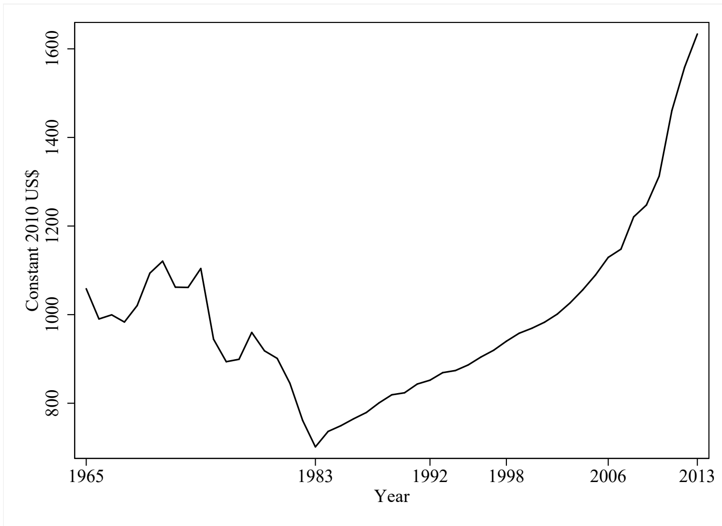
(a) Sector Share of GDP



(b) Hazard rates of strike duration in Ghana from Baah & Reilly (2009)



(c) GDP Growth in Ghana



(d) GDP per capita at 2010 constant US prices

2.3 Data

We use data from the Ghana Living Standard Survey (GLSS), rounds 4,5 and 6 conducted in 1998, 2006 and 2013 respectively. This means there are two pre-policy (1998, 2006) and one post-policy (2013) data points. This is a national representative and one of the largest repeated cross-section dataset with 5998 households in 1998, 8687 in 2006, and 16772 in 2013, surveyed across the 10 regions of Ghana (Ghana Statistical Service 2016).[1] The data include household socioeconomic characteristics and a roster of members in the household, their employment status, their sector of work, their earnings, their hours of works, their ages and educational attainment, ethnic composition and other demographic variables. We restrict our sample to only respondents above 15 years and employed.[2]

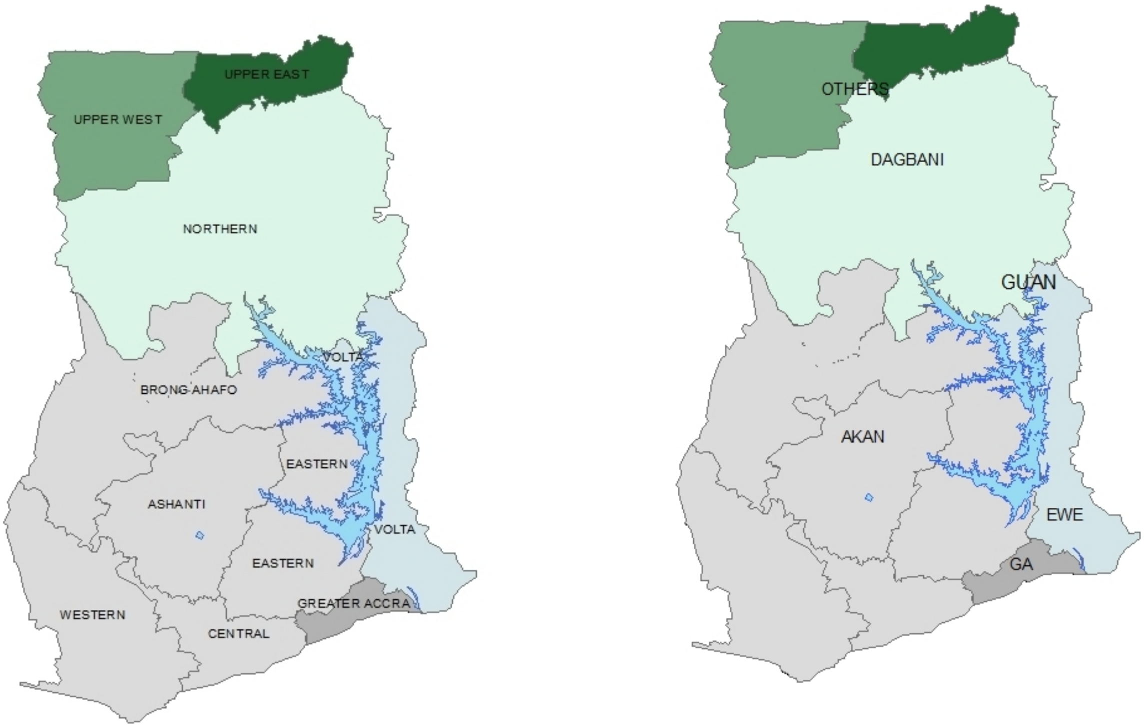
As the GLSS is a repeated cross-section data, the unavailability of a panel form makes it difficult to follow the respondents over time. We tackle this challenge by constructing a pseudo panel (Deaton 1985). The approach is such that respondents are grouped into cohorts according to the same time invariant characteristics that identify them. We then compute averages of continuous time-varying variables for each cohort across each survey and used them as observations. Discrete time varying variables like marital status and household status (head or not) are, however, used as reported because they are considered to be rid of errors (Deaton 1985). The individual fixed effect which identifies the unobserved heterogeneity in a panel data is then referred to as a cohort fixed effect. Though this is not necessarily following individuals over time but rather cohorts, it makes it possible to infer individuals' behavior from a group with similar characteristics. In the literature, the widely used time-invariant characteristics to construct cohorts have been the birth year and gender. We use these variables for the reasons that they depict the *life-cycle* and existing wage differentials between and among workers. The well-known Mincer (1974) wage equation considers age (experience) as an important determinant of

[1]The GLSS has a wider coverage than the Ghana Household Urban Population Survey which is a panel and covers only the urban cities in Ghana.

[2]This is because by the International Labour Law, working at age below 15 years is a child labour.

earnings, and this was proven to be the case in Ghana (Glewwe 1991). Glewwe (1991) found that the age-earning profile depicts the experience and earning profile of workers, and that even within the same age-earning profile, there exists a pay differential by gender. Various studies, Newell & Reilly (1996), Cohen & Huffman (2007) and Aizer (2010) also found that the gender wage gap exists in both developed and developing countries, mostly in favor of men.

Figure 2.2: Regions and Distribution of Major Ethnic Groups in Ghana



(a) Regions in Ghana **(b)** Ethnic demography

In addition to year of birth and gender, we also construct cohorts using the ethnic composition of the respondents. The use of the ethnic composition to construct cohorts is inspired by Easterly & Levine (1997), who investigated the effect of ethnic diversity on economic development in both developed and developing countries. They found that diversity of ethnic backgrounds in most countries (developed and developing) influences the differences in income and productivity. Easterly & Levine (1997) argue that these differences arise from various innate capabilities that characterise each ethnic group, making ethnicity an important factor to consider when estimating earnings and productivity.

The Ghanaian population is very diverse with different ethnic groups. This diversity affect their upbringing and this is reflected in their years of education, choice of work, and their earnings (Easterly & Levine 1997, Le 1999, Swee 2015). Across Ghana, the ethnic groups are widely dispersed in the regions. However, each region is very well represented by a major ethnic group and this affects the economic activity of the people in that region. The majority of the population belong to the Akan ethnic group and this is clearly seen in Figure 2.2.[3] The Dagbanis and the Ewes are the next most populous ethnic groups followed by the Ga-Adamgbes who are mostly found in the Greater Accra region. The northern part of Ghana is mostly occupied by minor ethnic groups with similar cultural orientation. The Dagbanis, Gonjas, and the Guans make up the majority of the population in the Northern part of Ghana. Other ethnic groups like the Gursi and Gurma are mostly found in the Upper East and West of Ghana. These groups and other minor ones are widely dispersed in the 3 northern regions.

In forming cohorts, it is necessary to ensure that there is enough heterogeneity in the groups. This requirement calls for larger cohort size and groups. The restriction on the available data makes it difficult to ensure these two requirements are satisfied, which usually leads to a trade-off between efficiency and bias. This is because a larger cohort size will reduce the number of groups (thus rendering the estimates efficient but biased), whereas a small cohort size and a larger number of groups will result in less efficient estimates but rid of bias. Verbeek & Nijman (1992) note that the main problem of cohort fixed effect is that it is time-varying, unobserved and very likely to be correlated with the averages of the variables. With the average cohort effect varying over time, treating them as random will result in inconsistent estimates, and treating them as fixed will lead to identification problems unless the variation of the cohort effect over time can be neglected. However, with cohorts sizes of at least 100, there is a chance of having the errors resulting from averaging the variables being neglected, and the estimates being consistent (Verbeek & Nijman 1992).

We form the cohorts, first, by combining all ethnic groups with less than 1,000

[3] These proportions are estimated using the 3 surveys. Figures A.1 and A.2 in the Appendix show the distribution of earnings per ethnic group and the distribution of ethnic groups in the public sector respectively in our sample.

respondents as Others. This group together with the Akan, Ewe, Ga-Adamgbe, Guan and Mole-Dagbani make up 6 ethnic groups. We then form the year of birth cohort by using different year intervals (25, 16, 6) so as to have an equal proportion (16 percent) of respondents in each cohort. Using equal year intervals will leave some year cohorts with fewer respondents. We finally form the cohorts from 6 ethnic groups, 6 birth years and 2 gender groups giving us 72 groupsin each survey.[4] Sixteen (16) percent of the total created cohorts have less than 100 respondents; this is tolerable from the literature on pseudo panel construction.

2.4 Empirical Strategy

To identify the effect of the SSPP, we use a quantile treatment approach along with a difference-in-differences estimation. Section 2.4.1 details the specification used, while Section 2.4.2 discusses briefly the identification issues related to this type of models.

2.4.1 Model Specification

We consider the following quantile treatment effect framework (Powell 2016):

$$\overline{Y}_{ct} = (PUB \times POL)'\beta(U_{ct}) + \overline{X}'_{ct}\gamma(U_{ct}) + a_t(U_{ct}) + r_c(U_{ct}) + s_c(U_{ct}) \quad (2.1)$$

$$U_{ct} = f(A_c, V_{ct}), \quad (2.2)$$

where $\overline{Y}_{ct}$ refers to the average of the outcome variables—log of monthly labour earnings or log of weekly hours of work (effort)—of cohort c at time t; $(PUB \times POL)$ is our variable of interest—PUB and POL are indicators for public sector and period after the SSPP—with coefficient of interest $\beta(U_{ct})$ measuring the effect of the SSPP on monthly earnings or effort of workers; $\overline{X}_{ct}$ is a vector of covariates—years of education, years of experience and demographic factors—and its coefficient γ measures the effect of a change in these covariates on log of monthly earnings or log of weekly hours of work; a_t, r_c and s_c are year, regional, and industry-specific fixed effects respectively,

[4]Other groups were also constructed but most of the cohorts size were less than 100 and had less heterogeneity in them. Details of the variables used are included in Tables A.1-A.4 of the Appendix.

that address any potential endogeneity in the variable of interest, $(PUB \times POL)$. U_{ct} denotes time-invariant and time-varying characteristics, modelled as a function of the cohort fixed effects A_c and the idiosyncratic shocks V_{ct}. It is worth noting that the policy effect, $\beta(U_{ct})$ is time-varying as U_{ct} incorporates time-varying characteristics. The monthly earnings used in the regressions only cover the work done within a month (in both the private and public sector). In the survey, respondents were asked to report their earnings from both the main and secondary jobs. We use only the earnings from the primary job for two reasons. First, there are many missing observations in the secondary jobs data, and second, the main job earnings suffice to achieve our objectives. The underlying assumption is that for $PUB \times POL$ to be exogenous, there should not be any information provided about U_{ct} conditional on $\overline{X}_{ct}$, i.e $U_{ct}|PUB \times POL, \overline{X}_{ct}$ has zero τ quantile. This means that, changes in $PUB \times POL$ and $\overline{X}_{ct}$ are uncorrelated with changes in U_{ct} when the cohort effects are controlled for. This implies that the structure of the rank is conditionally stable and yields the distribution of $\overline{Y}_{ct}|(PUB \times POL), \overline{X}_{ct}$. The function U_{ct} is often called the rank variable and it indicates the variation in the coefficients $\beta(U_{ct})$ and $\gamma(U_{ct})$ at the τ-quantile of $\overline{Y}_{ct}$. Therefore, U_{ct} indicates how these coefficients are to be interpreted in the quantile regression. The rank structure is useful in defining the distribution of the potential outcomes, thus workers with high quantiles have high value of U_{ct} which is a function of their cohort and idiosyncratic effects. The assumption on the rank structure is commonly used in the literature, and allows for recovering the joint distribution from the marginal ones. Each observation is assumed to maintain its rank in the distribution of earnings and effort regardless of the treatment status so that the estimated effect is the treatment effect for observations at the quantile of the potential outcome distributions (Melly & Wüthrich 2016). This rank assumption is different from that with additive fixed effects. While the former yields the estimation of the distribution of $\overline{Y}_{ct}|PUB \times POL, \overline{X}_{ct}$, the latter approach only yields the estimation on the distribution of $(\overline{Y}_{ct} - U_{ct})|PUB \times POL, \overline{X}_{ct}$. This means that in the latter, individuals at the bottom of the distribution $(\overline{Y}_{ct} - U_{ct})|PUB \times POL, \overline{X}_{ct}$ may be closer to the top of the distribution $\overline{Y}_{ct}|PUB \times POL, \overline{X}_{ct}$, thus contradicting the rank assumption. Interestingly, Powell (2016) methodology of estimating the quantiles of $\overline{Y}_{ct}|PUB \times POL, \overline{X}_{ct}$ yields consistent estimates even for short T ($T = 3$ in this study), which is an advantage over quantile regressions with additive fixed effects that require large T.

Conditioning on covariates like educational attainment and years of experience matters in the determination of earnings and productivity; e.g., Mincer (1974), Glewwe (1991), and Adamchik & Bedi (2000). Other factors like marital status, household head status, and father's working status also influence earnings (Le 1999). Ignoring these variables will result in a misspecified model, thus leading to imprecise estimates (Powell 2016).

The year fixed effects help in capturing various economic and political happenings that have evolved over time. Ignoring the activities of government which could in a way influence the earnings of workers will affect the identification of the policy effect. One interesting factor that made it possible for the implementation of the policy was the availability of an extra source of funding for the government as a result of an oil discovery in 2007. A new source of funding was needed as the government did not have stored up funds to embark on such a huge expenditure. The performance of the economy prior to the SSPP implementation, as noted by the World Bank, was declining. The growth rate increased from 6 percent in 2010 to 14 percent in 2011 (Figure 2.1c, Section 2) and declined to 9 percent the following year World Bank (2017). This shock could be attributed to the discovery and extraction of new oil fields from 2010. This discovery may make the policy endogenous and not accounting for this may result in an inefficient estimation of the policy effect. One way to address this, is to have a time dummy for the period of the oil discovery. The data available does not allow to have a different time dummy for the period after oil discovery and the pay policy. However, the inclusion of the year fixed effect helps to address this problem. Another way is the inclusion of regional effects which will account for the economic activities that evolved after the oil discovery.

The inclusion of the cohort fixed effect and industry-specific fixed effect is of essence as this helps in not attributing the effect of time invariant traits to the policy.

The literature on efficiency wages considers working hours as a measure of effort. (Katz 1986, Campbell 2006). Effort, according to the literature, is positively related to the level of productivity of a firm or an individual. In Ghana, workers are by law required to work 8 hours a day and 40 hours a week for a full time work.[5] This is admonished in the public sector and it was a reason for the government agreeing to a new pay policy. The believe is that, effectively working within this stipulated hours will result in higher level of productivity and result in a cut in employment in the public sector. This institutional setting renders it possible to measure the effort of workers, thus their level of productivity, through hours of work. Considering the unavailability of a better measure of productivity from the individual data, and more importantly the underlying theory, we use hours of work as an '*indirect*' measure of productivity. We propose two approaches in measuring effort. First, we use log of weekly hours of work. This approach is deemed appropriate as it is easier to capture a possible change in effort on average and also at the quantiles. Next we use a dummy that takes 1 if an individual works at least 40 hours a week (more productive worker) and 0 otherwise (less productive worker).

We estimate the difference-in-differences model using the Generalized Methods of Moments(GMM) approach by Powell (2016) with two moment conditions. The first is the within transformation of the data which ensures that the within cohorts comparison is used for identification. The second moment condition ensures that, on average, the expected probability of each cohort is equal to the quantile function. The two moment conditions can be written formally as:

$$E\left\{\frac{1}{2T^2}\sum_{t=1}^{T}\sum_{s=1}^{T}(Z_{ct}-Z_{cs})\left[\mathbb{1}(\overline{Y}_{ct}\leq q(D_{ct},\tau))-\mathbb{1}(\overline{Y}_{cs}\leq q(D_{cs},\tau))\right]\right\} = 0 \quad (2.3)$$

$$E\left[\mathbb{1}(\overline{Y}_{ct}\leq q(D_{ct},\tau))-\tau\right] = 0, \quad (2.4)$$

where Z_{ct} and Z_{cs} are instruments in cohort c at time t and s, D is the treatment variable, $PUB \times POL$, τ is the τ-quantile of $\overline{Y}_{ct}$, and $q(D_{cs},\tau)$ is a strictly increasing function of τ. The GMM estimator obtained by using the two moments conditions in

[5] See Ghanaian Labour Act 2003, Section on hours of work.

(2.1)–(2.2) may be difficult to compute. Powell (2016) proposes to use the following equivalent moment conditions:

$$E\left[\frac{1}{T}\sum_{t=1}^{T}(Z_{ct}-\overline{Z}_c)\left[\mathbb{1}(\overline{Y}_{ct}\le q(D_{ct},\tau))\right]\right] = 0 \tag{2.5}$$

$$E\left[\mathbb{1}(\overline{Y}_{ct}\le q(D_{ct},\tau))-\tau\right] = 0, \tag{2.6}$$

where $\overline{Z}_c = \frac{1}{T}\sum_{t=1}^{T} Z_{ct}$. The GMM estimator of $\beta(\tau)$ and $\gamma(\tau)$ in (2.1)–(2.2) solves the minimization problem

$$\min_{b\in\mathcal{B}} Q(b): \ Q(b) = m(b)'W(b)m(b), \tag{2.7}$$

$$m(b) = \frac{1}{N}\sum_{c=1}^{N} m_c(b), \quad m_c(b) = \begin{bmatrix} \frac{1}{T}\sum_{t=1}^{T}(Z_{ct}-\overline{Z}_c)\left[\mathbb{1}(\overline{Y}_{ct}\le D'_{ct}b)\right] \\ \frac{1}{T}\sum_{t=1}^{T}\mathbb{1}(\overline{Y}_{ct}\le D'_{ct}b)-\tau \end{bmatrix},$$

where $\mathcal{B} = \left\{b:\ \tau-\frac{1}{N} < \frac{1}{N}\sum_{c=1}^{N}\mathbb{1}(\overline{Y}_{ct}\le D'_{ct}b)\le\tau \text{ for all } t\right\}$, $b \equiv [\beta(\tau)', \gamma(\tau)']'$, $W(b)$ is a weighting matrix, and N is the size of cohorts. Restricting the parameters to $\mathcal{B}$ guarantees that the condition $\overline{Y}_{ct}\le D'_{ct}b$ holds for (approximately) $100\tau\%$ of the observations in each time period. We use the Markov Chain Monte Carlo algorithm (MCMC) to solve the optimization problem, as suggested by Powell (2016).

2.4.2 Threat to Identifying a Significant Policy Effect

The source of a policy variation needs to be understood better in order to avoid making erroneous inferences (Besley & Case 2000). A change in the monthly earnings and weekly hours of work could be as a result of series of factors but not necessarily the policy. Also, an important factor to consider is the control group with which the treated group is being compared to. The private sector is an equally viable option for public sector workers provided they find their efforts not to be rewarded accordingly. We use the private sector as a control group because there is a fear that the government will lose its workers to this sector, but not the other way around (FWSC 2009). Although there is job security in the public sector, the monetary gain is a clear cut for workers to move to the private sector (Adamchik & Bedi 2000).

From that perspective, we are interested in the existence of factors that could result in changes in monthly earnings and effort in favour of either the public or private sector.

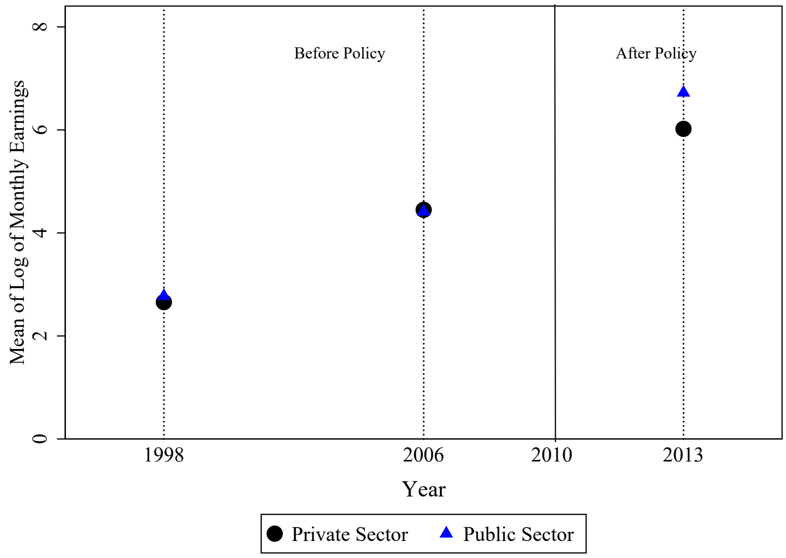
Table 2.1: Pre-Policy Descriptive Statistics

Variables	Total	Private Sector	Public Sector	Diff	P-Value
Log of Monthly Earnings	3.907***	4.066***	3.747***	0.318	0.244
	(0.061)	(0.009)	(0.114)	(0.274)	
Log of Hours of Work	3.807***	3.816***	3.798***	0.017	0.617
	(0.014)	(0.027)	(0.001)	(0.035)	
Years of Education	7.572***	7.374***	7.769***	0.394	0.591
	(0.037)	(0.023)	(0.579)	(0.733)	
Experience	10.602	10.535	10.789	0.254	0.133
	(6.176)	(6.197)	(6.119)	(0.411)	
Square of Experience/100	1.505	1.494	1.538	0.045	0.308
	(1.596)	(1.602)	(1.581)	(0.209)	
Married Workers	0.630	0.545	0.715	0.170	0.212
	(0.487)	(0.522)	(0.451)	(0.369)	
Male Workers	0.556**	0.538	0.572	0.033	0.808
	(0.272)	(0.519)	(0.495)	(0.371)	
Formally Employed Father	0.192	0.077	0.306	0.229	0.073
	(0.369)	(0.277)	(0.461)	(0.358)	
Observations	12,321	5,433	6,888		

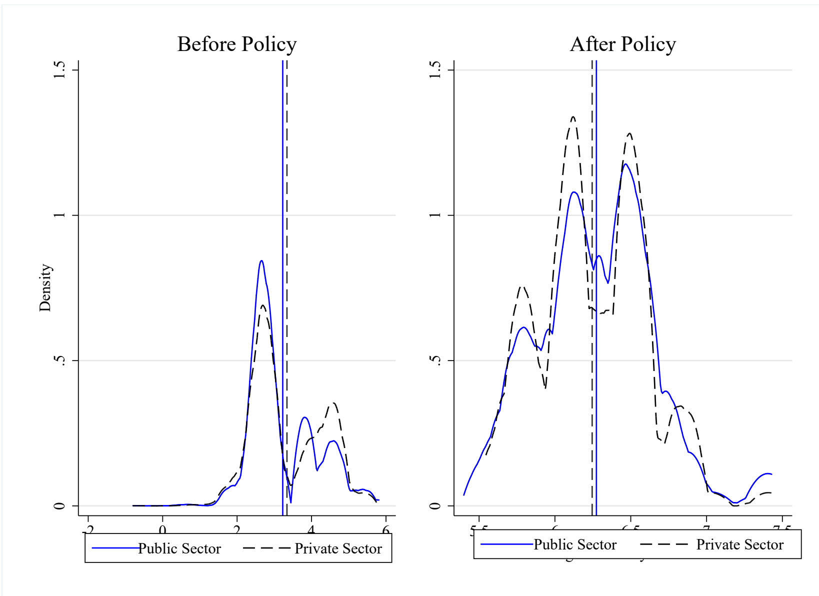
Note: Figures reflect averages prior to the policy. Monthly earnings are the earnings reported by the respondents to the question "What is the amount received for the work done". The frequency (daily, weekly, monthly, yearly) to which this amount was paid is also reported. As most workers in Ghana are paid monthly, we use this unit of measurement. Years of education refers to the average years of formal education completed. Experience refers to the number of years of actively being working. Married worker is a dummy variable taking the value of 1 if the respondent is married and 0 otherwise, and similarly for Male workers. Formally employed Father is a dummy variable taking the value 1 if the respondents' father has/had a white collar job. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 2.1 shows the mean differences in the monthly earnings, weekly hours of work among other explanatory variables of both sectors, prior to the implementation of the SSPP. The public sector workers seem, on average, to be more educated and highly experienced than those of the private sector, but such differences are statistically insignificant to contribute to any change in the monthly earnings and weekly hours of work. A closer look at the income and effort of workers reveal the story about unfolding. Figure 2.3 depicts the earnings of workers before and after the policy. There is an increase in the earnings of the public sector but their weekly hours

Figure 2.3: Distribution of Monthly Earnings



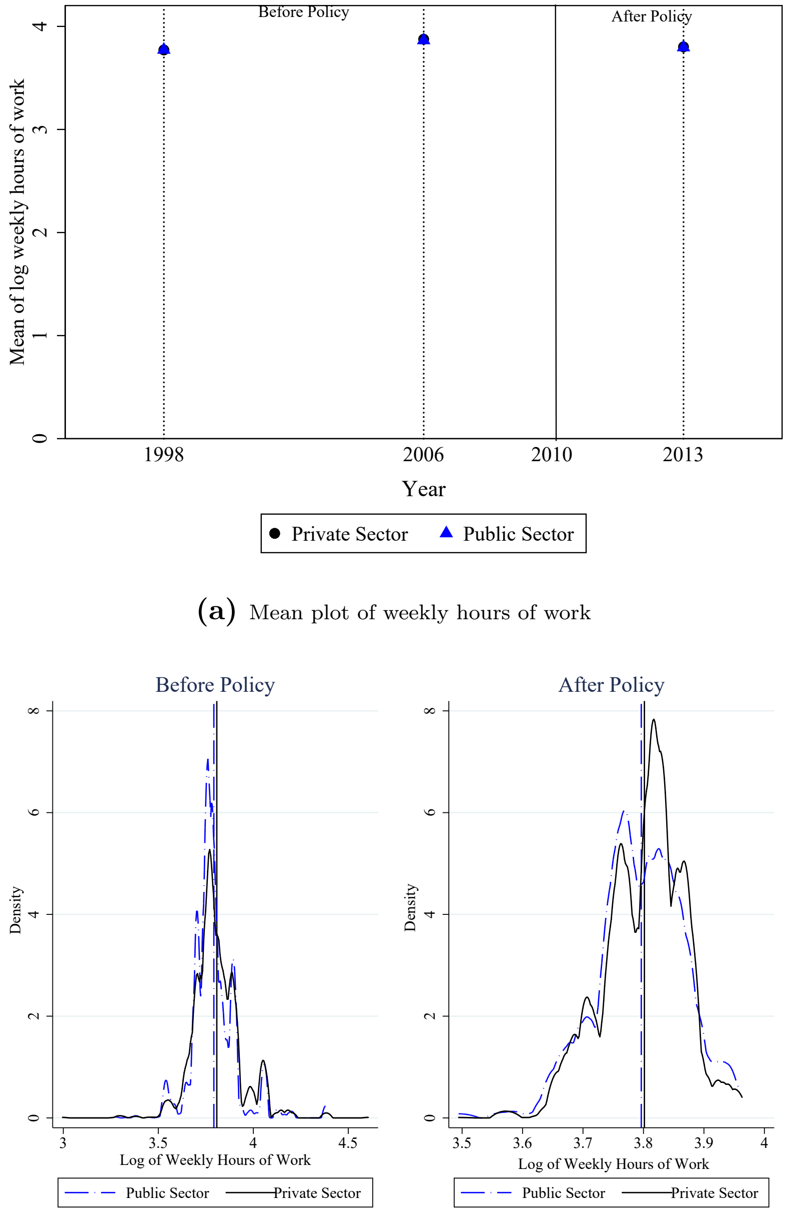
(a) mean plot of monthly earnings



(b) Distribution of monthly earnings

of work have decreased marginally after the SSPP was implemented. The distribution of the earnings in these two sectors, as depicted show that the public sector earnings are concentrated around the mean after the policy was introduced, with a reduction in the distribution towards the lower tail. This indicates homogeneity in the earnings of most workers in that sector, and similarly for the private sector. Regarding the weekly hours of work in Figure 2.4, the distribution did not change much for both sectors but a large fraction of workers have their weekly hours of work close to the mean after the SSPP was implemented. This, however, may not be enough in establishing the

Figure 2.4: Distribution of Weekly Work Hours



(a) Mean plot of weekly hours of work

(b) Distribution of weekly hours of work

absence of selections on unobservable factors. We thus conduct placebo tests, as well as other robustness checks in section 2.6.2 to ensure the estimates are well identified.

2.5 Results

For clarity, we present the effects of the SSPP on *earnings* and *effort* on separate sections.

2.5.1 Policy Effect on Earnings

Table 2.2 shows the estimates of the policy effect on log of monthly earnings. The OLS and pooled quantile estimates based on Koenker & Bassett Jr (1978) are presented in Table 2.2.I and Table 2.2.II, whereas Table 2.2.III shows the quantile fixed effect (QRPD) estimates using the approach by Powell (2016). The estimates in Table 2.2.I with no individual controls and cohort effects suggest the SSPP has a positive and statistically significant effect on average, and also across the earnings distribution, except at the 90$^{\text{th}}$ quantile. Including controls for workers education, years of experience, marital status, household status (head or not), and fathers' choice of work (white collar job or not), reduces the policy effect on average and also across quantiles of the distribution (Table 2.2.II). The reduction in the effect of the SSPP after the inclusion of control variables indicates the role individual factors play in determining earnings. Across the quantiles of the log of monthly earnings, the SSPP had its highest effect at the lower tail of the distribution and the impact decreases gradually as the quantiles increase. Figure 2.5 shows the graphs of the estimates in Table 2.2.II. The difference-in-differences estimates are on the y-axis and the quantiles of log of monthly earnings on the x-axis. The effect of the policy is significantly above and below the average effect (OLS), indicating the heterogeneous nature of the policy on the monthly earnings in the public sector.

These effects, however, reduces with the inclusion of the cohort fixed effects as shown in Table 2.2.III and in Figure 2.5. The inclusion of the cohort fixed effect indicates that omitting the unobserved heterogeneity arising from the year of birth, the gender and ethnic composition, will bias the effect of the SSPP upwards. Another significant result is that the effect of the SSPP is positive on average but negative and significant beyond the median quantile; indicating a negative effect on the earnings of public sector workers. Whereas the SSPP increased the monthly earnings of public sector workers at the 10^{th} quantile by 21.45 and 13.24 percentage points for workers at the 25^{th} quantile, it reduced the monthly earnings of public sector workers at the 75^{th} quantile by 0.56 and 0.48 percentage points for those at the 90^{th} quantile.

Table 2.2 also shows the public-private earnings gap in the absence of the SSPP. The first row of every panel shows the public sector workers, on average, earn less than their private counterparts, and also at every quantile of the earnings distribution. Though not statistically significant on average, these wage gaps are significant at the lower tails of the earnings distribution, with or without controls. The overall effect of the SSPP is obtained as the sum of the public-private wage gap and the difference-in-differences estimate in Table 2.2.III. We see that although the effect of the SSPP is positive, its objective of addressing the earnings gap was not realised as the public sector earn between 30 to 90 percent less across the quantiles.

Many studies on this topic often use hourly labour earnings from the main job in order to control for the number of hours worked. We estimate the model with hourly labour earnings as outcome variable and present the results in Table 2.3. As seen, the results are similar to the baseline model reported in Table 2.2. In particular, we observe an insignificant effect of the policy on average but a significant downward effect across the quantiles with the overall policy effect being negative.

Table 2.2: DID estimate of policy effect on log of monthly earnings

		Quantiles				
I-Pooled QR with no controls	OLS	0.1	0.25	0.5	0.75	0.9
Public Sector	-1.120	-2.221***	-1.261***	-0.799	-0.742	-0.012
	(0.324)	(0.425)	(0.499)	(0.654)	(0.191)	(0.646)
Public X Policy	2.107***	3.286***	2.489***	1.938***	1.525***	0.418
	(0.326)	(0.436)	(0.496)	(0.651)	(0.200)	(0.649)
Individual controls	No	No	No	No	No	No
Cohort fixed effect	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,473	24,473	24,473	24,473	24,473	24,473
II-Pooled QR with controls						
Public Sector	-1.628	-2.520***	-1.960***	-1.380***	-1.139**	-0.659***
	(0.283)	(0.119)	(0.186)	(0.155)	(0.188)	(0.076)
Public X Policy	1.931	3.173***	2.465***	1.655***	1.205***	0.542***
	(0.283)	(0.122)	(0.191)	(0.149)	(0.182)	(0.077)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,415	24,415	24,415	24,415	24,415	24,415
III-QRPD	FE	0.1	0.25	0.5	0.75	0.9
Public Sector	-1.191	-1.520***	-1.249***	-0.416	-0.035	-0.012
	(0.186)	(0.007)	(0.003)	(0.009)	(0.008)	(0.003)
Public X Policy	0.095	1.498***	1.201***	0.265***	-0.041***	-0.061***
	(0.187)	(0.122)	(0.191)	(0.011)	(0.008)	(0.004)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,579	24580	24,639	24,639	24,639	24,639

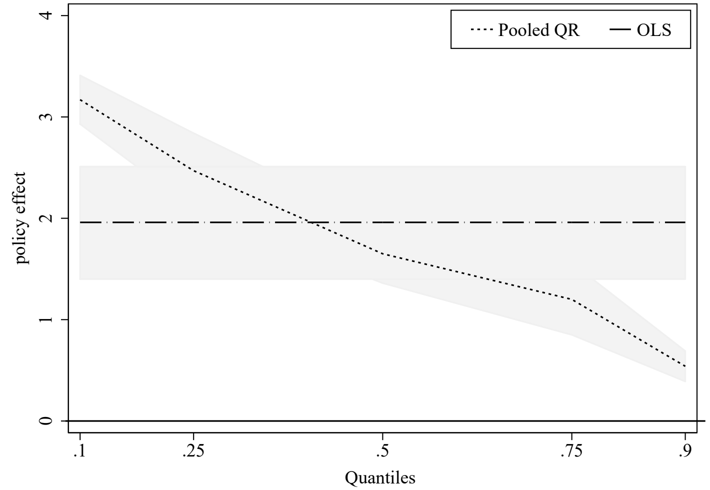
Note: We follow Koenker & Bassett Jr (1978) to estimate the pooled quantile regression of parts I and II, and Powell (2016) for III. Individual controls include workers education, years of experience, marital status, presence of union at place of work, household status (head or not) and fathers choice of work (white collar job or not). Bootstrapped Standard errors with 1000 replications in parentheses for parts I and II and MCMC algorithm for III. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 2.3: DID estimate of policy effect on log hourly earnings

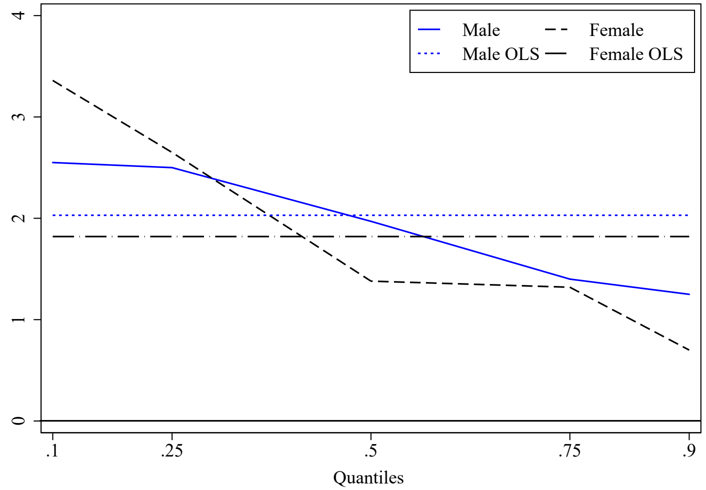
		Quantiles				
I-Pooled QR with no controls	OLS	0.1	0.25	0.5	0.75	0.9
Public Sector	0.579***	-0.549***	-0.296**	-0.434**	-0.226	-0.063
	(0.111)	(0.048)	(0.117)	(0.192)	(0.180)	(0.231)
Public X Policy	2.107***	0.839***	0.643***	0.742***	1.525***	0.123
	(0.326)	(0.051)	(0.116)	(0.192)	(0.180)	(0.230)
Individual controls	No	No	No	No	No	No
Cohort fixed effect	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,473	24,473	24,473	24,473	24,473	24,473
II-Pooled QR with controls						
Public Sector	-0.315	-0.595***	-0.372***	-0.253*	-0.289*	-0.050
	(0.095)	(0.098)	(0.072)	(0.143)	(0.170)	(0.206)
Public X Policy	0.428***	0.771***	0.545***	0.408***	0.354**	-0.003
	(0.096)	(0.099)	(0.072)	(0.143)	(0.171)	(0.209)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,415	24,415	24,415	24,415	24,415	24,415
III-QRPD	FE	0.1	0.25	0.5	0.75	0.9
Public Sector	-0.027	-0.328***	-0.271***	-0.029***	0.008***	0.002***
	(0.036)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
Public X Policy	0.022	0.324***	0.265***	0.023***	-0.011***	-0.005***
	(0.037)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,579	24580	24,639	24,639	24,639	24,639

Note: Bootstrapped Standard errors with 1000 replications in parentheses for parts I and II and MCMC algorithm for III. * $p < 0.1$. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

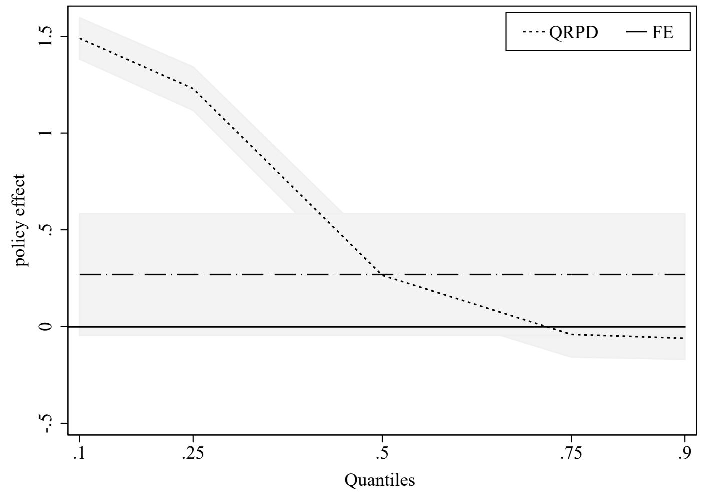
Figure 2.5: DID estimates of the policy effect on monthly earnings



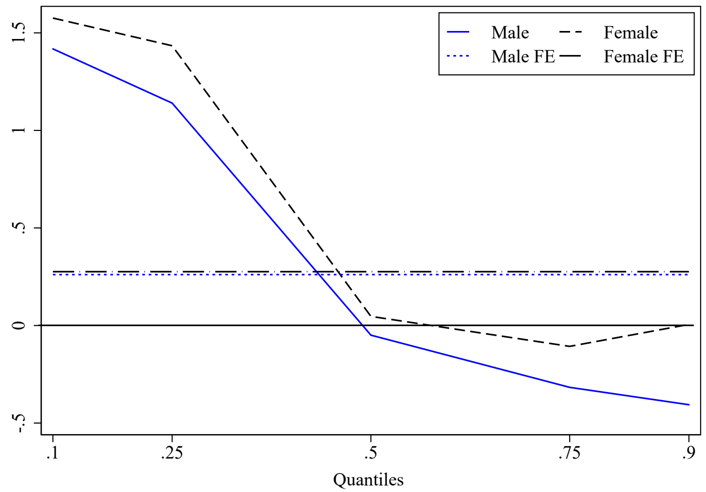
(a) Full sample



(b) Males vs. Females

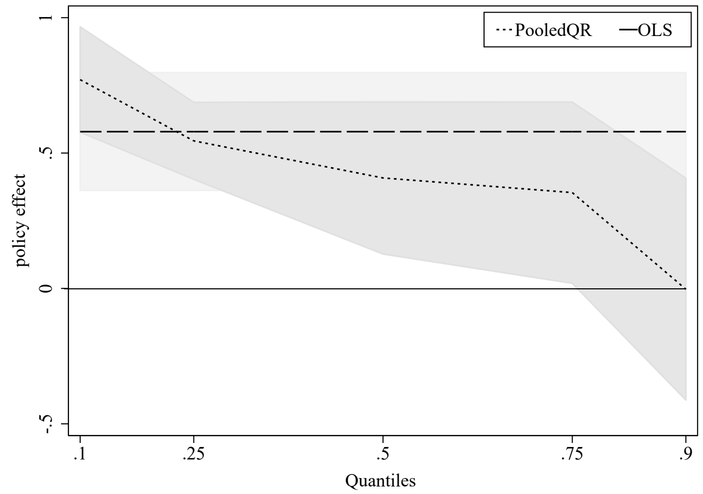


(c) Full sample

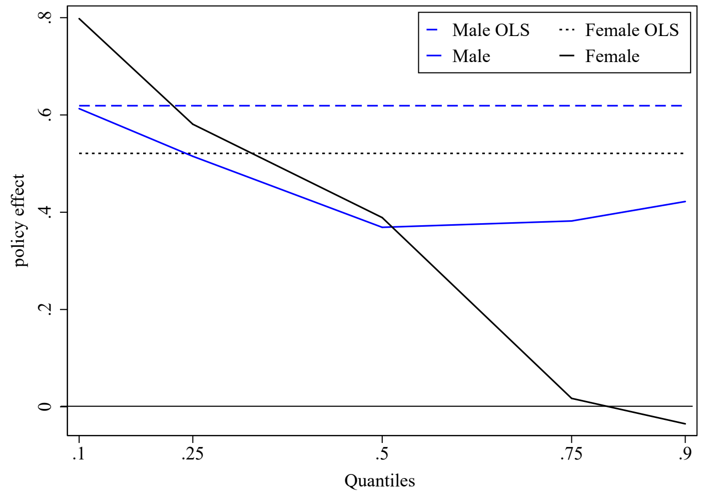


(d) Males vs. Females

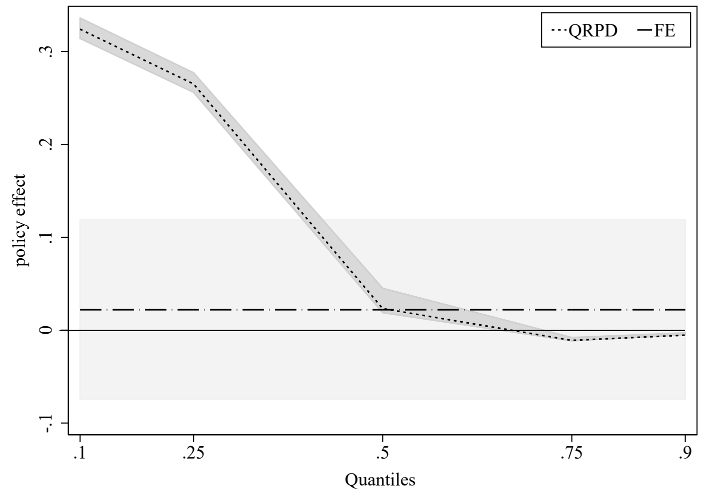
Figure 2.6: DID estimates of the policy effect on hourly earnings



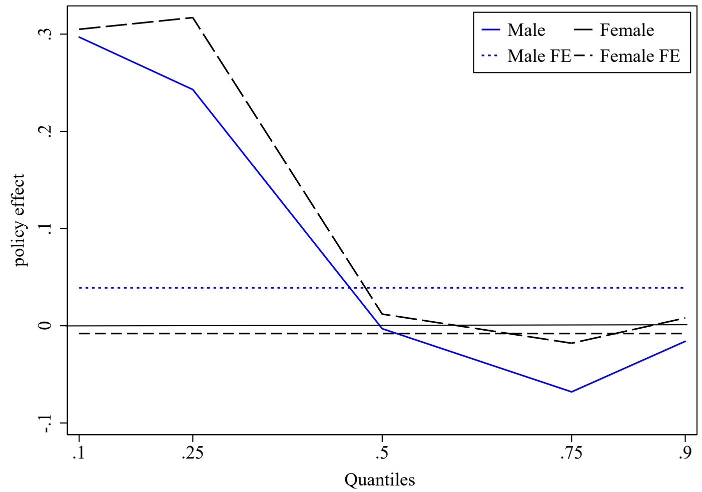
(a) Full sample



(b) Males vs. Females



(c) Full sample



(d) Males vs. Females

2.5.2 Policy Effect on Effort

We examine the effect of the SSPP on the effort of public sector workers. The estimates using the log of hours of work as outcome variable is presented in Table 2.4. As before, the OLS and pooled quantile estimates based on Koenker & Bassett Jr (1978) are presented in Table 2.4.I and Table 2.4.II respectively, whereas Table 2.4.III shows the fixed effect QRPD estimates using the approach by Powell (2016). The difference-in-differences estimates with no individual controls and cohort fixed effects are positive and significant on average and also at the 10^{th} quantile, but negative and significant at the 90^{th} quantile of weekly hours. This indicates a fall in the effort of public sector workers after the implementation of the SSPP.

The inclusion of individual controls reduces the effect of the wage policy on public sector effort on average and also at the 10^{th} quantile. The effect, however, is negative from the median and only statistically significant at the 90^{th} quantile (Table 2.4.II). Moreover, the SSPP effect on the effort of public sector workers reduces and turn negative on average and also beyond the median after including the cohort fixed effect (Table 2.4.III). Figure 2.7 shows the SSPP effect on the effort of workers. There is a significant effect of the SSPP below and above the average indicating that the heterogeneous effect across the quantiles is informative as an average estimate will disregard the reduction in effort of workers at higher tails of the effort distribution.

Like in the case of monthly earnings, the SSPP did not achieve its objective of ensuring an increase in the effort and in turn the productivity in the public sector. The public-private effort gap, without the policy, is significantly positive on average and also at the 90^{th} quantile (Table 2.4.III). The public sector reduced their effort by 0.4 percent on average and between 0.1 and 0.3 percent across the quantiles after implementation of the SSPP.

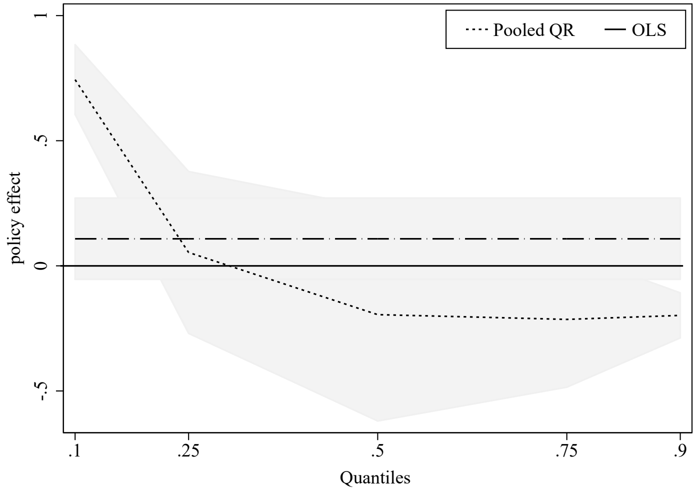
An alternative approach to test for the effectiveness of the SSPP on effort is to use a dummy variable taking a value of 1 if an individual works 40 hours or more a week, and 0 otherwise. We find that the SSPP has, on average, insignificantly reduced the effort of public sector work by around 10 percent (Table A.6 in the Appendix).

Table 2.4: DID estimate of the SSPP effects on weekly hours of work

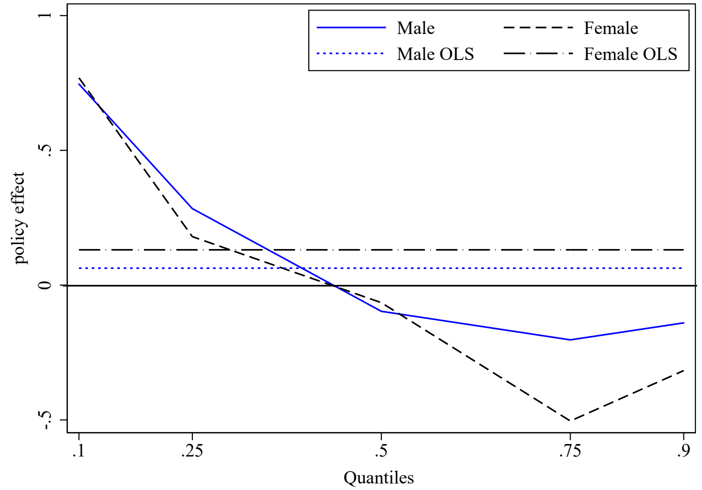
		Quantiles				
I-Pooled QR with no controls	OLS	0.1	0.25	0.5	0.75	0.9
Public Sector	-0.137	-0.588***	-0.154	-0.134	-0.056	0.125
	(0.082)	(0.100)	(0.125)	(0.155)	(0.144)	(0.124)
Public X Policy	0.144*	0.927***	0.154	0.093	0.150	-0.279**
	(0.083)	(0.114)	(0.126)	(0.158)	(0.145)	(0.127)
Individual controls	No	No	No	No	No	No
Cohort fixed effect	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,981	23,981	23,981	23,981	23,981	23,981
II-Pooled QR with controls						
Public Sector	-0.160**	-0.621***	-0.087***	0.087***	-0.013	0.047***
	(0.082)	(0.068)	(0.164)	(0.214)	(0.137)	(0.043)
Public X Policy	0.117*	0.744***	0.054	-0.195	-0.214	-0.198***
	(0.083)	(0.071)	(0.165)	(0.216)	(0.138)	(0.046)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,927	23,927	23,927	23,927	23,927	23,927
III-QRPD						
Public Sector	0.051***	-0.049	-0.004	0.027	0.041	0.104**
	(0.014)	(0.000)	(0.000)	(0.028)	(0.003)	(0.043)
Public X Policy	-0.055***	0.048***	0.0005	-0.028***	-0.041**	-0.108***
	(0.014)	(0.003)	(0.007)	(0.009)	(0.005)	(0.005)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,579	24580	24580	24580	24580	24580

Note: Individual controls and cohort fixed effects are the same as in Section 2.5.1. Bootstrapped standard errors with 1000 reps. are in parentheses for parts I and II and the MCMC ones for III.***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

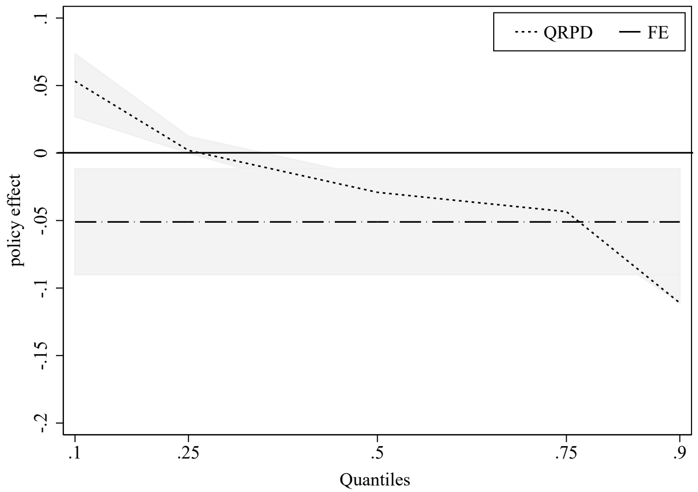
Figure 2.7: Pooled and QRPD DID estimates of the policy effect on weekly hours of work



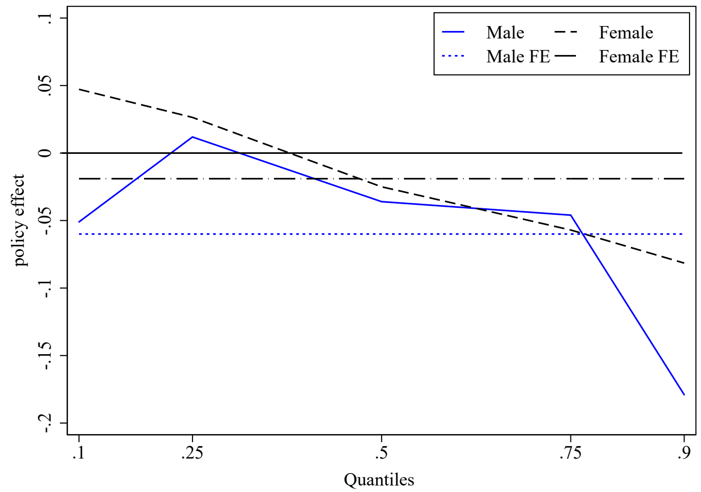
(a) Full sample



(b) Males vs. Females



(c) Full sample



(d) Males vs. Females

2.5.3 Heterogeneity across Gender

The heterogeneity of the effect of the SSPP is not observed only along the distribution of earnings and effort, but also by gender. Tables 2.5 and 2.6 present the difference-in-differences estimates of the policy on earnings and effort for males (Table 2.5) and females (Table 2.6). The results suggest that the negative effect of the SSPP on earnings are mainly driven by males. As it is positive and significantly higher for females, especially at the tails of the earnings distribution. Male public sector workers experience a negative and significant decrease of their earnings beyond the median of the distribution.

The magnitude of the public-private pay differential shows that female workers in the public sector were paid less relative to males workers, and that the policy has provided a mechanism to resolve this gender-pay gap. The overall effect, however, is negative on average and also across the distribution of earnings for both males and females. On average, the public-private wage differential is about 14 percent, and between 4 to 19 percent across the distribution of earnings. Nevertheless, males in the public sector are worse off than females after the implementation of the SSPP.

The effect of the SSPP on effort, however, is negative on average for both males and females, but positive and significant for females at the 10^{th} and 25^{th} quantiles. At the 90^{th} quantile, the effect of the SSPP on effort is higher and negative for males. In addition, while the effect of the SSPP is downward sloped for females along the distribution of effort, that of males is inverted W-shaped (Figure 2.7-(**d**)).

The objective of the policy to simultaneously reduce the public-private pay and effort gaps may not be completely unattainable but more work needs to be done to shape the policy in that direction. For example, the inability of the current form of the SSPP to catch up with rising earnings in the private sector may be due to the rigid nature of the pay system in the public sector. Most private sector employers adjust their employees earnings to changing macroeconomic performance such as inflation and living standard, which is not the case in the public sector.

Table 2.5: Policy effect on earnings and effort for males

		Male				
		Quantiles				
Log of monthly earnings	FE	0.1	0.25	0.5	0.75	0.9
Public Sector	-0.410	-1.447***	-1.201***	-0.267***	0.181**	0.313***
	(0.223)	(0.002)	(0.006)	(0.021)	(0.003)	(0.002)
Public X Policy	0.261	1.387***	1.113***	0.0684***	-0.252**	-0.360***
	(0.224)	(0.002)	(0.007)	(0.022)	(0.003)	(0.002)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,744	13,744	13,744	13,744	13,744	13,744
Effort						
Public Sector	0.065**	0.060***	-0.012***	0.037***	0.046**	0.181***
	(0.025)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
Public X Policy	-0.062**	-0.051***	0.012***	-0.036***	-0.046**	-0.179***
	(0.032)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,744	13,744	13,744	13,744	13,744	13,744

Note: Bootstrapped Standard errors with 1000 reps. are in parentheses for FE and the MCMC ones for QRPD.***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 2.6: Policy Effect on Earnings and Effort for Females

		Female				
		Quantiles				
Log of monthly earnings	FE	0.1	0.25	0.5	0.75	0.9
Public Sector	-0.337	-1.611***	-1.312***	-0.577***	0.109***	-0.154***
	(0.210)	(0.001)	(0.006)	(0.006)	(0.002)	(0.002)
Public X Policy	0.276***	1.593***	1.279***	0.470***	0.0554***	0.127***
	(0.192)	(0.001)	(0.006)	(0.006)	(0.002)	(0.001)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,835	10,836	10,836	10,836	10,836	10,836
Effort						
Public Sector	0.014*	-0.053***	-0.029***	0.024***	0.056**	0.075***
	(0.020)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Public X Policy	-0.019**	0.049***	0.023***	-0.025***	-0.056**	-0.082***
	(0.020)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,835	10,836	10,836	10,836	10,836	10,836

Note: Bootstrapped Standard errors with 1000 reps. are in parentheses for FE and the MCMC ones for QRPD.***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

2.5.4 Disaggregated Control and Treated groups

The public sector representing our treated group can be defined in three ways: (i) the public administration, (ii) public administration plus public enterprises (state-owned companies), and (iii) public administration plus public enterprises plus public education and health-care. Until now, the analysis pooled all these subgroups together but it is possible that the effect of the SSPP may differs across them, even if the industry fixed effect is controlled for. We thus estimate the model separately for: (a) education and health services workers, (b) public administration and public enterprises workers (due to insufficient data on workers in the public enterprises, we could not estimated the model for them separately).

Table 2.7 shows a positive and significant overall policy effect on the earnings of workers in the education and health services at lower quantiles, but a negative effect at higher quantiles. This positive overall effect is likely due to the positive increase in the earnings of female workers in education and health services sector. However, the effect of the policy on earnings of workers in the public administration (see the second part of Table 2.7) is mostly negative across the distribution of earnings. Nevertheless, males workers in the public administration sector are largely better off than females across the quantiles of earnings. These results show that the SSPP was successful in reducing the gender gap in the education and health services sector, but males workers have benefited more from the policy in the public administration sector. On the other hand, the overall effect of the policy on effort is positive and significant across the distribution of earnings for male workers in the education and health services sector but positive for female workers in the administration sub sector (see Table 2.8).

Another issue is the break down of the control group (here private sector). In the public-private wage gap literature some studies divide workers in the private sector into two comparison groups: (i) private employees and (ii) self-employed individuals. This allows investigating whether there are systematic differences in the wage gap between public workers and these two groups of private workers. To address this issue, we estimate the model separately for the two control groups.

Table 2.9 presents the results. First, we see a positive and significant policy effect across the distribution of earnings when *private employed individuals* is used as control group, while the policy has a negative and insignificant effect at the 10^{th}, but significant at the 25^{th}, 75^{th} and 90^{th} quantiles of the distribution of earnings when *self-employees* is used as control group. Second, the overall policy effect (sum of the estimated coefficients on *Public Sector* and *Public X Policy* in the table) is positive with *self-employees* as control group, but negative with *private employed individuals* as control group. However, the positive effect of the policy observed with *self-employees* as control group is very weak at the lower quantiles of the distribution of earnings. These results mean that the SSPP has only reduced the private-public wage gap in comparison with *self-employees* at quantiles of the distribution of earnings but has deepened the gap across the distribution of earnings in comparison with *private employed individuals*. The overall positive policy effect in comparison with *self-employees* may be explained by the fact that most self employed workers have inconsistent earnings which is mostly affected by general demand for goods and services that is partly influenced by macroeconomic factors. Also, most self employed individuals operate on a small scale affecting their source of earnings. Finally, we observe that the SSPP has reduced the effort of workers in the public sector in both sub control groups, a finding in line with our previous analysis.

Table 2.7: DID estimate of policy effect on Log monthly earnings of workers

		Quantiles				
	FE	0.1	0.25	0.5	0.75	0.9
		Education and health services				
Full sample						
Public Sector	0.049	0.103***	0.115***	0.048***	0.018**	0.088***
	(0.051)	(0.005)	(0.003)	(0.003)	(0.007)	(0.005)
Public X Policy	-0.041	-0.045***	-0.106***	-0.075***	-0.055***	-0.113***
	(0.051)	(0.004)	(0.003)	(0.002)	(0.006)	(0.006)
Observations	1,194	1,194	1,194	1,194	1,194	1,194
Male						
Public Sector	0.022	-0.003	0.044***	0.013***	-0.079***	-0.015
	(0.085)	(0.006)	(0.002)	(0.002)	(0.011)	(0.010)
Public X Policy	0.005	-0.031***	-0.070***	-0.026***	0.029*	-0.116***
	(0.094)	(0.007)	(0.005)	(0.003)	(0.014)	(0.009)
Observations	639	639	639	639	639	639
Female						
Public Sector	0.062	0.066***	0.071***	0.036	0.015*	-0.012
	(0.069)	(0.005)	(0.002)	(0.003)	(0.008)	(0.007)
Public X Policy	-0.083	0.000	-0.065***	-0.069	-0.045***	-0.006
	(0.0732)	(0.004)	(0.002)	(0.003)	(0.006)	(0.009)
Observations	555	555	555	555	555	555
			Administration			
Full sample						
Public Sector	0.000	-0.035***	-0.019***	-0.021***	-0.008***	0.033***
	(0.003)	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
Public X Policy	0.175	0.159***	0.001	-0.214***	-0.343***	-0.509***
	(0.285)	(0.003)	(0.002)	(0.003)	(0.004)	(0.006)
Observations	2,286	2,286	2,286	2,286	2,286	2,286
Male						
Public Sector	0.000	-0.004***	-0.006***	0.002*	0.005***	0.009***
	(0.003)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Public X Policy	0.373	-0.087***	-0.049***	0.125***	-0.267***	-0.112***
	(0.321)	(0.004)	(0.005)	(0.003)	(0.007)	(0.002)
Observations	1,696	1,696	1,696	1,696	1,696	1,696
Female						
Public Sector	0.000	0.013***	0.012***	0.015***	0.003***	0.034***
	(0.006)	(0.004)	(0.001)	(0.001)	(0.001)	(0.003)
Public X Policy	-0.424	-0.169***	-0.0257***	-0.884***	-0.757***	-0.580***
	(0.432)	(0.009)	(0.004)	(0.012)	(0.006)	(0.006)
Observations	590	590	590	590	590	590
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: Bootstrapped Standard errors with 1000 reps. are in parentheses for FE and the MCMC for QRPD.***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 2.8: DID estimate of policy effect on effort of workers

		Quantiles				
	FE	0.1	0.25	0.5	0.75	0.9
			Education and Health Services			
Full sample						
Public Sector	0.035**	0.018***	0.034***	0.042***	0.022***	0.011***
	(0.011)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Public X Policy	-0.034**	-0.015***	-0.0310***	-0.041***	-0.029***	-0.009***
	(0.011)	(0.005)	(0.001)	(0.000)	(0.002)	(0.001)
Observations	1,194	1,194	1,194	1194	1,194	1,194
Male						
Public Sector	0.016	0.004**	0.002	0.005***	-0.094***	0.023***
	(0.019)	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)
Public X Policy	-0.013	0.032***	0.002	-0.007***	0.096***	-0.021***
	(0.021)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Observations	639	639	639	639	639	639
Female						
Public Sector	0.029**	0.034***	0.031***	0.051***	0.033***	0.016***
	(0.010)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Public X Policy	-0.029**	-0.033***	-0.033***	-0.052***	-0.037***	-0.029***
	(0.011)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)
Observations	555	555	555	555	555	555
			Public Administration			
Full sample						
Public Sector	0.001	-0.003***	-0.005***	-0.006***	-0.001***	0.002***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.0002)
Public X Policy	0.033	-0.053***	-0.071***	-0.023***	-0.030***	-0.051***
	(0.075)	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)
Observations	2,286	2,286	2,286	2,286	2,286	2,286
Male						
Public Sector	0.001	-0.003***	-0.004***	-0.006***	-0.001***	0.001***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Public X Policy	0.033	-0.053***	-0.071***	-0.023***	-0.030***	-0.051***
	(0.075)	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)
Observations	1,696	1,696	1,696	1,696	1,696	1,696
Female						
Public Sector	0.000	-0.005***	0.00147***	0.002***	0.001*	0.001***
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Public X Policy	-0.050	-0.055***	-0.021***	-0.016***	-0.019***	0.036***
	(0.031)	(0.002)	(0.001)	(0.000)	(0.002)	(0.003)
Observations	590	590	590	590	590	590
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: Bootstrapped Standard errors with 1000 reps. are in parentheses for FE and the MCMC for QRPD.***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 2.9: DID estimate of policy effect with different control groups

	FE	Quantiles 0.1	0.25	0.5	0.75	0.9
			Self-employees			
Log of monthly earnings						
Public Sector	0.268***	0.016***	0.065***	0.150***	0.281***	0.726***
	(0.044)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Public X Policy	-0.226*	-0.003	-0.015**	0.045***	-0.014**	-0.575***
	(0.089)	(0.003)	(0.005)	(0.003)	(0.005)	(0.006)
Effort						
Public Sector	0.013*	0.001***	-0.001***	0.003***	0.016***	0.027***
	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Public X Policy	-0.026	0.013***	-0.007***	-0.008***	-0.012***	-0.031***
	(0.014)	(0.000)	(0.001)	(0.000)	(0.003)	(0.002)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7284	7284	7284	7284	7284	7284
			Private employed individuals			
Log of monthly earnings						
Public Sector	-0.511***	-0.120***	-0.252***	-0.893***	-1.218***	-0.929***
	(0.057)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Public X Policy	0.475***	0.048***	0.175***	0.827***	1.125***	0.794***
	(0.054)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Effort						
Public sector	0.009	-0.032***	-0.027***	-0.040***	-0.036***	-0.111***
	(0.007)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Public X Policy	-0.014	0.029***	0.019***	0.036***	0.035***	0.117***
	(0.008)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8772	8772	8772	8772	8772	8772

Note: Bootstrapped Standard errors with 1000 reps. are in parentheses for FE and the MCMC for QRPD.***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

2.6 Robustness Checks

2.6.1 Instrumental Variable Estimation of Policy Effect

An important threat to identifying the effect of the SSPP is that it may not be exogenous, thus resulting to the previous estimates being inaccurate. The activities of trade unions in the public sector have contributed largely to the implementation of the SSPP. Therefore, we use the presence of *unions* at the work place in public sector as an instrumental variable for the SSPP. The classical IV-diagnostic tests (Table A.8) indicate clearly that this IV is not poor, so we proceed with the QRPD-IV estimation. The QRPD-IV estimates are shown in Table 2.10, and Figures 2.8 &

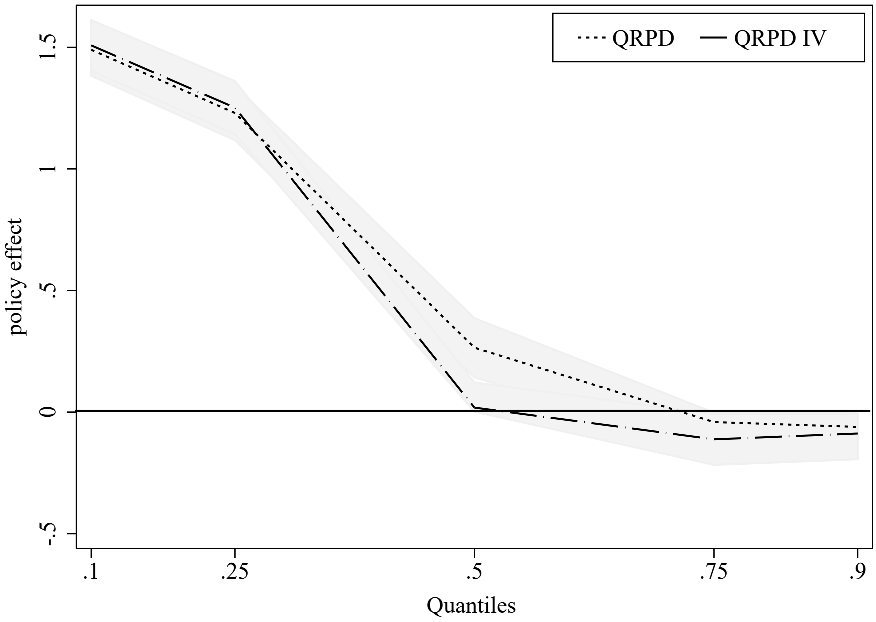
Table 2.10: Instrumental variable estimates

	Quantiles				
Log of monthly earnings	0.1	0.25	0.5	0.75	0.9
Public Sector	-1.530***	-1.294***	-0.057***	0.104***	0.076***
	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)
Public X Policy	1.508***	1.252***	0.0185***	-0.112**	-0.088***
	(0.003)	(0.005)	(0.002)	(0.003)	(0.003)
Individual controls	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes
Observations	24,639	24,639	24,639	24,639	24,639
Effort					
Public Sector	-0.044***	-0.001	0.036***	0.045**	0.114***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Public X Policy	0.040***	0.001	-0.034***	-0.044***	-0.115***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Individual controls	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes
Observations	24639	24639	24639	24639	24639

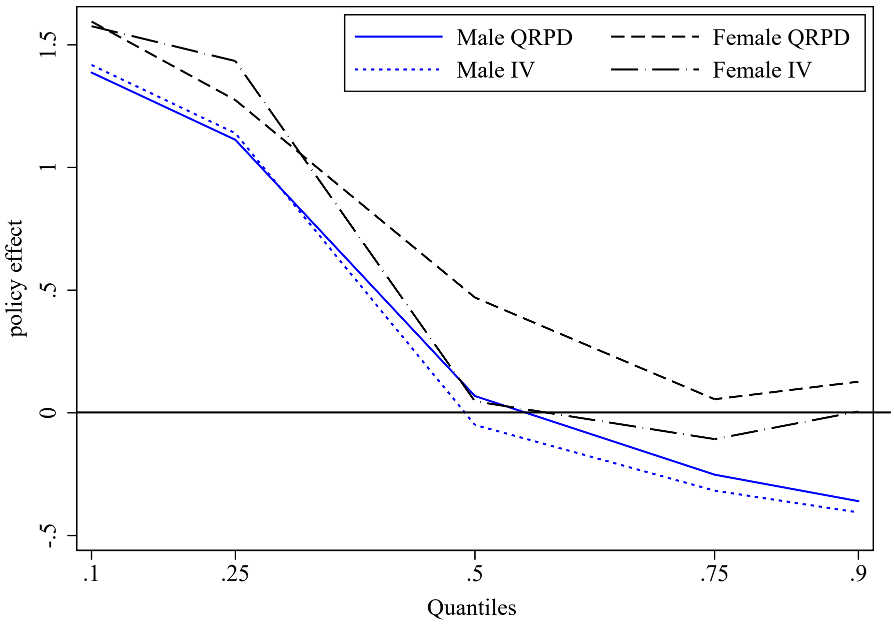
Note: The instrument for the *PublicXPolicy* is the presence of *unions* in the public sector. Standard errors from the MCMC method are in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

4.6 present the graphs of the resulting difference-in-differences estimates along the quantiles of monthly earnings and effort, both the full sample [Subfigures **(a)**] and the sub-samples of males and females [Subfigures **(b)**]. The results align qualitatively with our previous analysis in Section 2.5. Quantitatively, the SSPP has a smaller effect on monthly earnings at higher tail of the distribution compared with the results of Section 2.5. Regarding effort, the difference between the QRPD-IV estimates in Figure 4.6 and that of the standard QRPD estimates in Section 2.2 are quite similar.

Figure 2.8: DID estimates of the SSPP effect on monthly earnings

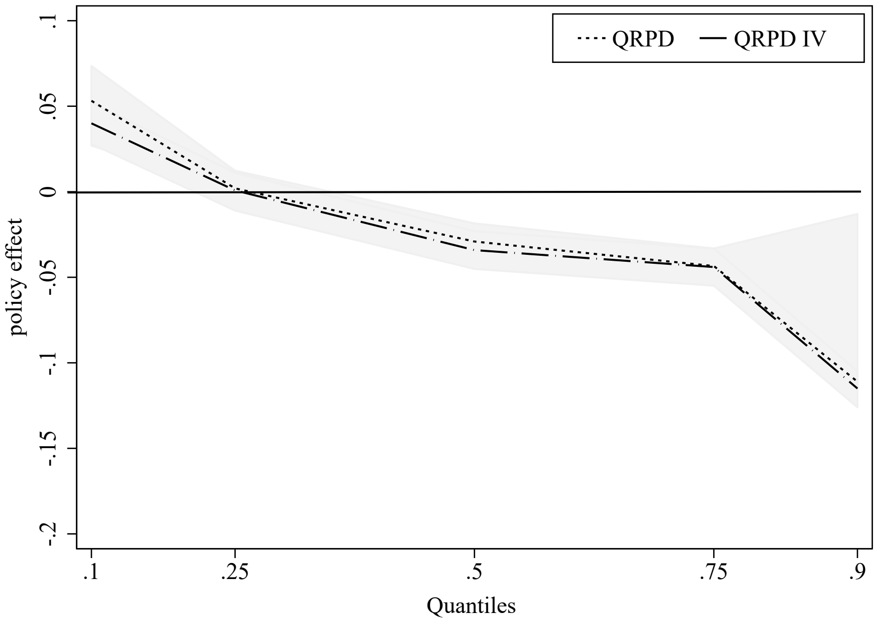


(a) Full sample

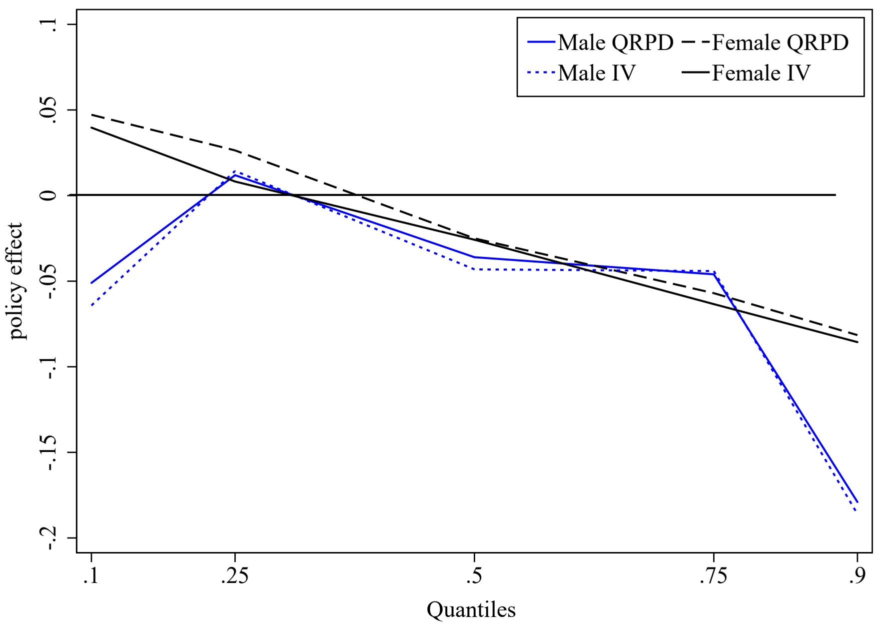


(b) Males vs. Females

Figure 2.9: DID estimates of the SSPP effect on effort



(a) Full sample



(b) Males vs. Females

2.6.2 Placebo Test and other Robustness Checks

The identification of the policy effect depends on the validity of the underlying assumptions. One of this assumption is that there are no *confounding factors* other then the SSPP that could actually affect earnings and effort in the public sector, once the observed heterogeneity of workers is controlled for. To explicitly test this assumption, We use a placebo test with fictitious year 2006 as a falsification strategy. We use 2006 as the year after which the policy was implemented and test the effect of the SSPP across the quantiles of earnings and effort. If earnings and effort in the public sector were significantly increasing or decreasing as compared to the private sector, then the policy effect would be wrongly attributed. We thus expect this

Table 2.11: Placebo test

	Quantiles				
Log of monthly earnings	0.1	0.25	0.5	0.75	0.9
Public Sector	-0.041	-0.041	-0.036	-0.040	-0.041
	(0.028)	(0.062)	(0.035)	(0.032)	(0.511)
Public X Policy_{2006}	-0.094	0.029	0.134	0.170	0.178
	(0.159)	(0.101)	(0.620)	(0.166)	(1.344)
Individual controls	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes
Observations	12,321	12,321	12,321	12,321	12,321
Effort					
Public Sector	-0.006	-0.011	-0.009	-0.013	-0.018
	(0.01)	(0.013)	(0.011)	(0.019)	(0.015)
Public X Policy_{2006}	0.006	0.015	0.067	0.079	0.081
	(0.715)	(0.0267)	(0.452)	(0.524)	(0.441)
Individual controls	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes
Observations	12,321	12,321	12,321	12,321	12,321

Note: We use 2006 as a fictitious year rather than 2013 as the year after the policy was implemented. Standard errors from the MCMC algorithm are in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

pseudo policy not be significant. As shown in Table 2.11, our expectation is met as the estimates are not significant across the distribution of both the monthly earnings and effort.

The literature on earnings and productivity argues that earnings and productivity should increase after a training program (Heckman & Smith 2004, De Grip & Sauermann 2013, Konings & Vanormelingen 2015). In our case, a significant coefficient for a training program after the implementation of the policy will bias the estimates attributed to the SSPP. To investigate this, we consider workers who undertook a training program for a month or more after the SSPP was implemented. This information is available in our data. Table 2.12 presents the QRPD estimates.

Table 2.12: Other robustness test

	Quantiles				
Log of monthly earnings	0.1	0.25	0.5	0.75	0.9
Public X Policy	1.502***	-1.201***	0.199*	-0.039	-0.031
	(0.100)	(0.125)	(0.109)	(0.195)	(0.131)
Training X Policy	-0.0301	-0.0276	0.00056	-0.004	0.039
	(0.026)	(0.023)	(0.022)	(0.019)	(0.0257)
Individual controls	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes
Observations	24,579	24,580	24,580	24,580	24,580
Effort					
Public X Policy	0.048*	-0.001	-0.031*	-0.043	-0.110 ***
	(0.026)	(0.019)	(0.017)	(0.031)	(0.031)
Training X Policy	-0.002	-0.008	-0.008	-0.001	0.008
	(0.005)	(0.021)	(0.022)	(0.001)	(0.005)
Individual controls	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes	Yes	Yes
Observations	24,579	24,580	24,580	24,580	24,580

Note: Standard errors from the MCMC method are in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively

The effect of the training program is insignificant across the quantiles of both the *monthly earnings* and *effort*, thus suggesting that our analysis in Section 2.5 is likely not impacted by confounding factors.

2.7 Policy Implications and Concluding remarks

In this study, we examine the effect of the Single Spine Pay Policy (SSPP) implemented in 2010 by the Government of Ghana. The SSPP objectives were to: (i) address the public-private wage gap, and (ii) increase the productivity in the public sector. Using a quantile treatment effect approach based on a difference-in-differences estimation, we show that the SSPP has yet to reduce the public-private sector pay differentials across the whole distribution of earnings in Ghana. The improvement observed is mostly at the lower tail of the distribution of earnings. Nevertheless, the SSPP was successful in reducing the gender-wage gap in the education and health services sub-sector in favour of females but widened the gap in the administration sub-sector. The policy has also decreased the productivity of workers, mainly due to a decrease in the effort of males in the administration sub-sector and females in the education sub-sectors of the public sector. Our findings are supported by a number of robustness checks, and the quantile approach adopted shows that examining a policy effect at the averages may not always be appropriate way as noted by Firpo (2007).

The reduction in the effort after the implementation of the policy, especially by female workers in the public sector, requires more attention. Indeed, females public sector workers have seen a major reduction in their hours of work after 2010. The backward bending nature of their supply curve is mostly seen beyond the 25^{th} quantile of the distribution of hours of work. Our understanding of this phenomena is that most females in the public sector with hours of work beyond the 25^{th} quantile are married and have children. The young and unmarried women are mostly those willing to spend 8 hours a day at work, as they have less family responsibilities. For example, Heath (2017) found in urban Ghana that women are likely to reduce their hours of work when they have children, except if they are self-employed. Another factor that could also explain the fall in effort in the public sector is the increasing number of strikes after the implementation of the SSPP. Most public sector workers were critical of this policy, and this was accentuated by their increase participation in unions' activities.

Furthermore, the discrepancies associated with late payments of wages and the possibility that some workers will not be paid in full, has resulted in a far more severe strikes in the public sector. This late payments mostly stem from the inconsistencies in the rents from the oil sale. As shown in Figure 2.1c, the fall in the contribution of oil rents to total GDP along with the over-dependence on the gains from a volatile source have introduced a lot of uncertainties in the pay of public sector workers. This volatile nature of the oil rents raises the question of whether the SSPP can be sustained. It is fair to say that the ability of the Ghanaian government to sustain this policy will largely depend on how it cautiously manages its expenditure, and more importantly the allocation of its resources towards more diverse productive areas.

Other macroeconomic factors have impacted the success of the SSPP. In particular, the continuous rise in inflation and daily depreciation of the local currency do not align with a policy that is revised only at the end of a calendar year. In the private sector, most firms have policies or measures that facilitate the revision of wages within a year to account for changing environment and living costs. This is quasi-nonexistent in the public sector, which does not favor a policy like the SSPP to have its desired impact. Nevertheless, the SSPP has had some successes. In particular, this policy has reduced the gender-wage gap in the education and health services sector, and it could be improved by putting in place a good managerial quality in government agencies. A critical problem that needs to be also addressed is the gap widening in the administration sub-sectors given this sub-sector plays a major role in ensuring a smooth run of any economy. Also, our econometric analysis of the effect of this policy has some challenges. For example, the availability of data does not make it possible to measure the effect of the policy over a longer time period. We hope that future research could be done in that perspective once data become available.

Appendix A

Figure A.1: Distribution of log monthly earnings across ethnic groups

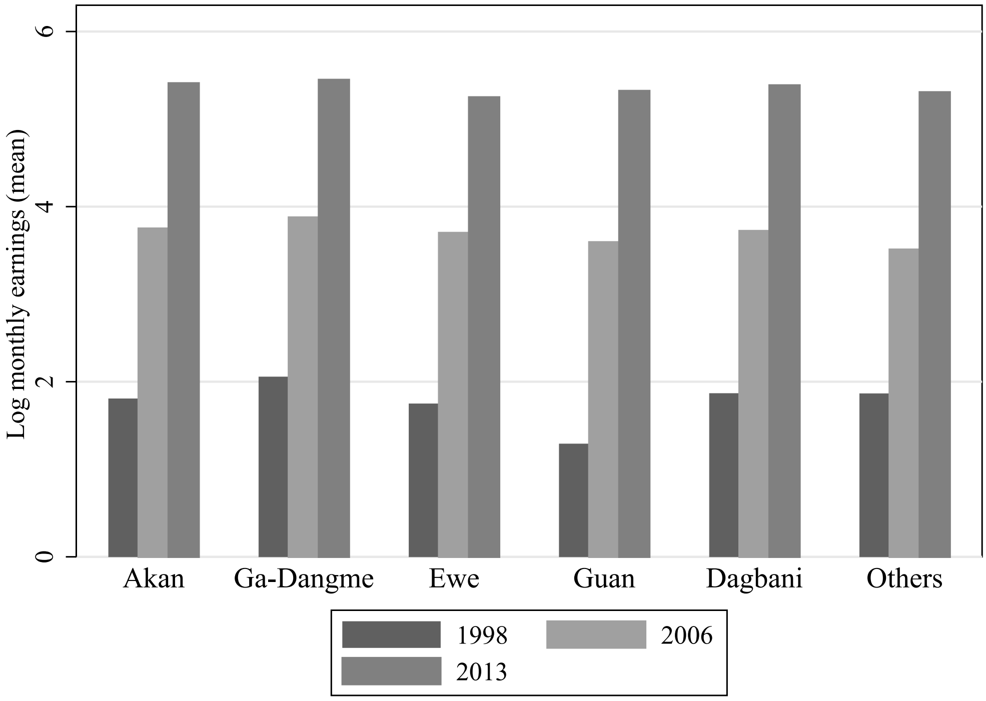


Figure A.2: Distribution of public sector workers across ethnic groups

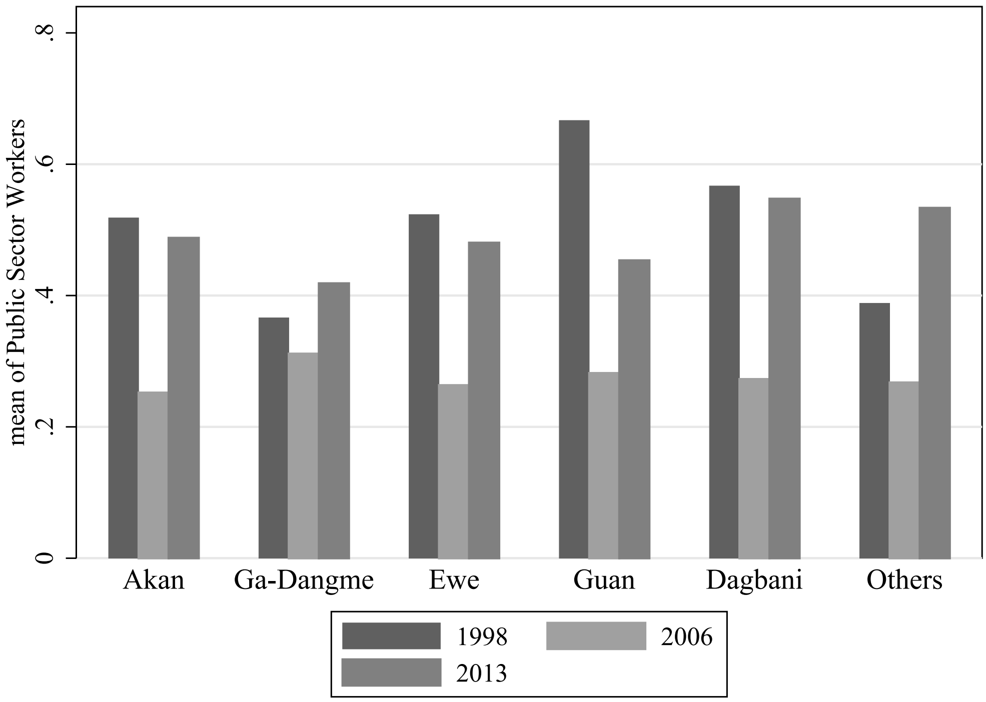


Figure A.3: Monthly earnings (pooled sample)

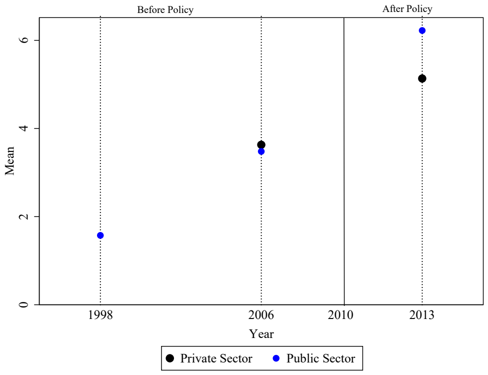


Figure A.4: Monthly earnings (pseudo sample)

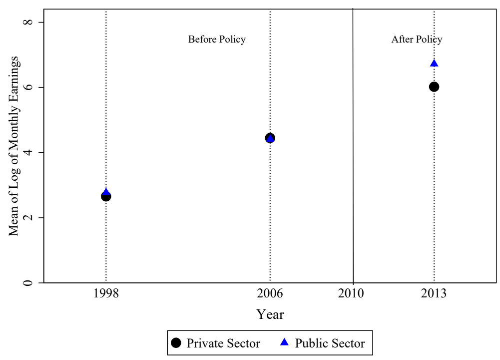


Figure A.5: Distribution of Monthly earnings (pooled sample)

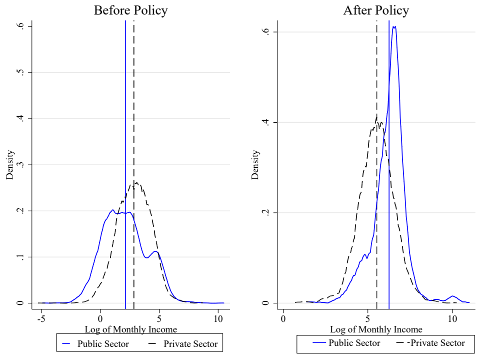


Figure A.6: Distribution of Monthly earnings (pseudo sample)

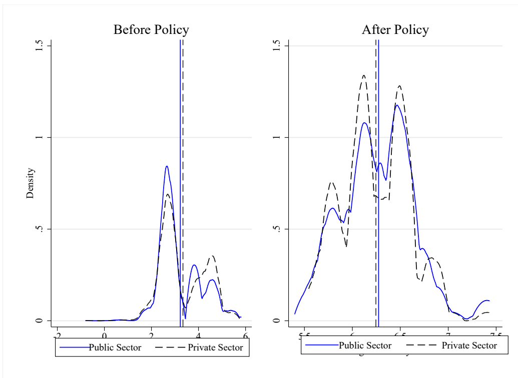


Figure A.7: Log Weekly hours of work (pooled sample)

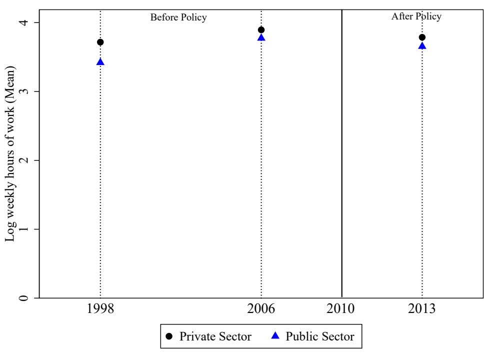


Figure A.8: Log Weekly hours of work (pseudo sample)

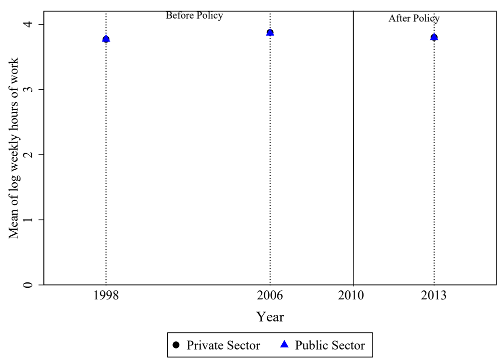


Figure A.9: Distribution of effort(pooled sample)

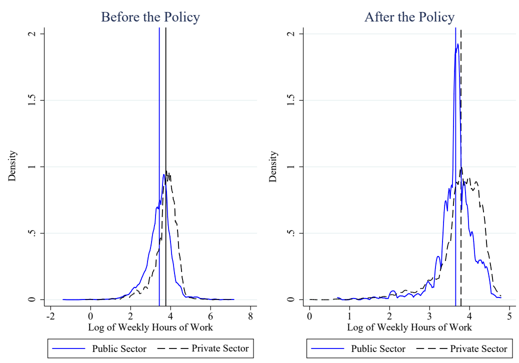
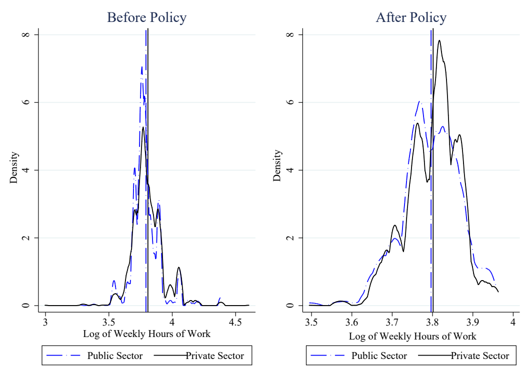


Figure A.10: Distribution of effort(pseudo sample)



2..1 Construction of Pseudo Panel

Table A.1: Survey years

Year	Frequency	Percentage
1998	5,433	22.05
2006	6,888	27.96
2013	12,318	49.99
Total	**24,639**	**100.00**

Table A.2: Respondents by gender

Year	Frequency	Percentage
Males	13,774	55.90
Females	10,865	44.10
Total	**24,639**	**100.00**

Table A.3: Year cohorts

Year Cohorts	Frequency	Percentage
1930-1955	4,001	16.24
1956-1962	3,772	15.31
1963-1968	4,156	16.87
1969-1975	4,176	16.95
1976-1982	4,197	17.03
1983-1999	4,337	17.60
Total	**24,639**	**100.00**

Table A.4: Ethnic cohorts

Year Cohorts	Frequency	Percentage
Akan	13,589	55.15
Ga-Dangme	2,309	9.37
Ewe	3,916	15.89
Guan	1,203	4.88
Dagbani	1,876	7.61
Others[1]	1,746	7.09
Total	**24,639**	**100.00**

Table A.5: Descriptive statistics

	Before Policy				After Policy			
	Total	Private Sector	Public Sector	Diff(Pr-Pu)	Total	Private Sector	Public Sector	Diff(Pr-Pu)
Log of Monthly Income	3.907***	4.066***	3.747***		6.217***	6.210***	6.274***	***
	(0.061)	(0.009)	(0.114)		(0.003)	(0.003)	(0.011)	
Log of Hours of Work	3.807***	3.816***	3.798***		4.786***	4.785***	4.796***	***
	(0.014)	(0.027)	(0.001)		(0.06)	0.006	(0.002)	
Years of Education	7.572***	7.374***	7.769***		7.642***	7.223***	11.641***	***
	(0.037)	(0.023)	(0.579)		(0.015)	0.012	0.023	
Experience	10.602	10.535	10.789		10.741***	10.723***	10.89***	
	(6.176)	(6.197)	(6.119)		(0.096)	(0.1023)	(0.2782)	
Square of Experience/100	1.505	1.494	1.538		2.287***	2.22***	2.29***	
	(1.596)	(1.602)	(1.581)		(0.039)	(0.043)	(0.107)	
Married Workers	0.630	0.545	0.715		0.679***	0.676***	0.703***	**
	(0.487)	(0.522)	(0.451)		(0.004)	0.004	0.012	
Male Workers	0.556**	0.538	0.572		0.546***	0.538***	0.615***	***
	(0.272)	(0.519)	(0.495)		(0.004)	(0.005)	0.013	
Formally Employed Father	0.192	0.077	0.306		0.404***	0.389***	0.526***	***
	(0.369)	(0.277)	(0.461)		(0.004)	(0.005)	(0.014)	
Observations	12,321	5,433	6,888		12,318	7,532	4,786	

Note: Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table A.6: Alternative measure of effort

$Effort \geq 40hrs/week$	Full Sample	Male	Female
Public Sector	0.0692	-0.149	-0.019
	(0.151)	(0.217)	(0.215)
Public X Policy	-0.109	-0.200	-0.011
	(0.157)	(0.223)	(0.220)
Constant	0.039	-0.095	0.217
	(0.163)	(0.226)	(0.254)
Individual controls	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes
Industry-Specific effects	Yes	Yes	Yes
Observations	24639	13,774	10,865

Note: Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table A.7: DID estimate of policy effect for *new hires*

	FE	0.1 Quantile	0.25 Quantile	0.5 Quantile	0.75 Quantile	0.9 Quantile
Log Monthly Earnings						
Public Sector	-0.0726	-1.584***	-1.276***	0.066**	0.077***	0.074***
	(0.193)	(0.001)	(0.003)	(0.003)	(0.001)	(0.003)
Public X Policy	0.083	1.590***	1.254***	0.034***	-0.083***	-0.089***
	(0.203)	(0.001)	(0.003)	(0.003)	(0.003)	(0.002)
Public X Policy X Entrants	-0.109***	-0.085***	-0.074***	-0.046***	-0.030***	0.004***
	(0.024)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Observations	24,580	24,580	24,580	24,580	24,580	24,580
Effort						
Public Sector	0.0563***	-0.046***	0.002***	0.029***	0.044***	0.112***
	(0.016)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Public X Policy	-0.055***	0.040***	-0.004***	-0.025***	-0.043***	-0.113***
	(0.016)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Public X Policy X Entrants	0.002	0.006***	0.002***	-0.008***	-0.009***	-0.003***
	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	24,580	24,580	24580	24,580	24,580	24,580

Note: Entrants are workers with less than 2 years tenure. Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table A.8: First-stage IV diagnostics

	Statistic	P-value
Weak identification test		
Cragg-Donald statistic	14.981	
Kleibergen-Paap statistic	10.918	0.001
Stock-Yogo critical values		
5% maximal IV relative bias	16.38	
10% maximal IV relative bias	8.96	
20% maximal IV relative bias	6.66	
30% maximal IV relative bias	5.53	

Note: The IV is the presence of a trade union at the work place in the public sector.

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Chapter 3

Oil Extraction and Spillover Effects into Local Labour Market: Evidence from Ghana

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Contribution to the Paper	Contributed to literature review, helped with data collection and collation and proposed the empirical methodology. I also estimated and interpreted parts of the results, and wrote part of the manuscript.		
Overall percentage (%)	70%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the co-author of this paper.		
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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Abstract

This paper investigates the effects of oil extraction on local labour market and migration into areas close to oil deposits in Ghana. Most empirical studies on this topic have focused on developed economies using aggregated state or country level data. Using household level data from the Ghana Living Standard Survey, we employ a difference-in-differences technique to show that oil extraction has positive spillover effects on both income in non-oil sectors and migration into areas close to oil deposits, but a negative impact on employment. The magnitude of the effects decreases for income and migration and increases for employment, in districts further away from the oil extraction area. The positive effect on income is largely observed for men and workers in both the agricultural and retail sectors. The migration effect, on the other hand, is mostly for women and workers in the retail and other services sectors.

Key words: Oil extraction; Spillover effects; Employment; Resource booms; Migration; DID estimation.

JEL classification: O13, O15, Q32, Q33, R11, R23.

3.1 Introduction

A natural resource boom can have both direct and indirect effects on labour markets in resource and non-resource sectors. The indirect effects are usually termed spillovers (see Marchand & Weber 2017). Much of the existing literature on natural resources have focused on quantifying the direct effect resources have on economic growth and development at the macro-economic level using aggregate data (Sachs & Warner 1995, Gylfason 2001). These studies find a positive effect for developed economies and a negative effect for developing economies. The conclusion is that resource endowments alone are not enough to guarantee economic development. Combining them with stable government, strong institutions and better infrastructure is vital for economic growth and development. The absence of the aforementioned factors could explain the so-called 'natural resource curse' phenomenon, i.e., countries that have not developed, despite abundant natural resources; see Sachs & Warner (1995), Michaels (2011), and Smith (2015).

A key limitation of the above studies is that the reliance on aggregate data masks the source of changes in labour market activity resulting from a resource boom. For example, an increase in employment documented using aggregate data can arise from both within, and outside of, the resource sector. Spillover effects – which are the effects one industry has on another industry, or on other segments of the economy – are naturally ignored (Marchand & Weber 2017).

Natural resource spillovers using disaggregated data and analysis have been increasingly popular as they provide more complete picture of the consequence of resource endowments on the economy. The evidence of resource spillover effects, however, varies in empirical studies. Black et al. (2005) examine the impact of coal boom and bust in the US in the 1970s and 80s using county-level data and find a positive spillover effect of coal on income and migration, but a negative effect on employment. Brown (2014) analyses the effect of shale gas production in the US on employment and income using county-level data and finds a moderate positive spillover on employment in the manufacturing sector, and income in all sectors. Fleming & Measham (2014) study the local job multipliers of mining in Australia using aggregate local government data and find no significant spillover on employment in agriculture and manufacturing sectors.

Much of the extant evidence focus on developed economies and are largely US-centric. Moreover, the aforementioned studies use aggregated state or regional level data which makes it difficult to capture spillovers since they are largely experienced among individuals in a district or region. In this paper, we take advantage of a recent oil extraction in Ghana and the availability of detailed information on individuals and their household characteristics, to examine oil spillover effects on labour market circumstances in non-oil sectors. Specifically, we examine the following outcomes: (1) income and employment in non-oil sectors, and (2) migration into districts in the immediate proximity of oil extraction sites.

Ghana discovered one of the largest oil reserves in West Africa off the coast of Western region in 2007 and started extraction in 2010. Using this extraction as a potential exogenous shock to the oil sector, we employ difference-in-differences estimation by assigning treatment status to individuals residing in the coastal districts in the Western region of Ghana. These districts are in the immediate vicinity of the area of oil extraction. We adopt a Synthetic Control Approach to select individuals residing in other regions in Ghana as control group.

Our results indicate that there are significant spillover effects of oil extraction on non-oil sectors. Specifically, we find positive spillover effects on income and migration, but a negative effect on employment. The magnitude of the effects, however, varies with proximity to the oil extraction area when treatment is extended to districts further from the coast in the region. We further consider heterogeneity in the size of the effects by both gender and sectors. In particular, the effect on income is larger for males and for workers in the agricultural sector. The migration effect, on the other hand, is observed for females, and among individuals working in the retail and other services sectors. Although the overall employment spillover is negative, the oil extraction effect on the manufacturing sector, where women make up the majority of the labour force, is positive.

Our results also indicate that prior to oil extraction, income, employment and migration were not significantly different between the treated and control districts. The identification strategy of the difference-in-differences relies on the assumption that any difference in our outcomes are attributable only to the new oil extraction. We show that the spillover effects of oil extraction on our outcome variables are identified only for individuals at immediate coastal districts of the Western region, as we use as control group, other regions in Ghana. However, a potential source of bias arises from not having controlled for unobserved individual heterogeneity. To address this, we use the approach proposed by Oster (2017) to show that the included covariates in our regressions are informative enough in explaining the spillover effects of oil extraction. Hence any potential bias due to omitted and confounding factors is minimal.

The study contributes to the literature in two ways. First, we suggest an empirical identification strategy for measuring the impact of natural resources extraction at a disaggregated level. Earlier studies that employ difference-in-differences strategy select as control groups, individuals or districts further away from the natural resource sites (Black et al. 2005, Kotsadam & Tolonen 2016). The challenge is that the chosen control group may not be the most similar to the treated group which has the potential of influencing the estimates. This study uses a Synthetic Control Approach in selecting comparable individuals into a control group before adopting a difference-in-differences strategy. This approach reduces the mean squared errors in having a comparable group to the treated sample.

Second, earlier research on the topic in developing countries use aggregated regional or district level data (see e.g. Caselli & Michaels 2013, Aragón & Rud 2013, Loayza & Rigolini 2016). By contrast, our study uses individual household level data, thus allowing for more heterogeneous variations in the sample. A recent study on Sub - Saharan Africa is from Mamo et al. (2019) who, using nightlight density at district and regional level, examine the spillover effects of mine discovery, and find no evidence. A closely related study is Kotsadam & Tolonen (2016) who combine household level data with information on mines at the district level, and find the opening and closing of mines impact women employment in Sub - Saharan

Africa. The study finds little to no effect of mines on women employment in the manufacturing sector. This finding is contrary to our study and shows that different natural resources can bring about different impact on individuals in an economy (Marchand & Weber 2017).

The rest of the paper is organised as follows. Section 3.2 provides a background to the Ghanaian economy and gains from the oil extraction and the data used in the study. Section 3.3 discusses the identification strategy adopted. Sections 3.4 and 3.5 present the results and their robustness. Sections 3.6 and 3.7 detail the causal mechanism and discuss the results. Section 3.8 concludes.

3.2 Background and Data

3.2.1 Oil Production in Ghana

The Government of Ghana in 2004 sold licences to foreign oil extracting companies to explore and produce oil offshore of Ghana. These companies discovered oil reserves at Cape Three Points, off the coast of Western Region in 2007. The area was named Jubilee Fields and was estimated to have between 600 million and 1.8 billion barrels of oil, making it one of the largest oil reserve discovered in West Africa (Ayelazuno 2014). Extraction and production started in 2010 and it was found that the oil from the Jubilee Fields commanded competitive prices in the world market given its unusually light and sweet characteristics (Ayelazuno 2014).[1] As shown in Figure 3.1, production of crude oil increased significantly from an average of 10,000 barrels per day prior to 2010 to an average of 78,000 barrels per day from 2011 to 2013.

The discovery of oil contributed significantly to oil rents, and GDP growth in Ghana (Figure B.1 in the appendix). GDP growth increased considerably after 2010, to an average of 9.6 percent between 2010-2013 from an average of 6.5 percent in 2006-2009. This led the World Bank to reclassify Ghana as a lower middle income

[1] An American Petroleum Institute, API Gravity is a measure of petroleum heaviness. Oil with an API of more than 10 is considered lighter than water. Another measure of petroleum quality is its sulphur content. Oil with sulphur content of less than 0.5 weight percent (wt%) is considered sweet (Demirbas et al. 2015). Ghana's oil has an API Gravity of 37.6 degrees and sulphur content of 0.25 wt%

Figure 3.1: Crude oil production in Ghana: 2006-2013

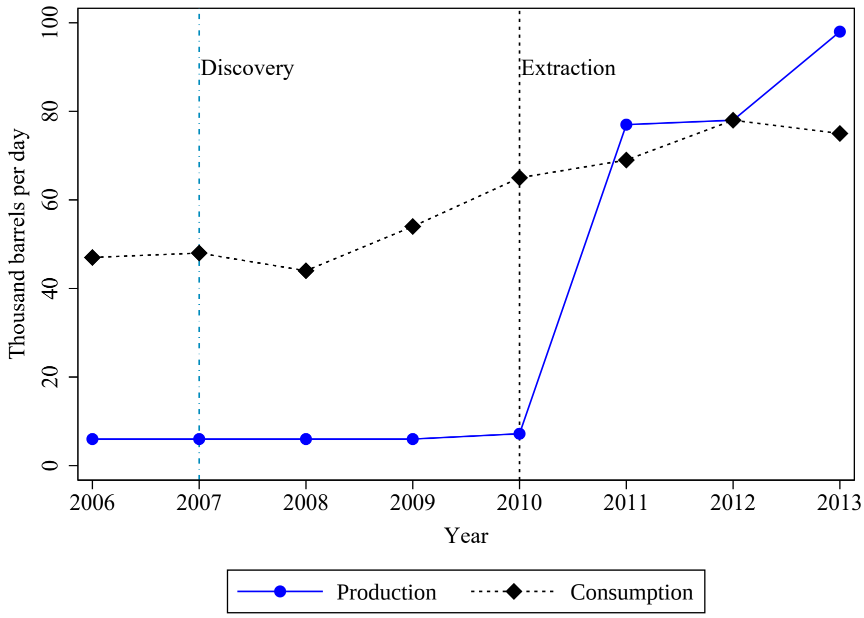
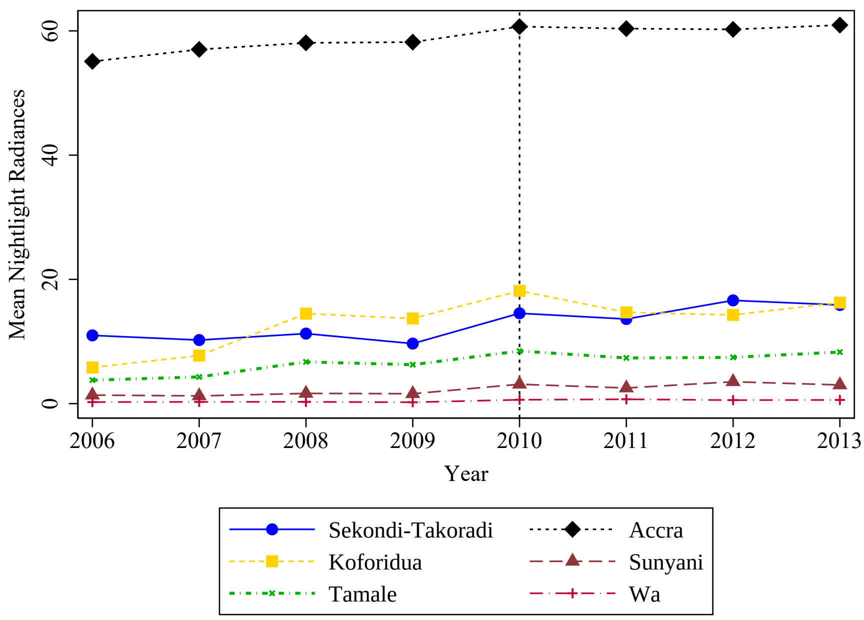


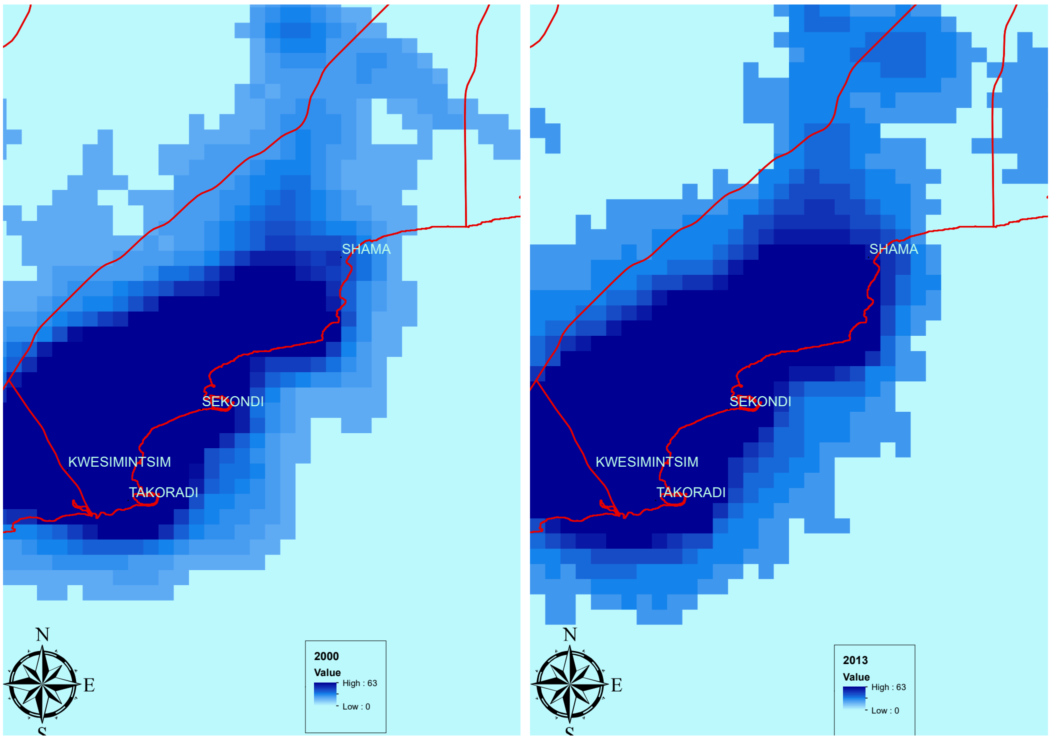
Figure 3.2: Nightlight luminosity



economy in 2011 (World Bank 2011). Oil production also boosted the level of economic activity.

Figure 3.2 depicts nightlight luminosity – the amount of man-made light observed from space at night that is often used as a proxy of economic activity. We observe that from 2010 to 2013, there is a rise in luminosity in the Western regions compared

Figure 3.3: Nightlight luminosity in Sekondi-Takoradi Metropolitan Area



(a) Nightlight luminosity in 2000 **(b)** Nightlight luminosity in 2013

Notes: Figures (a) and (b) plot the nightlight variations for Sekondi-Takoradi Metropolitan Area in the Western region for the years 2000 and 2013.

with other districts as depicted in the regional capitals.[2]

Figure 3.3 presents the intensity of nightlight in the Sekondi-Takoradi Metropolitan Area. Figure 3.3a shows that prior to the new oil extraction, the intensity was largely at Sekondi-Takoradi. The luminosity in the north and south of the area increased in 2013 indicating a high level of economic activity as shown in Figure 3.3b.

3.2.2 Data

We use data from the Ghana Living Standard Survey (GLSS) Rounds 4, 5 and 6 conducted in 1998, 2006 and 2013 respectively. This is a nationally representative survey and one of the largest repeated cross-section data collection in Ghana. The 1998 round surveyed 5,998 households and the 2006 and 2013 rounds surveyed 8,687 and 16,772 households respectively (Ghana Statistical Service 2016). The

[2]The capitals of the regions (in brackets) are as follows Sekondi-Takoradi (Western), Accra (Greater Accra), Koforidua (Eastern), Sunyani (Brong Ahafo), Tamale (Northern) and Wa (Upper West).

survey collects detailed information on demographic (gender, age, ethnicity) and socio-economic (education, income, employment) variables of the households and its members. We use individuals in the households as the unit of observation. Our key outcome variables of interest are monthly income, employment and migration status. We use monthly income that is derived from the primary job of workers. We do not include income from secondary jobs given the number of missing observations in the data. We follow the convention in the literature and use the logarithm of monthly income. The employment variable is a binary indicator for individuals who have done work for pay during the last 7 days. The migration variable is an indicator of whether individuals were living elsewhere previously and have migrated into their current locality.[3] The remaining control variables are gender, age, marital status, ethnicity, own education (in years), parents' education (in years) and household head status.

The lowest administration level in Ghana is the district. These districts make up a region. The GLSS is carried out at the district level in all 10 regions of Ghana as shown in Figure 3.4. The regions differ in their economic environment and ethnic composition. Northern Ghana which comprises of Upper East, Upper West and Northern regions; is considered the most deprived part of Ghana, with huge differences in the level and standard of living compared to the south (World Bank 2011, Ghana Statistical Service 2016). Southern Ghana is seen as the most vibrant and developed even before the discovery and extraction of oil. The oil extraction is about 60 kilometres off the coast of the Western region and 225.3 kilometres from the nation's capital, Accra. Figures 3.4 & 3.5 show the regions in Ghana and the oil extraction area respectively. Our empirical strategy involves examining the effect of oil extraction with districts in closer proximity to areas with oil, compared with districts further away. This is implemented in a difference-in-differences framework which we will elaborate further in Section 3.3.

To this end, we use districts in the immediate coast of Western region as treated

[3]The income variable is a response to the question 'What is the amount received for the work done?', Employment is to the question 'Did (NAME) do any work for pay during the last 7 days?' and Migration is to the question 'Where was (NAME) living previously?' The frequency (daily, weekly, monthly, yearly) at which the income is paid is also reported.

group.[4] The challenge, however, is in choosing comparable control group for the treated sample. To do this, we compare economic indicators (average of sources of household income, proportion of migrants, household size and proportion of educated adults.) from the GLSS survey reports of all regions in Ghana which are shown in Table B.1 in the Appendix. The indicators show that Eastern, Greater Accra, Ashanti and Volta regions are similar to the Western region. To do away with arbitrariness in choosing comparable controls, we use the Synthetic Control Approach (SCA), following Abadie et al. (2010), to select the most appropriate control group. The technique uses a data-driven approach to reduce the mean squared errors in selecting a comparable control group, by estimating weights for each region using the indicators in Table B.1. The region with the highest estimated weight is the most comparable to the Western region. The SCA requires panel data, which is not feasible using a cross-sectional survey like the Ghanaian Living Standard Survey. We, therefore, use the GLSS survey to estimate the weights for the regions, and apply these weights to individuals in the survey.[5]

Table 3.1 presents the estimated weights, using SCA, for regions in Ghana that are comparable to the Western region. The table shows that the Eastern region is the most comparable given the large estimated weight. This is followed by Ashanti, Brong Ahafo, Volta and Greater Accra regions.

Based on this result, we use individuals in Eastern region as control group. In addition, we include individuals in Greater Accra in the control group for the reason that the national capital, Accra, is located in the region. The other reason is that the Greater Accra region is home to the national capital and other developed areas in Ghana. As a robustness check, we use individuals in other regions as controls. To test for the absence of confounding factors, we conduct a balancing and parallel trend tests and report these in Section 3.3.2. A descriptive summary of the variables used for the treated and control sample is presented in Table B.2 in the Appendix.

[4]We use immediate coastal districts —Jomoro, Ellembelle, Nzema East, Ahanta West, Sekondi-Takoradi,Tarkwa Nsuaem, Shama, Wassa East and Mpohor— in the Western region as treated group and all districts in Eastern and Greater Accra regions as control group.

[5]See Abadie et al. (2010), Cheong et al. (2017) for estimation of the synthetic control approach. Stata user-written command *Synth* is used in estimating Synthetic Controls

Figure 3.4: Treated and control districts in Ghana

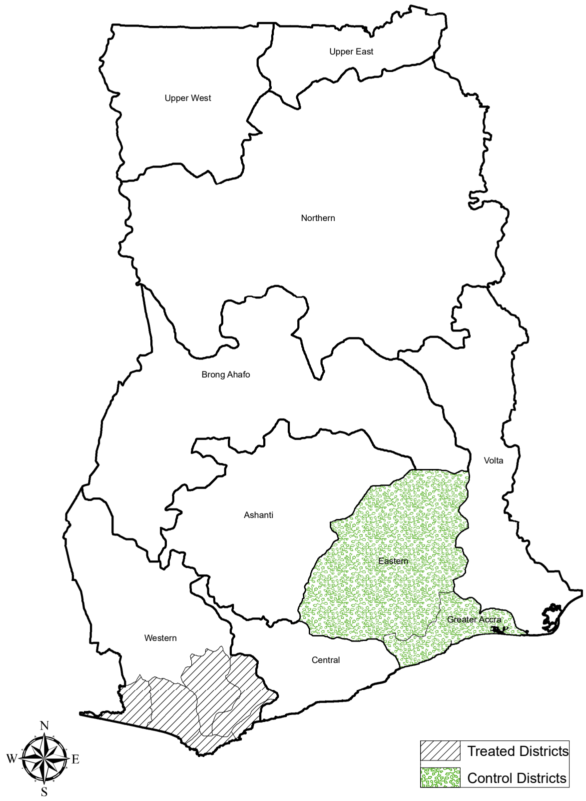


Figure 3.5: Location of oil extraction area

Source: Eni S.p.A (2015)

Table 3.1: Region with weights

Regions	Weights
Ashanti	0.246
Brong Ahafo	0.181
Central	0
Eastern	0.313
Greater Accra	0.083
Northern	0
Upper East	0
Upper West	0
Volta	0.177

Note Weights are computed using Synthetic Control Approach of Abadie et al. (2010). These weights are assigned based on the socio - economic indicators in the reports of the 1998, 2006 and 2013 GLSS survey.

3.3 Empirical Strategy

3.3.1 Specification

Our objective is to identify any spillover effects on income, employment and migration in the immediate coastal districts in the Western region. To do so in non-oil sectors, we employ a difference-in-differences regression with the following specification

$$Y_{ihr} = \beta_0 + \beta_1 PostOil_t + \beta_2 Dist_{ihr} + \beta_3 Dist_{ihr} \times PostOil_t + \gamma_c X_{ihr} + a_t + \epsilon_{ihr}, \quad (3.1)$$

where Y_{ihr} is the outcome variable — log of monthly income, dummy for employment or migration status — of individual i in household h in district r. $PostOil_t$ equals 1 for the period after oil extraction (2013) and 0 otherwise (1998 and 2006). $Dist_{ihr}$ equals 1 for the treated districts (immediate coastal districts) in the Western region and 0 otherwise (districts in Eastern and Greater Accra regions). $Dist_{ihr} \times PostOil_t$ is the key variable and β_3 the key coefficient of interest; it captures the difference-in-differences estimate or spillover effect of oil extraction in the treated districts. X_{ihr} is a set of covariates, Gender, age, years of education, as well as size household, of individual i that may explain the variation in the outcome with coefficient vector, γ_c. a_t is the time (survey year) fixed effects and ϵ_{ihr} is the usual error term.

The identification of the spillover estimates is conditional on controlling for district fixed effects. This unobserved factor captures any differences in the outcome variables that are a result of, for instance, local government administration projects across the survey period. The inclusion of individual and household characteristics capture any factors that may influence the outcome variables. Gender, age and years of education, as well as size of the household may determine an individual's decision to work and not move away from a particular district. Furthermore, the inclusion of survey year fixed effects also captures year-specific trends that could impact the outcome variables during the time period analysed. These year fixed effects would account for other government policies that were introduced to boost economic growth alongside the discovery of oil, thus also affecting the outcomes we study. Not accounting for these factors may wrongly attribute any changes to the new oil boom.

The timing of the 3 surveys is essential for our analysis, given that there are two periods before (1998, 2006) and one period after oil extraction (2013). Thus, we have three (3) years post oil extraction, giving room for the possibility of measuring any effect from the extraction. In our sample, we include all members in the household beyond 15 years in the model estimation.[6] Standard errors are clustered at the district level.

3.3.2 Threats to Identification

In equation (3.1), the spillover effect of oil extraction on the outcome variables, captured by β_3, represents the difference in log of monthly income, employment or migration between the treated and control districts, before and after oil extraction began. The identifying assumption is that changes in the outcome variables in both the treatment and control districts are same prior to or in the absence of oil extraction.

To maximise comparability in the treated and control sample, we first conduct a balancing test between treatment and control groups in the pre-extraction period. Table 3.2 shows the difference of the average of the outcome and covariates between the treated and control districts. The mean logarithm of monthly income of respondents in the control district is higher than those in the treated district, but

[6] Household members under or aged 15 are excluded as the International Labour Law postulates that working at age below 15 years of age is considered as child labour.

Table 3.2: Balancing test

Variables	Districts			Diff	P-value
	Total	Treated	Control		
Log of Monthly Income	4.082	3.853	4.091	0.238	0.169
	(0.035)	(0.155)	(0.035)	(0.173)	
Employment	0.385	0.418	0.383	0.034	0.540
	(0.015)	(0.056)	(0.016)	(0.057)	
Migration	0.616	0.696	0.610	0.086	0.123
	(0.015)	(0.052)	(0.016)	(0.057)	
Age	40.551	39.867	40.591	0.725	0.492
	(0.243)	(0.988)	(0.251)	(1.055)	
Age Squared/100	17.862	17.202	17.901	0.699	0.464
	(0.220)	(0.857)	(0.228)	(0.955)	
Married	0.692	0.741	0.689	0.051	0.212
	(0.009)	(0.038)	(0.009)	(0.041)	
Male Workers	0.718	0.756	0.716	0.039	0.324
	(0.009)	(0.037)	(0.009)	(0.039)	
Own Years of education	8.999	8.207	9.046	0.838	0.103
	(0.065)	(0.227)	(0.067)	(0.879)	
Father's Years of education	8.235	8.054	8.243	0.189	0.611
	(0.074)	(0.291)	(0.077)	(0.273)	
Mother's Years of education	7.035	6.642	7.052	0.409	0.123
	(0.053)	(0.166)	(0.055)	(0.265)	
Head of Household	0.934	0.948	0.933	0.015	0.484
	(0.005)	(0.019)	(0.005)	(0.022)	
Observations	2,820	561	2,259		

Note The treated group comprises of districts in the coastal regions in the Western region of Ghana which are in the immediate vicinity of the oil fields. The control group are districts in the Eastern and Greater Accra regions. The standard errors are in parentheses. P-value is for a test of the difference (Diff) between two means

the difference is not statistically significant. Similarly, on average, employment and migration are higher in the treated district but not statistically different from that in the control districts. Means of the covariates also show that respondents in the control districts are older and highly educated than those in the treated districts, though the differences between the two groups are not statistically significant.

To test the identifying assumption and rule out the possibility that the economic situation is changing for regions in the treatment group compared to the control group prior to the discovery of oil, we conduct a parallel trend test, following Muralidharan & Prakash (2017) and present the results in Table 3.3. We interact an indicator for 2006 with the treatment districts and include this as a regressor, along with the full set of covariates, on the outcomes we study. Our results show that income, employment and migration are not changing at different rates prior to 2010, hence supporting our parallel trends assumption.

Table 3.3: Parallel trend assumption test

	(1)			(2)		
	Income	Employment	Migration	Income	Employment	Migration
District × Post Oil_{2006}	-0.178	0.009	0.295	-0.219	-0.009	0.241
	(0.259)	(0.064)	(0.104)	(0.344)	(0.035)	(0.151)
District × Post Oil_{2006} X Male				-0.339	-0.023	0.070
				(0.308)	(0.015)	(0.075)
Adjusted R^2	0.411	0.522	0.157	0.325	0.514	0.154
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,759	2,759	2,759	2,644	2,644	2,644

Note: The year 2006 is considered as period after oil discovery and extraction.The regressions include full set of covariates; demographic and socio-economic controls. Bootstrapped Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

We also use individuals in different districts in other regions as treated and control groups to investigate any possible economic shock other than the oil extraction. Importantly, we use individuals in districts assigned weights by the Synthetic Control Approach and present the results in Section 3.5.2. This is of particular importance as the shocks that may have contributed to the rising economic growth in Ghana could have also explained the differences in outcomes between the treated and control districts, thus confounding the spillover effects of oil extraction.

The identification of the spillover effect on migration is based on the assumption that migrants are from districts, other than the control group. Although this assumption may not hold generally, the GLSS report on the sixth round show that out of the 11 percent of respondents in the Western region that were reported as migrants, only 0.8 percent migrated from the Greater Accra region (Ghana Statistical Service 2016). As such, migration from the largest control group is very low and should not significantly affect our identification strategy.

3.4 Results

In this section, we first present the full sample estimates of the spillover effects of oil extraction on income, employment and migration at immediate coastal districts

(Section 3.4.1). We then examine how these effects vary across gender, sectors and geographic proximity to the treated districts (Section 3.4.2).

3.4.1 Spillover Effects of Oil extraction

Table 3.4 presents the estimated spillover effects of oil extraction on outcomes of individuals in the immediate coastal districts. For each outcome variable, the columns report the difference-in-differences estimates when different set of covariates are used. Column (1) reports the model with no covariates, columns (2)-(4) present the estimates after accounting for demographic and socio-economic factors, while column (5) shows the estimates with the full set of covariates. We will refer to column (5) as controlled baseline effect.

Table 3.4: Spillover effect on income, employment and migration

	(1)	(2)	(3)	(4)	(5)
(I) Log of Monthly Income					
Districts × Post Oil	0.673***	0.762***	0.498***	0.567***	0.499***
	(0.141)	(0.135)	(0.126)	(0.117)	(0.115)
Adjusted R^2	0.393	0.406	0.482	0.492	0.518
Mean of monthly income	4.662	4.656	4.662	4.657	4.657
(II) Employment					
Districts × Post Oil	-0.014	-0.009	-0.030*	-0.025*	-0.028**
	(0.030)	(0.030)	(0.016)	(0.0140)	(0.014)
Adjusted R^2	0.106	0.112	0.162	0.169	0.170
Mean of employment	0.869	0.868	0.869	0.868	0.868
(III) Migration					
Districts × Post Oil	0.088***	0.104***	0.100***	0.115***	0.140*
	(0.029)	(0.029)	(0.028)	(0.029)	(0.085)
Adjusted R^2	0.040	0.059	0.053	0.071	0.117
Mean of migration	0.477	0.478	0.478	0.479	0.479
Demographic controls	No	Yes	No	Yes	Yes
Socioeconomic controls	No	No	Yes	Yes	Yes
Regional level controls	No	No	No	No	Yes
District level controls	Yes	Yes	Yes	Yes	Yes
Survey year controls	Yes	Yes	Yes	Yes	Yes
Observations	7,360	7,264	7,275	7,179	7,179

Note: The demographic controls include dummies for ethnic composition and marital status, whereas socio-economic controls include age and square of age, parental completed years of education, own completed years of education and dummy for household head status. Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

The results for the main specification (see column (5)) show that oil extraction has a positive effect on income and migration, and a negative effect on employment (likelihood of being employed) in non-oil sectors. On average, incomes of non-oil sector workers in the treated districts increased by 0.50 percentage points as a result of the oil extraction. This means that a standard deviation increase of being in the treated districts (33 percent) leads to a 18.14 percent rise in income.[7] Furthermore, the new oil extraction has increased the likelihood of migration by 14 percent but has marginally decreased the likelihood of employment by 2.8 percent. The higher income spillover is expected given the boom and the rise in various economic activities. The same observation holds for migration into these areas of intensified economic activities. However, the overall negative effect on employment could be interpreted as a result of higher production cost due partly to both micro and macro economic factors like unstable electricity supply and inflation in the economy.

While we observe some minor differences in the difference-in-differences estimates across the different specifications, the estimates are qualitatively similar. We also obtained better goodness of fit and efficiency gains, viz-a-viz smaller standard errors, in the models with covariates. As a robustness check, we examine the spillover effect of oil extraction across the distribution of income following Firpo et al. (2009) As presented in Table B.3 in the Appendix, we observe positive decreasing spillover effects along the distribution of income with spillovers beyond the 75$^{\text{th}}$ quantile not significantly different from zero.

The above results reflect the overall impact of oil extraction and may not reflect the heterogeneity across gender and sectors. To explore this, we re-estimated model (3.1) for males and females separately, for five disaggregated sectors: agriculture, construction, manufacturing, retail, and services, and geographic proximity to the coastal districts. Section 3.4.2 presents the details.

3.4.2 Gender, Sectoral and Proximity Variations

Table 3.5 shows the oil spillover effect on the outcome variables by gender. The results show that the effect on income is positive and statistically significant for males. For females, the estimated effect is positive but statistically insignificant. For

[7]We standardised the variable of interest, Districts×Post Oil (thus mean=0, variance=1) and observe the effect of a standard deviation change on the outcome variable. A 33% increase in the standard deviation leads to a 16.7% point increase in income which translates to $100[exp(0.1667) - 1]$=18.4%

the employment variable, the estimated effect for both males and females is negative but not statistically different from zero. In contrast, the positive effect of migration is statistically significant for females but not for males. As such, the overall positive oil spillover effect on migration found in Table 3.4 seems to be due to females.

Table 3.5: Spillover effect of oil extraction by gender

	Income		Employment		Migration	
	Male	Female	Male	Female	Male	Female
Districts × Post Oil	0.684***	0.222	-0.011	-0.029	0.095	0.254***
	(0.123)	(0.157)	(0.016)	(0.033)	(0.088)	(0.079)
Adjusted R^2	0.533	0.496	0.136	0.268	0.120	0.115
Mean of Y	4.678	4.622	0.888	0.835	0.492	0.459
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,424	2,755	4,424	2,755	4,424	2,755

Note: Regressions include full set of covariates. Standard errors clustered at the district level in parentheses. Regressions include full set of covariates. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

We further examine the spillover effect on migration at different age cohort for both males and females. The results are presented in Figure B.2 in the appendix. The graphs (dashed-blue for males and dotted-dark for females) show oil extraction slightly increases the likelihood of males, under 45 years, to migrate compared with the same female cohort. However, the effects reversed for cohorts beyond 45 years up to 75 years, where females are now more likely to migrate than males. Note however, that the effect are within the same confidence band (thus are not statistically different) except at the upper tail of the age distribution where only the spillover effect for females lies outside this confidence band of male cohort.

Table 3.6 shows the oil spillover effect across sectors. For workers in the agricultural and retail sectors, the new oil extraction led to a positive and significant increase in income but for construction, manufacturing and services sectors, the estimates are positive but not significantly different from zero. The increased income for agricultural workers is as expected since most coastal districts residents are farmers and predominately fishermen.

That we find no spillover effect on income of manufacturing workers is unexpected and raises the issue of the precision of the estimate. The difference-in-differences

Table 3.6: Spillover effect of oil extraction across sectors

	Agriculture	Construction	Manufacturing	Retail	Services
Log monthly income					
Districts × Post Oil	0.887***	0.357	0.257	0.421***	0.165
	(0.199)	(0.217)	(0.276)	(0.161)	(0.153)
Adjusted R^2	0.478	0.736	0.518	0.494	0.551
Mean of monthly income	3.862	5.428	4.654	4.902	4.943
Employment					
Districts × Post Oil	-0.122***	-0.058	0.126**	-0.033	-0.049***
	(0.031)	(0.269)	(0.056)	(0.038)	(0.016)
Adjusted R^2	0.263	0.268	0.180	0.495	0.035
Mean of employment	0.837	0.864	0.844	0.808	0.933
Migration					
Districts × Post Oil	-0.084	0.180	0.246**	0.426***	0.181*
	(0.120)	(0.215)	(0.096)	(0.053)	(0.097)
Adjusted R^2	0.048	0.149	0.126	0.144	0.137
Mean of migration	0.571	0.495	0.470	0.469	0.428
Controls	Yes	Yes	Yes	Yes	Yes
Observations	1,708	301	945	1,581	2,635

Note: Regressions include full set of covariates. Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

estimate of the spillover effect on income in manufacturing is quite large (0.257) but its estimated standard error is also large (0.276), thus rendering the estimate statistically insignificant. There is a large variability in manufacturing workers' income in the treated districts, which is reflected in the difference-in-differences estimate of the oil spillover effect.

Moreover, the probability of being employed is negative and significant in agriculture and other services sectors but positive and significant in manufacturing sectors. The higher likelihood of employment in the manufacturing sector after oil expansion support our previous analysis that the insignificant oil spillover effect on manufacturing workers' income may be due to large standard error estimate. Employment in manufacturing is boosted by the new oil expansion but the resulting income vary largely across workers, making the average oil spillover effect on income of manufacturing works statistically insignificant.[8]

Migrants are more likely to move into retail, manufacturing and other services sectors, compared to both the agricultural and construction sectors. This could be explained by the high education levels, skills and knowledge of most migrants moving

[8]The manufacturing sector includes small and medium scale businesses set up by self-employed individuals.

to take advantage of the opportunity in the treated districts.

Now, considering the geographic proximity to the treated districts, there is a possibility that the spillover effect might not only impact individuals at immediate coastal districts but extend further to individuals in other districts in the Western region. For this reason, we extend treatment to individuals in all districts in the region. Table B.4 in the Appendix presents the spillover effects of oil extraction on our outcome variables in the Western region. We observe lower spillover effect beyond the immediate coastal districts, irrespective of the gender or sector. The signs, however, are in accordance with that of the estimates in Tables 3.4 & 3.6, except for the income in districts farther away the coast where the sign seems to be reversing. Most importantly, a test of differences within the Western region is insignificant (see Table B.5) and solidifies our approach of using districts outside the Western region as control group.

We analyze the above results further by considering heterogeneous effects among our treated sample by re-estimating the model for different districts based on their distance to the oil extraction area in Table 3.7. As stated earlier, the oil extraction area is 60 km off the coast of Western region. For this reason, we re-estimate the effect using district at the coast and an increment of 20 km upward up to 200 km.

Table 3.7: Oil spillover effect with distance (km)

	Distance							
	60	80	100	120	140	160	180	200
Log of Monthly Income	0.960***	0.694***	0.652***	0.531***	0.346**	0.392	0.351	-0.428*
	(0.277)	(0.179)	(0.149)	(0.152)	(0.174)	(0.242)	(0.262)	(0.240)
Adjusted R^2	0.526	0.531	0.532	0.521	0.529	0.524	0.524	0.522
Mean of monthly income	4.652	4.653	4.671	4.675	4.657	4.658	4.656	4.655
Employment	-0.102***	-0.094***	-0.089***	-0.033***	-0.025**	-0.023*	-0.013	0.010
	(0.012)	(0.013)	(0.013)	(0.013)	(0.012)	(0.013)	(0.015)	(0.014)
Adjusted R^2	0.180	0.180	0.182	0.180	0.181	0.182	0.178	0.179
Mean of employment	0.874	0.873	0.875	0.874	0.874	0.874	0.872	0.871
Migration	0.410***	0.365***	0.289***	0.266***	0.212***	0.188***	0.112***	0.081***
	(0.022)	(0.020)	(0.023)	(0.025)	(0.026)	(0.026)	(0.024)	(0.022)
Adjusted R^2	0.102	0.105	0.127	0.103	0.111	0.105	0.100	0.108
Mean of migration	0.436	0.437	0.461	0.435	0.442	0.437	0.434	0.438
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5879	5844	6322	5805	5906	5839	5817	5841

Note: Distance is measured from oil extraction area. Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Figure 3.6: Heterogeneous effect by distance

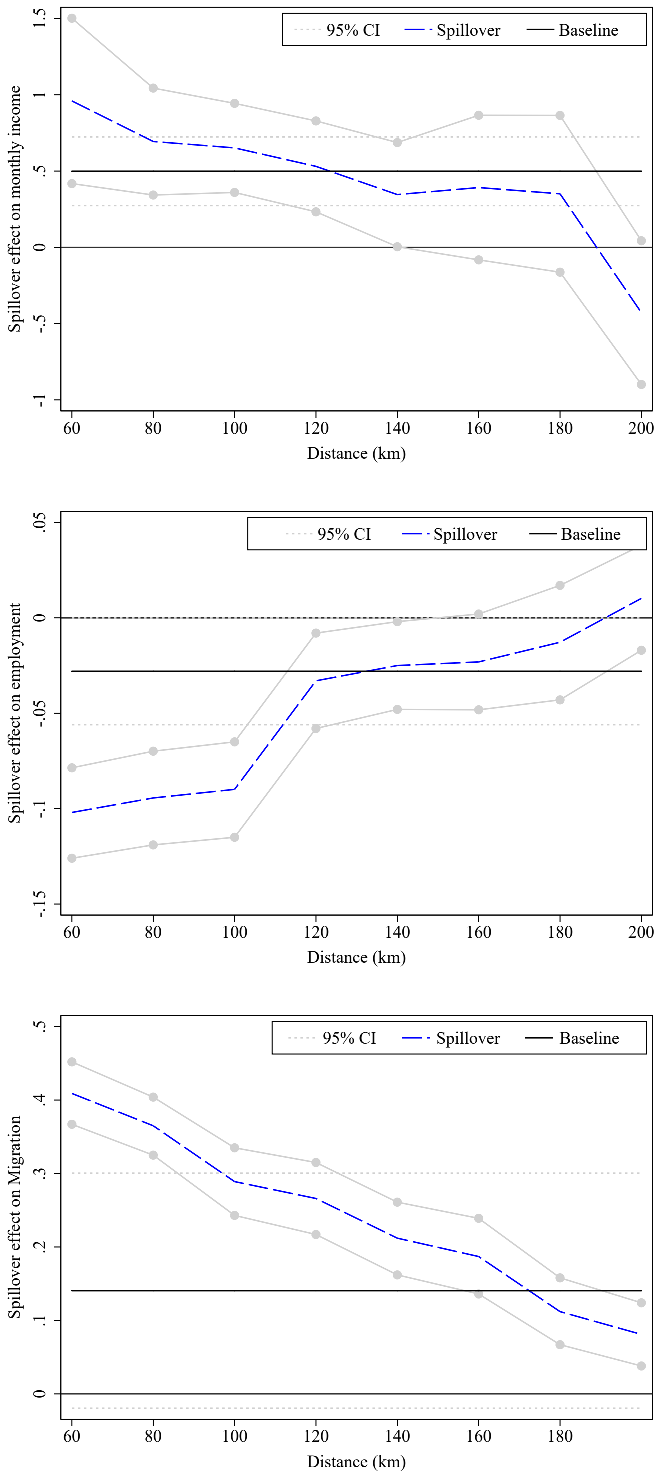


Figure 3.6 plots the spillover effects on the three outcomes. The mean estimates (blue dotted line) show a higher effect at districts that are 60 km from the extraction area. The effects tend towards zero as proximity increases and become insignificant for income and employment. Moreover, we find higher effects for income and migration than the baseline (black solid line), and lower negative effect for employment than the baseline estimate.

Given the national capital, Accra, is included in the control group (Greater Accra), and the regional capital of the Western region (Sekondi-Takoradi) is included in the treated districts, we examine the spillover effect on the outcome variables at the regional capitals of these regions. The reason being that Accra is home to various economic activities and more developed, which is observed in the trend in nightlight luminosity (See Figure 4.1). Examining the spillover effect at the major cities will inform about various developments in the capital. We hereby conduct a sub-sample analysis by assigning treatment to Sekondi-Takoradi which is the *oil city* and use Accra, the *capital city*, as control districts. Using model (3.1), these difference-in-differences estimates are presented in Table 3.8. The results show that the spillover effects on income and migration were high and significant in the regional capital of the treated district (Sekondi-Takoradi). Section 3.5 presents other robustness checks.

3.5 Robustness Checks

3.5.1 Accounting for Omitted Variable Bias

The identification of the estimated spillover effects on our outcome variables above, is based on the difference-in-differences strategy with the inclusion of a number of covariates. However, there is a possibility that the covariates included in the estimation may not be sufficient in capturing unobserved individual heterogeneity in the sample. If so, this will result in biased estimate of the oil spillover effect. Econometric techniques have been developed in recent years (see e.g. Oster 2017) to evaluate the importance of these confounding factors. To assess the robustness of

Table 3.8: Oil effect at regional capitals

	Income	Employment	Migration
Panel A			
Sekondi-Takoradi × Post Oil	1.222**	-0.032	0.291***
	(0.559)	(0.068)	(0.101)
Adjusted R^2	0.522	0.174	0.086
Mean of Y	4.888	0.874	0.301
Panel B			
Sekondi-Takoradi × Post Oil	0.831	0.001	0.283**
	(0.604)	(0.085)	(0.133)
Sekondi-Takoradi × Post Oil × Male	0.579*	-0.049	0.013
	(0.320)	(0.081)	(0.119)
Adjusted R^2	0.522	0.173	0.085
Controls	Yes	Yes	Yes
Observations	1,955	1,955	1,955

Note: Sekondi-Takoradi is the capital city of the Western region. Control group is Accra which is regional and national capital of Greater Accra and Ghana. Bootstrapped Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

our estimates to omitted variable bias, we follow the methodology of Oster (2017). This approach makes full adjustment to the estimates after the inclusion of controls by exploiting the movements and changes in the coefficients and the R-square of the model to compute bounding values for the spillover effect.[9]

The results are presented in Table 3.9. We observe that the degree of proportionality of observed to unobserved variables in the model is less than 1 (i.e. $\hat{\delta} < 1$) in all models, indicating a smaller importance of unobservables in influencing the outcome variables after including the covariates. For each outcome variable, the bias-corrected spillover effects, $\tilde{\beta}$, is fairly similar in magnitude to the controlled baseline effects, $\hat{\beta}$. This suggests that the included covariates have sufficient explanatory power to balance any potential bias due to unobserved confounding factors. As such, there is no evidence in support of omitted variable bias in our regressions.

[9]See Oster (2017) on computation of the bias-corrected estimates. Stata user-written command *PSACALC* is used in estimating biased corrected estimates.

Table 3.9: Omitted variable bias correction

Outcomes	Baseline effect, $\dot{\beta}_3$ (S.E), $[\dot{R}]$	Controlled effect, $\hat{\beta}_3$ (S.E), $[\hat{R}]$	Delta, δ	Corrected effect, $\tilde{\beta}_3$
Log Monthly income	0.673 (0.141)[0.393]	0.499 (0.115)[0.518]	0.1748	0.437
Employment	-0.014 (0.030)[0.106]	-0.028 (0.014)[0.170]	-0.0276	-0.020
Migration	0.088 (0.029)[0.040]	0.140 (0.029)[0.117]	0.0315	0.125

Note: Results on baseline effect are from OLS regressions with no controls whereas results from controlled effects are OLS regression with controls. Delta,δ is computed by following Oster (2017) and it indicates how important observables are to unobservables. If $\delta = 1$ it shows unobservables are equally as important as observables whereas if $\delta > 1$ it indicates unobservables are more important than observables. Corrected effect is accounting for the Omitted Variable Bias in the model. R^2 values are from OLS regressions of these two models and standard errors are clustered at the district level.

3.5.2 Alternative definition of Treated and Control districts

As stated earlier, the choice of control group is based on the similarity in characteristics between the districts in Eastern & Greater Accra and the Western region as chosen by the Synthetic Control Approach. However, the Western region may also be similar to other regions in southern Ghana based on characteristics– such as co-ethnics, linguistic similarity, or other forms of economic activities. It is therefore useful to examine the robustness of our spillover estimates to different control groups.

We use districts in Ashanti region as control group for the reason that residents share similar language and majority in the region belong to the same ethnic group; Akan (see Table B.6 in the Appendix).[10] We also use districts in Volta region as control group given they are on the coast and have similar economic activity; fishing, comparable to residents in the coast of Western region. The expectation is that significant oil spillover effects will still be identified even when different control groups were assigned. The results are reported in Panel A of Table 3.10. Overall, the estimates are similar in sign and smaller in magnitude to the baseline estimates (Table 3.4) indicating robustness of the findings.

To further examine the presence of economic shocks other than the new oil extraction, we assign placebo (false) treatment to districts in Ashanti and Volta regions keeping districts in Eastern and Greater Accra regions as the control group.

[10]See Easterly & Levine (1997) for the role of ethnicity in ensuring development.

The estimates on the placebo test are shown in Panel B of Table 3.10. All estimates are not significantly different from zero, thus validating the use of immediate coastal districts as treated group and evidence of the presence of shocks other than the oil extraction that would have biased the estimates.

It is worth mentioning that there is a rise in the outcomes of the placebo districts in Ashanti region. This shows that income, employment and migration were increasing during the period covered by this study, although these increases are not statistically significant. We also use districts in Ashanti and Volta as "placebo" groups in addition to the immediate districts in the Western region and examine a possible oil spillover effects on the outcome variables. Panel B of Table 3.11 shows the results. A significant spillover effects is observed on income and employment for the immediate coastal districts in the Western region but no such evidence in the placebo treated districts.

We further examine the spillover effects by including as control group all individuals in the regions assigned weights by the Synthetic Control Approach. We examine the weighted spillovers and present this in Table 3.12. The estimates from this approach is similar in sign as the baseline results indicating robustness of our estimates, hence indicating the spillovers are well identified.

Table 3.10: Using alternative treated and control groups

Panel A	Control: Ashanti			Control: Volta			Control: Brong Ahafo		
	Income	Employment	Migration	Income	Employment	Migration	Income	Employment	Migration
Districts × Post Oil	0.187	-0.043*	0.044	0.163	-0.062**	0.184**	0.431*	-0.148***	0.107
	(0.169)	(0.022)	(0.105)	(0.175)	(0.029)	(0.077)	(0.217)	(0.043)	(0.151)
Adjusted R^2	0.498	0.177	0.029	0.487	0.193	0.034	0.541	0.558	0.136
Mean of Y	4.462	0.841	0.583	4.197	0.809	0.625	4.384	0.827	0.589
Observations	4,835	4,835	4,835	3,623	3,623	3,623	2926	2926	2926

Panel B	Treatment: Ashanti			Treatment: Volta			Treatment: Brong Ahafo		
	Income	Employment	Migration	Income	Employment	Migration	Income	Employment	Migration
Ashanti × Post Oil	0.346	0.007	0.075						
	(0.215)	(0.037)	(0.050)						
Volta × Post Oil				0.456	0.069	-0.046			
				(0.275)	(0.061)	(0.068)			
BA × Post Oil							0.243	0.098	0.012
							(0.196)	(0.035)	(0.102)
Adjusted R^2	0.492	0.188	0.038	0.495	0.203	0.057	0.588	0.520	0.181
Mean of Y	4.561	0.862	0.472	4.454	0.851	0.474	4.562	0.863	0.454
Controls	Yes	Yes	Yes	Yes	Yes	Yes			
Observations	9,104	9,104	9,104	7,862	7,862	7,862	7,193	7,193	7,193

Note: In panel A, districts in the Ashanti and Volta regions are used as control samples whereas in Panel B, Ashanti and Volta districts are assigned placebo treatment with districts in Eastern and Greater Accra regions used as control groups. Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 3.11: Using alternative treated and control groups

Panel A			
		Using placebo treatment	
	Income	Employment	Migration
Eastern Accra × Post Oil	-0.243	-0.015	-0.077
	(0.163)	(0.034)	(0.048)
Adjusted R^2	0.508	0.201	0.072
Mean of Y	4.435	0.848	0.495
Observations	11,257	11,257	11,257

Panel B			
		Inclusion of placebo treatment	
	Income	Employment	Migration
Districts × Post Oil	0.395***	-0.042*	0.122
	(0.116)	(0.023)	(0.103)
Ashanti × Post Oil	0.194	-0.005	0.083
	(0.177)	(0.031)	(0.054)
Volta × Post Oil	0.164	0.041	-0.024
	(0.172)	(0.032)	(0.069)
Adjusted R^2	0.500	0.193	0.076
Mean of Y	4.446	0.847	0.525
Controls	Yes	Yes	Yes
Observations	13,633	13,633	13,633

Note: In panel A, treated group is made up of residents in all districts in Eastern and Greater Accra, and Control group is made up of residents in Ashanti and Volta. In Panel B, Control group is districts in Eastern and Greater Accra regions. Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 3.12: Using weights from Synthetic Control Approach

	Baseline			Unweighted			Weighted		
	Income	Employment	Migration	Income	Employment	Migration	Income	Employment	Migration
Districts × Post Oil	0.499***	-0.028**	0.14*	0.421***	-0.074*	0.061	0.372***	-0.085**	0.040
	(0.115)	(0.014)	(0.085)	(0.126)	(0.042)	(0.119)	(0.118)	(0.039)	(0.112)
Observations	7,179	7179	7179	14,183	14,183	14,183	14,183	14,183	14,183
Adjusted R^2	0.518	0.170	0.117	0.580	0.537	0.133	0.576	0.510	0.104
Mean of Y	4.657	0.868	0.479	4.424	0.844	0.515	4.424	0.844	0.515
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Survey Year controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Control group is made up of individuals in the five (5) regions -Ashanti, Brong Ahafo, Eastern, Greater Accra and Volta- selected by the Synthetic Control Approach, SCA. Weights used are as reported by the SCA in Table 4.1. Significant estimates are within the 95% confidence interval of the baseline model for income (0.319, 0.679), employment (-0.056, -0.000) and migration (-0.020, 0.300). Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

3.6 Mechanism Explaining Oil Spillover Effects

The possible mechanism through which the oil spillover effects are observed can be disentangled easily. Indeed, the possibility of increased households income and migration come from the increased economic activity that is observed as a result of the oil extraction off the Western region coast. Theory predicts that a natural resource boom will lead to direct and indirect effects in the resource industry as well as other industries in an economy. Our key findings that the extraction of oil in Ghana since 2010, has impacted positively on income and migration but negatively on employment of workers in the immediate area of the extraction, could have some foundations in that theory. To elucidate this, we use nightlight density in districts before and after the new oil extraction as proxy for economic activity to explore the channel through which these effects are transmitted. Table 3.13 presents the difference-in-differences estimates using data from the National Oceanic and Atmosphere Administration website, where the dependent is the log of mean nightlight density. Using the same treated and control group as in the baseline model, we find an increase in the level of nightlight density for the treated group (Table 3.13, column (1)). We extend the treatment to all districts in the Western region but use the same control group and find an increase but insignificant effects (Table 3.13, column (2)). We also use all other districts in the 5 regions with estimated weights as control and the treated sample in the baseline and find a statistically significant increase in nightlight density for the treated districts (Table 3.13, column (3)).

Clearly, these results indicate an increased economic activity, which in turn led to increased spillovers on income and migration. Although employment as a whole was negatively affected, there was an increase in the number of workers in the retail sector as expected given the informal nature of retail businesses in Ghana. Majority of workers in this sector were reported to be migrants.

Table 3.13: Nightlight variation in treated districts post oil extraction

	log(nightlight+1)		
	(1)	(2)	(3)
Districts× Post Oil	0.096**	0.007	0.149***
	(0.042)	(0.029)	(0.036)
Mean of log(nightlight+1)	1.290	1.098	0.794
Observations	224	288	720
Districts	28	36	90
Regions	3	3	6
Year	8	8	8
District FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: Column (1) includes treated and control districts same as baseline model, Column (2) extends to all districts in the Western region but same control group. Column (3) includes all treated districts in Column (1) and all other districts in the 5 regions assigned weight by SCA. Clustered standard errors at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

3.7 Discussion of Results

The key findings in this paper are in line with earlier studies in the natural resource literature. Michaels (2011) finds an increase in income in all sectors and employment in the manufacturing sector for the southern part of the United States which is known to be predominately an agrarian economy but endowed with oil. His study attributes the increase in employment to an increase in unskilled labour (as some sectors tend to cut down on cost by replacing highly skilled workers with unskilled ones). Black et al. (2005) estimates the spillover effect of coal mining in the United States and finds an increase in income for all sectors but no growth in employment in other sectors. They have attributed the stagnant growth in employment to the high income growth in those sectors (which makes it difficult for other job seekers to penetrate the workforce). These findings indicate that natural resources do affect local labour market outcomes. For developing economies, Mamo et al. (2019) find a positive effect of mines discovery on the level of economic activity for Sub-Saharan African economies but the absence of significant spillover effect. Kotsadam & Tolonen (2016) examine the effect of mines discovery on women employment in Africa and find women to move from agriculture sector to either the service sector or out of employment. The understanding of the key findings in our study is that examining a natural resource spillover effect requires not only a micro level (household level in our data), but also an appropriate econometric identification strategy suitable to address the question at hand more accurately. In our case, a combination of the use of individual level data, a difference-in-differences technique based on a control group chosen by the Synthetic Control Approach and the distance from oil extraction site has enabled us to disentangle the heterogeneous impact of oil spillover effects on labour market outcomes in Ghana.

The heterogeneity in the spillover effect in our study is influenced by various activities in the economy, some stemming from the operations of the oil extracting companies and others from the macro economy. The rise in income gains for agricultural workers with a reduction in employment indicate that these gains are distributed to existing workers of this sector. However, the extraction of oil comes with a negative externality; pollution. There are numerous concerns in the Ghanaian media about contamination of water bodies from the activities of natural resource extraction which makes it difficult for farmers.[11] This externality resulted in raising the cost of production for farmers, especially fish farmers in the region and has a higher chance of even reducing the number of workers in the sector given the increasing cost of inputs needed for farming activities. The role of extracting industries causing pollution is well documented; see e.g. Aragón & Rud (2015) who use the same data and find that gold mining in some communities in Ghana reduced agricultural total factor productivity by 40%.

The fall in employment in the agriculture sector but rise in the manufacturing sector may indicate as a move towards an innovative population in the economy. The Ghanaian economy has been known to be largely agrarian in the past. With a gradual shift towards self employment, there is a higher chance the economy will move towards a more developed face with the extraction of oil. Another important observation is the increasing number of females in the manufacturing sector. This development seems to make for an inclusive development and growth for all. It is however, important to add that with an insignificant effect on income of workers in

[11] See Deutsche Welle (2017).

the manufacturing sector (if this were not due to high variability of income in the sector), increasing numbers of workers into small scaled self-employment could have a negative long term effect, with either workers being paid less than they deserve or willing to accept a wage below what they are qualified for. The insignificant effect in the manufacturing sector but significant effect in the retail could also indicate consumers demand for imported goods with an increase in income, which would tend to affect local production of goods by these manufacturing firms.[12]

However, the fall in employment in general may not be attributed to the Dutch disease syndrome which is mostly associated with oil producing countries. Surprisingly, the Ghanaian economy departs from the old known theory as data from the central bank (Bank of Ghana) indicate a depreciating currency even with an inflow of oil rent. This departure could be mainly as a result of increased demand for imported goods. The inability of various sectors like the retail and other services to employ a larger number stems from the increasing production cost from electricity and other inputs needed. Until such challenges are addressed, the increasing number of migrants into the Western region will add up to the rising unemployed population in the country.

The positive and significant spillover effect of migration for women shows how most women were empowered to venture into businesses. Table B.13 in the Appendix shows majority of the women migrated from within the Western region and the Upper East region. As mentioned earlier, the manufacturing sector includes small and medium scale enterprises which are largely dominated by women. The new oil boom made it possible for these women to undertake various economic activities.

Given that oil extraction is off-shore, we believe the magnitude of the spillover effect will have been larger, especially for the construction sector if extraction was on-shore. More importantly, with new discoveries of oil and gas fields in 2017 and the implementation of the local content bill in 2014 which requires all foreign firms to have a percentage of local workers, the government's goal of ensuring the gains are beneficial to all citizens should be realised. The expectation has seen people

[12]See WITS (2018) for more details.

enrolled in training and skill development not only in oil but also in other sectors of the economy (Obeng-Odoom 2013). Also, the local leadership of towns and cities in the Western region plan to embark on a number of policies outlined in 2015 aimed at improving the lives of residents in the region. This will play a major role in ensuring a greater development for all residents in different sectors of the economy. However, the existing extraction and new discoveries off the coast in the Western region set to deepened the disparities between the south and north of Ghana. We believe these oil shocks in the south could result in most residents in the north migrating southward.

To relate the study to existing theories, the findings in this study are in line with the spillover theory which postulates that an expansion of a sector has a ripple effect on other sectors of the economy. This theoretical foundation dates back to Corden & Neary (1982) and Moretti (2010) who argue that the extraction of natural resource will increase the demand for workers in upstream and downstream industries associated with the natural resource industry and the income and or employment of non-natural resource industries. Although our empirical evidence suggests an overall fall in employment in non-resource sectors, there is an increase in employment in the manufacturing sector (thus corroborating the theoretical prediction).

The study is also in line with the economic geography literature, that explains how focused the spillover effects of the natural resources may be (see Vaughn 1994, Fujita et al. 2001). A natural resource boom in a specific locality is sudden, significant and has a possibility of affecting local market outcomes. The theory further explains that the effects decrease with proximity from the natural resource location. We find empirical evidence of this with higher spillover effect at immediate districts and a decreasing effect further away from the extraction point. This, to an extent, explains the reason why studies on aggregated economy might not always show the heterogeneous spillover effects of natural resource in developing economies.

The study, however, is limited. With the available data, the spillover effects are not as expected, for example the effects in the construction sector. The availability of annual panel data from time of oil discovery to post extraction would have made it possible to examine how individuals reacted to such information and how it affected various economic activities as can be seen in the movement of the night light radiance over the years.

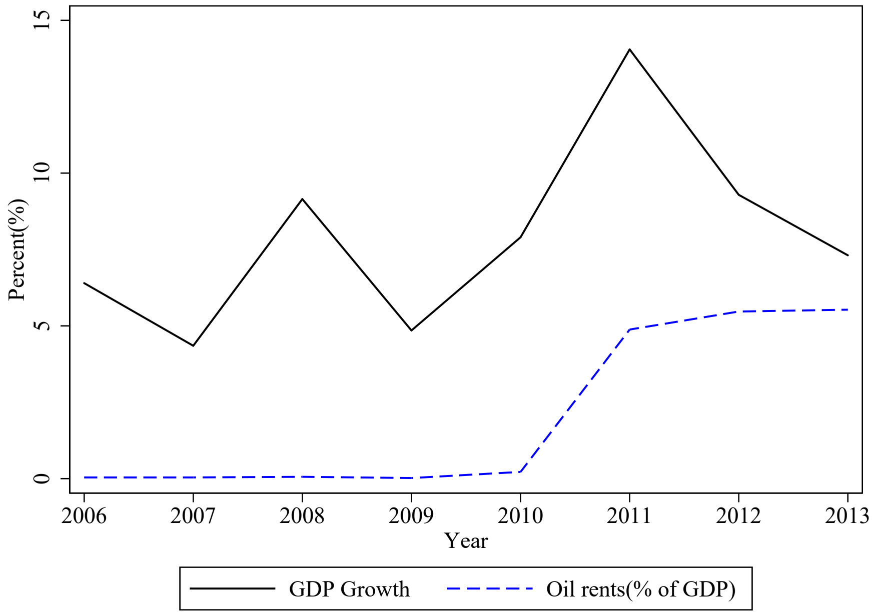
3.8 Conclusions

The study investigates the spillover effect of oil extraction on income and employment of non-oil sector workers, and migration into areas close to oil deposits in Ghana. The results show a positive spillover effect on income and migration but a negative effect on employment. In addition, heterogeneous spillover effects are observed across gender, sector of the residents, and proximity to the oil extraction area.

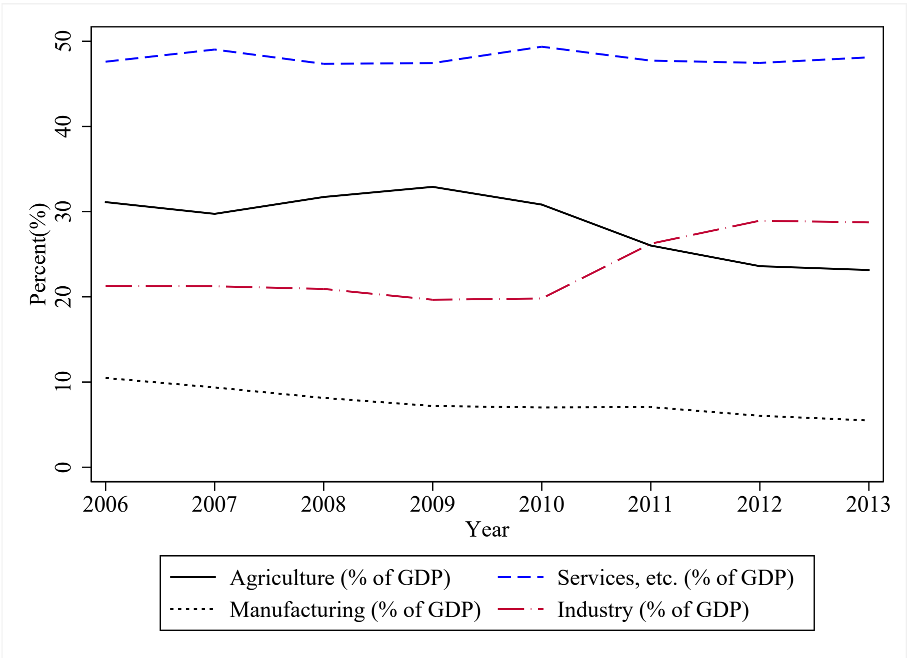
The findings suggests that examining a natural resource spillover effect requires not only a micro level analysis, but also an appropriate econometric identification strategy suitable to address the question accurately. We believe future work could complement the limitations of study once data become available.

Appendix B

Figure B.1: An Outlook of the Ghanaian economy

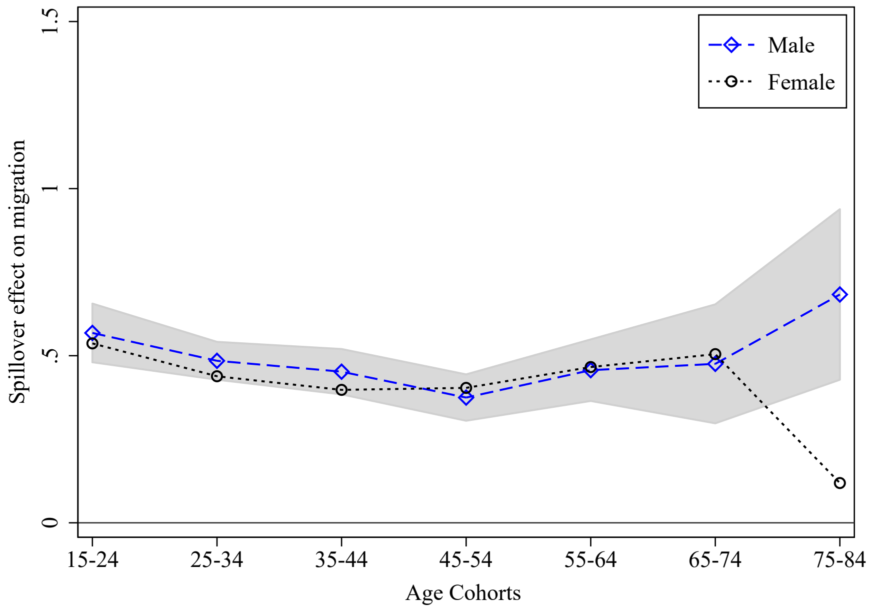


(a) GDP Growth and Oil rent Share



(b) Sector Share of GDP

Figure B.2: Spillover effects on migration at different Age Cohorts(Predictive Margins)



Notes: Age cohort of males in dashed-blue and dotted-black for females. Confidence band is for estimates for male age cohort.

Figure B.3: Oil Spillover effects on income and employment using Synthetic Control approach

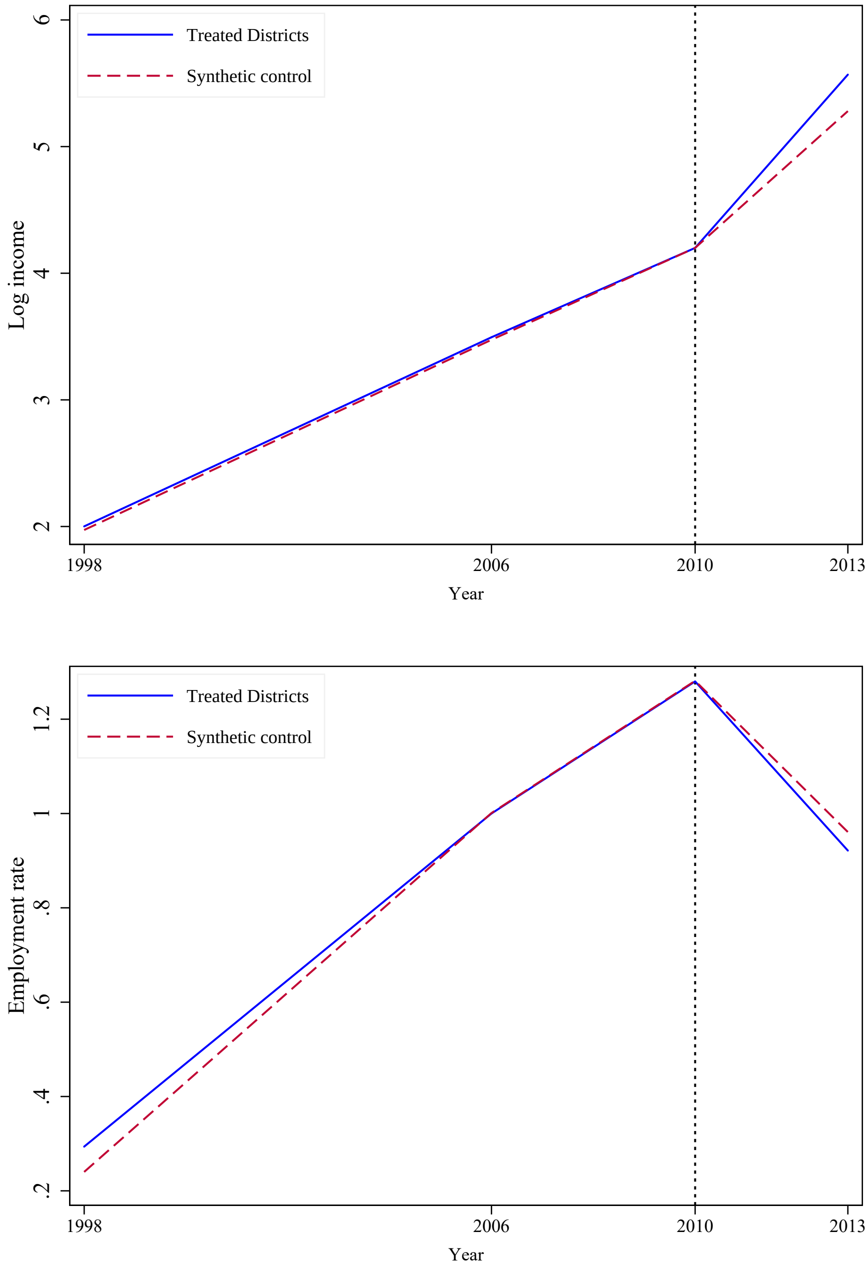


Table B.1: Key indicators of regions in Ghana

Indicators	**Western**	**Eastern**	**Greater Accra**	**Central**	**Volta**	**Ashanti**	**Brong Ahafo**	**Northern**	**Upper East**	**Upper West**
Pre-Oil extraction										
Mean household income (Ghc)	1,222	1,145	1,529	1,310	913	1,149	1,202	1,452	616	606
Sources of Household income (%)										
Wage	24.3	21.1	56.6	27.2	17.2	26.5	19.8	10.4	11.0	20.1
Agricultural	45.1	42.4	5.0	37.7	40.4	20.9	56.5	68.5	56.9	50.1
Sel-employment	21.1	28.1	24.3	26.1	29.9	34.3	15.5	13.8	26.1	20.8
Other	9.4	8.4	14.2	9.0	12.5	18.3	8.2	7.3	6.0	9.0
Mean household expenditure (Ghc)	393	379	544	464	272	410	443	296	124	106
In Migration (%)	7.4	20.2	38.7	22.7	7.9	25.9	9.7	11.3	6.7	6.1
Proportion of educated adults (%)	78.0	77.0	88.5	78.1	72.3	80.6	68.9	28.0	30.9	29.9
Mean Household size	3.9	3.7	3.4	3.6	4.0	3.9	4.1	5.5	5.3	6.5
Post-Oil extraction										
Mean household income (Ghc)	9,529	7,838	13,303	8,133	8,217	9,489	8,154	7,153	6,210	5,991
Sources of household income (%)										
Wage	25.2	22.4	27.2	59.7	16.6	39.8	31.7	8.5	24.4	23.3
Agricultural	11.1	30.8	7.5	6.6	7.6	4.1	11.9	31.8	14.4	4.6
Sel-employment	43.6	33.4	51.2	22.1	39.8	43.2	35.0	33.2	19.9	57.7
Other	20.1	13.4	14.1	11.6	54.7	12.9	21.4	26.5	41.3	14.4
Mean Household expenditure (Ghc)	3,119	2,555	4,875	2,825	2,508	3,318	2,511	1,790	1,753	1,476
In Migration (%)	11.1	11.3	38.9	24.3	15.6	10.8	18.5	5.8	5.4	4.6
Proportion of educated adults (%)	84.3	83.9	90.4	79.1	74.1	84.7	72.7	38.2	50.4	51.7
Mean Household size	4.0	4.1	3.8	3.8	4.3	3.7	4.3	5.4	4.5	5.5

Notes: Figures are from GLSS 4-6 (1998,2006 and 2013) reports by GSS.

Table B.2: Descriptive statistics

	(1)	(2)	(3)
		Sample	
	Full	Pre-oil	Post-oil
Monthly income	4.860	3.718	5.333
	(1.739)	(1.835)	(1.457)
Employment	0.851	0.685	0.892
	(0.356)	(0.467)	(0.312)
Migration	0.454	0.546	0.448
	(0.499)	(0.500)	(0.499)
Age	36.30	38.35	35.49
	(10.95)	(11.72)	(10.58)
$Age^2/100$	14.37	16.07	13.71
	(9.224)	(10.47)	(8.613)
Head of Household	0.758	0.889	0.695
	(0.429)	(0.316)	(0.462)
Married	0.677	0.694	0.655
	(0.469)	(0.463)	(0.476)
Education(yrs)	8.825	8.241	8.995
	(3.028)	(3.010)	(3.012)
Father's education(yrs)	5.052	6.389	4.325
	(4.959)	(3.533)	(5.330)
Mother's education(yrs)	3.636	5.787	2.665
	(4.237)	(3.079)	(4.349)
Observations	269	108	203

Table B.3: Spillover effect on Income

	OLS	Quantiles								
		0.1	0.20	0.25	0.30	0.50	0.60	0.75	0.90	0.95
Districts × Post Oil	0.499***	1.143***	0.650***	0.640***	0.635***	0.329***	0.158**	0.051	0.003	-0.088
	(0.115)	(0.241)	(0.167)	(0.148)	(0.133)	(0.084)	(0.077)	(0.087)	(0.106)	(0.118)
Observations	7179	7273	7273	7273	7273	7273	7273	7273	7273	7273
Adjusted R^2	0.518	0.192	0.339	0.388	0.408	0.439	0.401	0.264	0.125	0.059
Controls	Yes	Similar controls for all quantiles								

Note: Results are unconditional quantile estimates following Firpo et al. (2009). Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table B.4: Spillover effect on income, employment and migration in the Region

	Pooled		Gender		Sector				
	OLS 1	OLS 2	Male	Female	Agriculture	Construction	Manufacturing	Retail	Other Services
Log Monthly income									
Western × PostOil	0.505***	0.340**	0.631***	0.342*	0.104	0.635**	0.066	0.273	0.268
	(0.099)	(0.125)	(0.106)	(0.166)	(0.184)	(0.283)	(0.311)	(0.205)	(0.163)
Western × PostOil × Male		0.286***			0.662***	0.134	0.371*	0.182	0.006
		(0.085)			(0.106)	(0.196)	(0.193)	(0.127)	(0.124)
Adjusted R^2	0.512	0.513	0.526	0.495	0.480	0.740	0.524	0.501	0.553
Employment									
Western × PostOil	-0.000	0.013	0.026	-0.024	-0.064	0.123	0.167***	-0.037	-0.069*
	(0.024)	(0.030)	(0.028)	(0.048)	(0.039)	(0.131)	(0.052)	(0.068)	(0.03)
Western × PostOil × Male		-0.024			0.013	0.025	-0.089***	-0.028	-0.006
		(0.015)			(0.030)	(0.031)	(0.025)	(0.028)	(0.025)
Adjusted R^2	0.176	0.176	0.152	0.263	0.275	0.254	0.219	0.487	0.044
Migration									
Western × Post Oil	0.134	0.128	0.098	0.246***	-0.020	-0.011	0.254**	0.376***	0.127
	(0.088)	(0.091)	(0.095)	(0.066)	(0.093)	(0.219)	(0.116)	(0.082)	(0.097)
Western × Post Oil × Male		0.011			0.051	0.016	-0.065***	0.063*	0.062
		(0.015)			(0.051)	(0.015)	(0.019)	(0.032)	(0.057)
Constant	0.665***	0.667***	0.608***	0.707***	0.979***	0.475*	0.632***	0.725***	-0.006
	(0.126)	(0.125)	(0.131)	(0.167)	(0.152)	(0.241)	(0.153)	(0.206)	(0.102)
Adjusted R^2	0.153	0.153	0.145	0.171	0.110	0.147	0.182	0.199	0.158
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,085	8,085	5,066	3,019	2,250	312	1,020	1,684	2,810

Note: Bootstrapped Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table B.5: Within regional variation

	Income	Employment	Migration
Districts× Post Oil	0.217	0.012	0.035
	(0.329)	(0.001)	(0.099)
Post Oil	2.553***	0.226***	0.238**
	(0.349)	(0.044)	(0.106)
Districts	0.058	-0.037	-0.099
	(0.319)	(0.035)	(0.094)
Constant	0.586	-0.430***	-0.293*
	(0.376)	(0.067)	(0.176)
Observations	1523	1523	1523
Adjusted R^2	0.442	0.154	0.048
Controls	Yes	Yes	Yes

Note: Control group is northern districts in Western region. Bootstrapped Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table B.6: Ethnic distribution

	Akan		Ga-Adamgbe		Ewe		Guan		Dagbani		Others		Total	
	N	%	N	%	N	%	N	%	N	%	N		N	%
Western	1961	81.54	86	3.576	146	6.071	35	1.455	108	4.491	69	2.869	2405	100
Central	1499	84.74	46	2.600	107	6.049	67	3.787	18	1.018	32	1.809	1769	100
Greater Accra	1282	38.93	980	29.76	653	19.83	88	2.672	158	4.798	132	4.009	3293	100
Volta	51	2.739	28	1.504	1445	77.60	231	12.41	12	0.644	95	5.102	1862	100
Eastern	1626	57.86	504	17.94	422	15.02	127	4.520	49	1.744	82	2.918	2810	100
Ashanti	2885	84.11	37	1.079	119	3.469	45	1.312	163	4.752	181	5.277	3430	100
Brong Ahafo	1073	71.49	27	1.799	66	4.397	58	3.864	138	9.194	139	9.260	1501	100
Northern	20	3.378	7	1.182	25	4.223	59	9.966	355	59.97	126	21.28	592	100
Upper East	11	2.564	1	0.233	3	0.699	2	0.466	292	68.07	120	27.97	429	100
Upper West	20	5.362	4	1.072	4	1.072	7	1.877	247	66.22	91	24.40	373	100
Total	10428	56.48	1720	9.315	2990	16.19	719	3.894	1540	8.341	1067	5.779	18464	100

Table B.7: Proportion of workers

	Male	Female	Total
Agriculture	4,737	1,339	6,076
Construction	629	113	742
Manufacturing	1,156	940	2,096
Retail Services	1,212	2,432	3,644
Other Services	2,271	3,928	6,199

Table B.8: Parallel trend assumption test

	Income	Employment	Migration
Western × Post Oil_{2006}	-0.168	0.059	0.303
	(0.220)	(0.051)	(0.104)
Post Oil_{2006}	1.672***	0.590***	-0.292*
	(0.081)	(0.041)	(0.097)
Western	0.134	0.0164	-0.131
	(0.166)	(0.053)	(0.095)
Constant	0.861***	-0.0621	0.304*
	(0.329)	(0.105)	(0.082)
Observations	3143	3143	3143
Adjusted R^2	0.371	0.537	0.142
Demographic controls	Yes	Yes	Yes
Socio-economic controls	Yes	Yes	Yes

Note: The year 2006 is considered as period after oil discovery and extraction. Bootstrapped Standard errors clustered at the district level in parentheses.***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table B.9: Spillover effect : Accounting for locality

	Income	Employment	Migration
Districts ×Post Oil	0.457***	-0.0401	0.163
	(0.072)	(0.039)	(0.101)
Districts×Post Oil× Urban	-0.282**	-0.040*	0.248***
	(0.143)	(0.023)	(0.049)
Districts	0.148	0.021	-0.191***
	(0.097)	(0.044)	(0.066)
Urban	0.407***	0.025	-0.075*
	(0.074)	(0.017)	(0.038)
Constant	0.310*	0.250***	0.687***
	(0.165)	(0.086)	(0.120)
Observations	5641	5641	5641
Adjusted R^2	0.648	0.415	0.133
Controls	Yes	Yes	Yes

Note: Bootstrapped Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table B.10: Spillover effect of oil extraction across gender and sector

	(1)					(2)				
	Agriculture	Construction	Manufacturing	Retail	Services	Agriculture	Construction	Manufacturing	Retail	Services
Log monthly income										
Districts × Post Oil	0.887***	0.357	0.257	0.421***	0.165	0.593***	0.273	0.0512	0.365**	0.093
	(0.199)	(0.217)	(0.276)	(0.161)	(0.153)	(0.151)	(0.217)	(0.331)	(0.157)	(0.164)
Districts × Post Oil × Male						0.385***	0.104	0.470***	0.203***	0.134*
						(0.100)	(0.117)	(0.170)	(0.069)	(0.075)
Constant	1.939***	1.128***	1.076***	0.764**	2.800***	2.025***	1.528***	1.097***	0.773**	2.811***
	(0.360)	(0.342)	(0.286)	(0.376)	(0.719)	(0.355)	(0.322)	(0.296)	(0.376)	(0.692)
Adjusted R^2	0.478	0.736	0.518	0.494	0.551	0.478	0.736	0.520	0.494	0.551
Employment										
Districts × Post Oil	-0.122***	-0.058	0.126**	-0.033	-0.049***	-0.161***	-0.052	0.156***	-0.035	-0.037*
	(0.031)	(0.269)	(0.056)	(0.038)	(0.016)	(0.034)	(0.269)	(0.058)	(0.039)	(0.022)
Districts × Post Oil × Male						0.051	0.005	-0.068**	0.005	-0.022
						(0.044)	(0.012)	(0.031)	(0.016)	(0.020)
Constant	0.600**	0.372***	0.655***	0.376***	0.362	0.611***	0.341***	0.652***	0.376***	0.360
	(0.246)	(0.139)	(0.095)	(0.056)	(0.277)	(0.231)	(0.139)	(0.093)	(0.057)	(0.287)
Adjusted R^2	0.263	0.268	0.180	0.495	0.035	0.263	0.268	0.180	0.495	0.035
Migration										
Districts × Post Oil	-0.084	0.180	0.246**	0.426***	0.181*	-0.139*	0.264	0.264***	0.409***	0.113
	(0.120)	(0.215)	(0.096)	(0.053)	(0.097)	(0.082)	(0.215)	(0.093)	(0.056)	(0.116)
Districts × Post Oil × Male						0.073	0.031	-0.040	0.062**	0.127*
						(0.069)	(0.045)	(0.052)	(0.027)	(0.071)
Constant	0.521*	0.698***	0.267**	0.827***	-0.336***	0.537*	0.301***	0.265*	0.830***	-0.325***
	(0.307)	(0.149)	(0.136)	(0.114)	(0.087)	(0.302)	(0.184)	(0.136)	(0.113)	(0.095)
Adjusted R^2	0.048	0.149	0.126	0.144	0.137	0.048	0.149	0.126	0.144	0.138
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1708	301	945	1581	2635	1708	301	945	1581	2635

Note: Bootstrapped Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table B.11: Using alternative definitions of treated and control districts

	Income	Employment	Migration
Ashanti	0.227	0.022	-0.065
	(0.187)	(0.019)	(0.039)
Ashanti × Post Oil	0.133	-0.002	0.114
	(0.127)	(0.032)	(0.076)
Constant	0.414	0.143***	0.406***
	(0.488)	(0.046)	(0.116)
Observations	5548	5548	5548
Demographic controls	Yes	Yes	Yes
Socio-economic controls	Yes	Yes	Yes

Note: Ashanti region is the treated region and Volta the Control region. Bootstrapped Standard errors clustered at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table B.12: Alternative control groups

	Income	Employment	Migration
Baseline	0.499***	-0.028**	0.14*
	(0.115)	(0.014)	(0.085)
Observations	7,179	7,179	7,179
Adjusted R^2	0.518	0.170	0.117
Eastern× Post Oil	0.271	-0.115**	-0.000
	(0.164)	(0.045)	(0.125)
Observations	3891	3891	3891
Adjusted R^2	0.575	0.508	0.021
Ashanti× Post Oil	0.187	-0.043*	0.044
	(0.169)	(0.022)	(0.105)
Observations	4865	4865	4865
Adjusted R^2	0.498	0.177	0.029
BrongAhafo× Post Oil	0.431*	-0.148***	0.107
	(0.217)	(0.043)	(0.151)
Observations	2926	2926	2926
Adjusted R^2	0.541	0.558	0.136
Volta× Post Oil	0.163	-0.062**	0.184**
	(0.175)	(0.029)	(0.077)
Observations	3623	3623	3623
Adjusted R^2	0.487	0.193	0.034
GreaterAccra× Post Oil	0.661***	0.064	0.347*
	(0.161)	(0.083)	(0.162)
Observations	4702	4702	4702
Adjusted R^2	0.585	0.395	0.155

Note: Alternative control groups are designated in each row. These are used based on the weights assigned to each region from the Synthetic Control Approach- Eastern, Ashanti, Brong Ahafo, Volta and Greater Accra. Standard errors clustered at the district level in parentheses. Significant estimates are within the 95% confidence interval of the baseline model for income (0.319, 0.679), employment (-0.056, -0.000) and migration (-0.020, 0.300). ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table B.13: Proportion of Origin of Migrants to treated districts

	Sample	Male	Female
Ashanti	4.76	4.93	4.46
Brong Ahafo	0.91	1.11	0.56
Central	11.74	11.61	11.98
Eastern	1.52	1.75	1.11
Greater Accra	12.04	12.72	10.86
Northern	1.21	1.43	0.84
Upper East	24.90	23.69	27.02
Upper West	0.20	0.32	0.00
Volta	3.44	4.29	1.95
Western	39.27	38.16	41.23

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Chapter 4

Oil at work: Natural Resource Effects on Household Wellbeing in Ghana

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Overall percentage (%)	100%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	19/09/2019

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Abstract

The extraction of natural resources can have social and economic impacts on residents in a locality. Existing micro level studies examining natural resources impact, like oil, have focused on developed economies and examine the impact at the means. This paper examines the effect of oil extraction across the distribution of households' expenditure in Ghana. Using household level data, we employ an unconditional quantile difference-in-differences strategy to show that oil extraction has a positive effect on low expenditure or poor households but negative effects for high expenditure or rich households. Additionally, there are heterogeneous effects across household expenditure share on food and non-food items, localities and gender. Results are broadly consistent with theoretical predictions from standard microeconomics models.

Key words: Expenditure; Natural resources; Resource booms; DID estimation; quantiles; welfare

JEL classification: D1, D6, O13, Q32, Q33, R11

4.1 Introduction

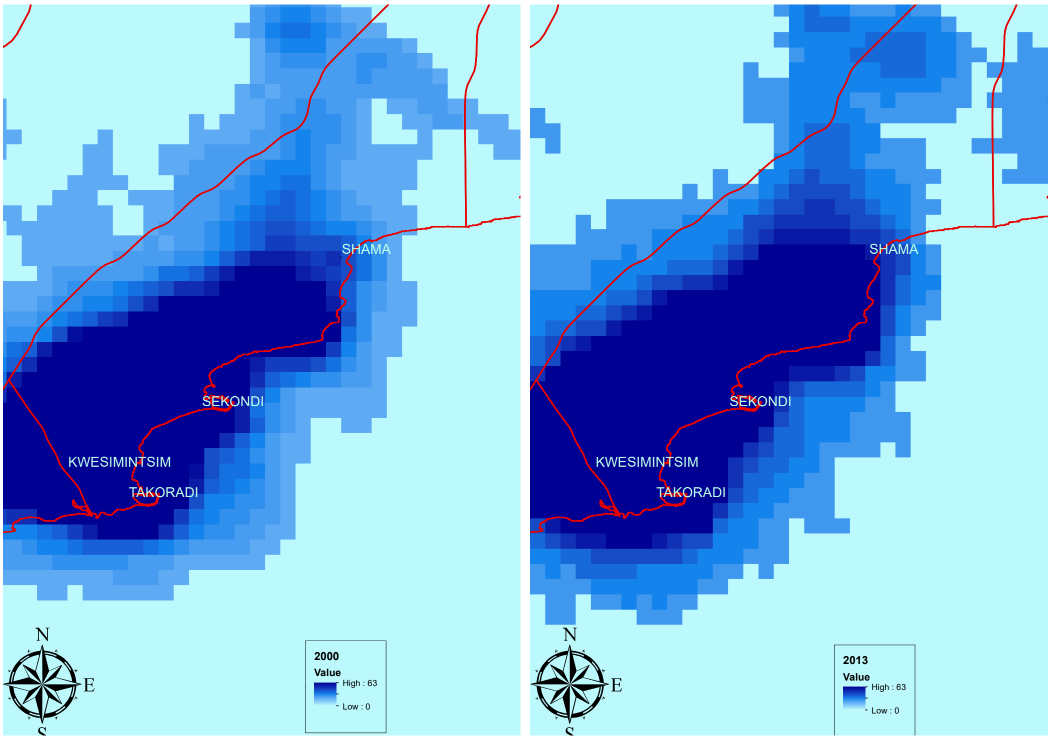
The effects of natural resources on the development of economies have been a topic of interest for economists and public policy professionals since time immemorial and extensively after the work of Sachs & Warner (1995). Existing empirical studies have focused on the effect of resources, like oil, on macroeconomic outcomes, with most studies finding a negative effect of the resource on growth and development in most developing countries (Sachs & Warner 1995, Gylfason 2001, Papyrakis & Gerlagh 2004, Mehlum et al. 2006, Robinson et al. 2006).

Recently, there has been an increasing trend in the literature to examine specific impact of the natural resource on the wellbeing for individual economies and regions. Black et al. (2005) examine spillover effects of United States oil booms in the 1970s and 80s using county level data, and find positive effect on income. Aragón & Rud (2013) combine household and district level data to examine the effect of gold mine's demand on local input on real income, and find a positive effect on income and on the supply market in neighbouring areas. On Africa, Kotsadam & Tolonen (2016) examine effect of large-scale mining on employment for women in Africa, using household and district level data. They find an increase in employment and income for women living in mining districts. Mamo et al. (2019) find a positive effect of oil discovery on the level of economic activity in Sub-Saharan Africa using district level night light data. The aforementioned studies and others in the literature, examine the effect at either the county or region-level which hardly capture the impact on individual or households. Additionally, studies examining household effects undertake a partial analysis of the wellbeing with most focused on average estimation of crime, income, employment and rate of education with no consideration for changes along the distribution of these outcomes. For example, analysis of income informs how much an individual, household or region earn from an activity related to the natural resource extraction, either directly or indirectly. However, households have a tendency to spend those earnings differently based on their position in the distribution which could inform about how beneficial the resource has been for residents' expenditure on food and non-food items (Deaton 1997). Another shortfall is that income measures are not stable, making it difficult to use as a measure of wellbeing (Deaton & Zaidi 2002, Gillis et al. 2001, Meyer & Sullivan 2003). Using expenditure as a measure for wellbeing gives a better estimate of addressing issues of the poor in most developing economies, as it reflects the accumulation of assets especially in the presence of a natural resource shock. The possibility of an increased economic activity as a result of an oil boom may affect household spending differently along the distribution of expenditure and this may impact their wellbeing.

In this paper, we examine the distributional impact of an offshore oil extraction on the wellbeing of households using household level data from Ghana. The study examines the extraction of oil along the distribution of household expenditure. In 2007, Ghana discovered the largest oil deposit in Sub-Saharan Africa off the coast of Western region and began extraction in 2010 (Figure C.1a). Figure 4.1 shows a wide spread of night light density -a proxy for economic activity- for Sekondi-Takoradi Metropolitan Area, whose coast is about 60 km from the oil extraction site. Light density was very much concentrated along the coast and the centre in 2000. We observe a spread in light density to the north of the area in 2013. The study uses households in districts closest to the extraction area as treated group and those farther away (about 250 km) as control group. The identification of the oil extraction effects is thus, by the proximity of households to the extraction site. The choice of control group are, however, selected using the Synthetic Control Approach in order to find comparable households to the treated sample. We then use an unconditional quantile approach in a difference-in-differences framework to identify the impact. This approach makes it possible to examine the distributional impact solely for households in the treated districts by accounting for unobservable factors. The new oil extraction serves as a potential source of exogenous variation between the treated and control group and hence aids in identifying impact for the treated sample.

We find that the extraction of oil has a downward sloping impact on expenditure; positive at low expenditure but negative at higher levels. This means that poor households were positively impacted whereas the rich were negatively impacted. We further find that this downward sloping effect is more evident for household

Figure 4.1: Nightlight density in Sekondi-Takoradi Metropolitan Area



(a) Nightlight density in 2000 **(b)** Nightlight density in 2013

Notes: Figures (a) and (b) plot the nightlight variations for Sekondi-Takoradi Metropolitan Area in the Western region and for the year 2000 and 2013.

expenditure share on food than non-food items. With an upward sloping impact for household expenditure share on non-food items, we find rich households substituted food purchase for non-food items and the poor, non-food for food items. These findings are consistent with theories on a shock to expenditure.

With rising prices for household items in the wake of the oil extraction, we find a fall in the real expenditure of poor households but an increase for those in the 90^{th} quantile, hence a decrease in the welfare of most households in the treated district.

There is a possibility that migration into the treated district from the control group may contaminate our identification strategy especially when such migrants positively select themselves. We observe a high level of migration into the Western region of Ghana prior to the oil extraction (40 percent) but a reduction post extraction period (7 percent). We, however, account for the birthplace of household head and the duration of household stay in a specific district but find the estimates to be immune to these inclusions. By including these variables, we account for sorting into our treated districts which may not possibly be as a result of the new oil extraction. We further test for the absence of migration influencing the estimates by running a linear probability model of household migration status within a difference-in-differences framework.

While we attribute our difference-in-differences estimates to the proximity of districts to oil extraction area, we test the possibility of other confounding factors. We estimate our model with alternative control groups, thus districts in Ashanti and Volta regions and find our results robust to these checks, hence validating our identification strategy.

The contributions of this paper are as follows. First, the study contributes to the literature by examining the distributional effect of oil shock which is hardly known in the literature even for micro level studies on developed economies. Most studies in the literature pay little attention to the heterogeneous impact and examine the effect of natural resources at the mean; which may result in statistically insignificant effect. A mean estimate of oil extraction impact for this study, even after accounting for covariates, is an example of this situation. Our estimation technique following Firpo et al. (2009) also makes it possible to account for a shift in the distribution of the outcome variables and the explanatory variables. This makes it possible to examine the impact not only by accounting for the within-group variation but also between-group variation at each quantile.

Secondly, the study adds to the limited literature on the effects of natural resources, specifically oil, to the development of an economy at the micro level, especially developing economies. The growing literature is largely dominated by studies on developed economies with a few studies on developing economies in Central and South America. Most empirical studies on developing economies use aggregated district or regional level data. This study, on the other hand, uses household level data which allows for much heterogeneity in the sample.

The closest study to this paper is by Aragón & Rud (2013) who examine the effect of a Peruvian gold mine expansion on residents in the mining locality. They examine the effect of mine expansion on the demand for local input which they believe affects the income, prices and expenditure of goods in the locality. Whereas the aforementioned study estimates the effect of gold mine at the mean, we use a novel unconditional quantile approach and find varying impact of oil extraction along the distribution of expenditure. This study is also different from Agyire-Tettey et al. (2018) who examine welfare differences between rural and urban dwellers in Ghana and focus on the changing pattern of welfare. Our study, however, examines the wellbeing of households given a notable exogenous shock to expenditure.

Microeconomic theory, like the Engel Curve, suggests that households will reduce their consumption of inferior goods to spend more on normal goods given an increase in income (Engel 1857). The theory further adds that poor households will consume more food items for a given increase in income. We find an alignment of these predictions in our study given a positive impact of the oil extraction on poor households' consumption of food and rich households' consumption of non-food items.

However, the study's findings are not consistent with insights from the money metric utility measure of welfare proposed by Blackorby & Donaldson (1988). The theory assumes that households will choose a set of goods to maximise at a given budget set and will prefer higher level of satisfaction for an increase in income. With a rise in income and a higher rise in prices, a larger proportion of households fail to reach a higher welfare level.

The rest of the paper is structured as follows. The next section, 4.2.1, gives a brief background of oil production in Ghana. Section 4.2.2 describes the data used, Section 4.3 details the empirical strategy and the identification strategy. Section 4.4 reports the results using the data and estimation technique. Section 4.5 presents some robustness checks and finally Section 4.6 concludes.

4.2 Background and Data

4.2.1 Oil Production in Ghana

In 2004, the government of Ghana sold licences to foreign companies for offshore oil exploration and production. These companies discovered oil deposit at the Cape Three Points, located on the coast of the Western Region in 2007. Figures 4.2 and

4.3 show the regions in Ghana and the oil extraction area. The area is about 60km from the coast of the Western region and 285.3 kilometres from Accra, the national capital. The area discovered was estimated to have oil reserves between 600 million and 1.8 billion barrels, and with extraction beginning in 2010, the oil commanded competitive price on the world market because of its unusual characteristics of being light and sweet.[1] (Kastning 2011, Ayelazuno 2014)

Oil production increased from as low as 10,000 barrels per day prior to 2010 to an average of 78,000 barrels per day from 2011 to 2013 as shown in Figure C.1a. The high production rate and gains from the oil increased the GDP of Ghana with a growth from 6% on average prior to the extraction to 9% post extraction era. This increased GDP growth was largely as a result of the oil rent which increased from about 0.1% to about 5% as shown in Figure C.1b in the Appendix. Ghana was reclassified as a middle income economy by the World Bank after these developments (World Bank 2011).

The increased growth in the Ghanaian economy is evident not only in the GDP but also in the level of economic activity undertaken at the micro level. Nightlight density is the amount of man-made light emitted at night from space. It serves as a proxy for economic activities that are undertaken in a locality (Henderson et al. 2012, Mamo et al. 2019). With increased oil production, the density for Ghana increased substantially among peers in West Africa post oil extraction. However, the increase is mainly observed in the Western region districts closest to the oil extraction area, with districts in Greater Accra, Ashanti and Eastern regions having relatively stable radiance post oil extraction period as seen in the regional capitals of these regions in Figure 4.4.[2]

[1]Ghana's oil has an API Gravity of 37.6 degrees which is more than the benchmark of 10 and hence considered lighter than water. It also has a sulphur content of 0.25 wt% which is less than 0.5 wt% and hence considered sweet (Demirbas et al. 2015).

[2]The regional captials (and their regions) are Sekondi-Takoradi (Western), Accra (Greater Accra), Koforidua (Eastern), Sunyani (Brong Ahafo), Tamale (Northern) and Wa (Upper West).

Figure 4.2: Treated and control districts in Ghana

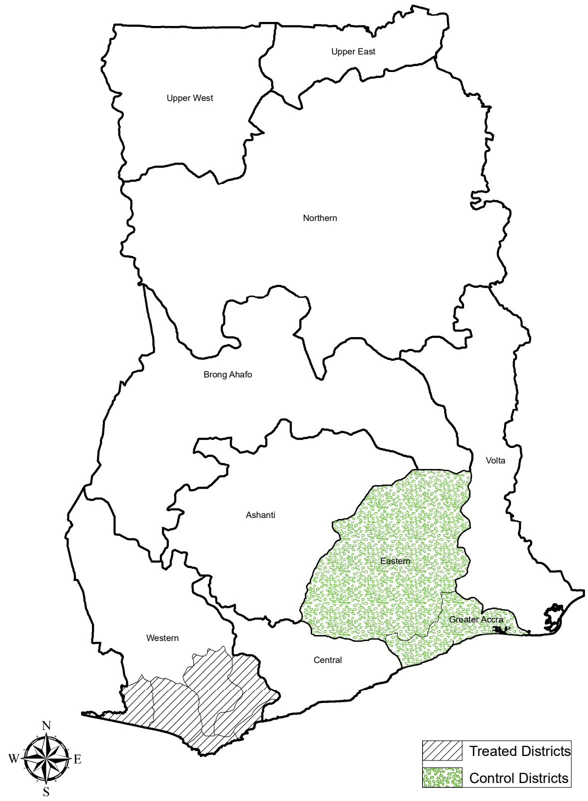


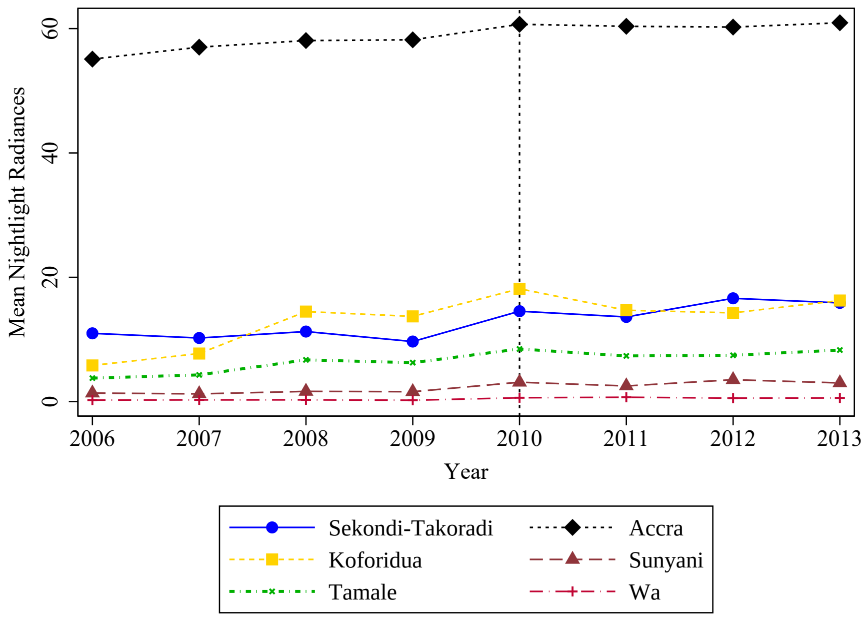
Figure 4.3: Location of oil extraction area

source:Eni S.p.A (2015)

4.2.2 Data

The study uses data from the Ghana Living Standard Survey (GLSS) rounds 4, 5 and 6 undertaken in 1998, 2006 and 2013 respectively. These are nationally

Figure 4.4: Nightlight density



The regional captials (and their regions) are Sekondi-Takoradi (Western), Accra (Greater Accra), Koforidua (Eastern), Sunyani (Brong Ahafo), Tamale (Northern) and Wa (Upper West).

representative cross-section surveys. 5,998 households were surveyed in the 4th round, 8,687 households in the 5th round and 16,772 in the 6th round. Each household was asked about socio-economic characteristics of its members; age, years of education, employment status, income and expenditure patterns of members as well as other demographic factors. In this study, we consider the household as a unit of measure and estimate the oil effect at the individual household level.

The outcome variable, households' annual expenditure, is made up of expenses made within a 12-month period on food and non-food items.[3] With the shock of the oil extraction, there is a possibility of an increase in economic activity and this has the potential of increasing households purchasing behaviour. This behaviour may be different for households on the expenditure distribution. Rich households may have enough resources to undertake more economic activity which may lead to an increase in their wealth. Poor households on the other hand, may spend a larger share of their gains on their most immediate needs which largely are food items. The effect on food and non-food expenditure are therefore, expected to be different along the distribution of expenditure.

[3]Households responded to the question "During the past 12 months, how much did the household spend on:".

The effect of prices has a potential impact on households' expenditure. The trend in prices increased significantly during the study period as shown in Figure C.2 in the Appendix. We account for this by deflating the annual expenditure with annual regional prices at the time of the survey. We refer to this variable as real expenditure which is used as a proxy for welfare measure.[4]

4.2.3 Assignment of Treatment

The GLSS is carried out in the lowest administrative level; districts in Ghana. These districts make up a region. There are 10 regions and each react differently to shocks. Southern Ghana is more developed than the north and this is evident in the nightlight density presented above.

The possibility of the oil extraction having an impact is dependent on the distance households are from the oil extraction area. Given the coast of the Western region is about 60 km from the extraction area, We use households in the immediate coastal districts of the region as treated group. By this reasoning, households farther from the Western region would be less affected by the oil extraction and would be used as a control group. The difficulty lies in choosing the most appropriate control group for the treated sample. One way is to compare characteristics among the 10 regions and select the most appropriate control group. Table C.1 in the Appendix presents some key indicators (average of sources of household income, proportion of migrants, household size and proportion of educated adults.) of households in the 10 regions of Ghana as stated in the final reports of the 3 surveys used. The Western region is similar in characteristics to the Eastern, Greater Accra, Ashanti and the Volta regions. Selecting among these regions may seem arbitrary though they are farther from the Western region. Hence, we adopt the Synthetic Control Approach by Abadie et al. (2010) in selecting the most appropriate control group based on the indicators in Table C.1. The technique uses a data-driven approach to minimize the error in selecting comparable control groups, by estimating weights to each region to show their comparability to the treated group. Region with highest weight is the most

[4]See Deaton & Zaidi (2002).

comparable to the Western regions.[5] Table 4.1 presents the weights of each region and this shows that based on the indicators, Eastern region is the most comparable, followed by Ashanti, Brong Ahafo, Volta and Greater Accra. The 3 northern and Central regions are assigned no weights showing their dissimilarity to the Western region.

Table 4.1: Region with weights

Regions	Weights
Ashanti	0.246
Brong Ahafo	0.181
Central	0
Eastern	0.313
Greater Accra	0.083
Northern	0
Upper East	0
Upper West	0
Volta	0.177

Note: Weights are computed using Synthetic Control Approach of Abadie et al. (2010). The estimated weights are based on the socio - economic indicators in the final GLSS reports of the 1998, 2006 and 2013 survey.

Based on this approach, we use households in coastal districts in the Western region as treated group and households in Eastern region as control group.[6] We include households in Greater Accra in the control group given it is home to the national capital and it is the most developed region in Ghana. Moreover, we undertake a parallel trend test with the sample in Section 4.5.1 and check the robustness of our choice of control by using households in different regions as alternative control group in Section 4.5.5.

A descriptive summary of the variables used in the study are presented in Table C.3 in the Appendix. Table 4.2 presents the mean of log expenditure for the treated and control sample. Rows (1) and (2) show higher average expenditure levels for households in the control districts before and after the oil extraction. This may reflect the high economic activities in the control group as shown in Figure 4.4.

[5] See Abadie et al. (2010), Cheong et al. (2017) for estimation of the synthetic control approach.

[6] Treated districts are —Jomoro, Ellembelle, Nzema East, Ahanta West, Sekondi-Takoradi,Tarkwa Nsuaem, Shama, Wassa East and Mpohor— control includes all districts in Eastern region and Greater Accra regions.

However, the average expenditure increase is higher for households in the treated districts as shown in Row (3) indicating a shock in the treated sample. A test of difference, in Row (4), for the two means shows a statistically insignificant increase in expenditure for the treated group.

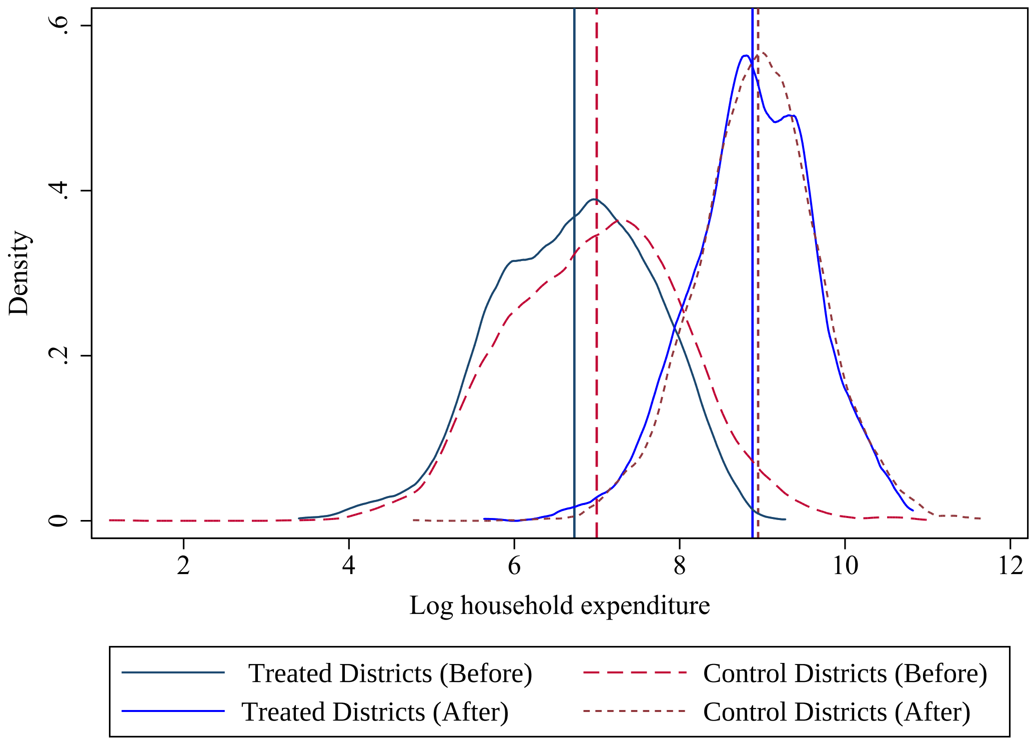
Table 4.2: Expenditure means by treatment

	Treated Districts		Control Districts
(1) Before oil extraction	6.726		6.821
	(0.056)		(0.111)
(2) After oil extraction	8.881		8.955
	(0.079)		(0.123)
(3) Rows [(2)-(1)]	2.155		2.134
	(0.097)		(0.081)
(4) treated (3) - control(3)		0.021	
		(0.126)	

Note: Estimates are means of treated and control districts. Standard errors clustered at the district level in parentheses.

Additionally, we plot the kernel density of expenditure for our treated and control groups and present them in Figure 4.5. The distribution for food and non-food items share have been deferred to the Appendix. Figure 4.5 shows household expenditure is widely spread but lesser for treated than control group before the oil extraction. There is an increase in density and much convergence around the mean post oil extraction period for the two samples. The distribution for the treated sample is near symmetry and higher along sections of the distribution, indicating an uneven rise in household expenditure. We also observe a switch at high density of log expenditure before and after the oil extraction. In Figures C.3 and C.4, we observe the increase in the density of household expenditure is from the distribution of food and the switch in the average is as a result of changes in non-food expenditure.

Figure 4.5: Distribution of household expenditure before and after oil extraction



4.3 Empirical Strategy

Most empirical studies examine micro level natural resource effects at the average of the outcome variable of interest, using an OLS regression or fixed effect model.[7] Though these approaches result in consistent estimates provided all assumptions are satisfied, they are not enough in capturing the marginal effects across entire distribution of the outcome variable. The studies using these techniques may over or under state the estimates.

Several econometric techniques have been developed to examine marginal effects along a distribution of outcomes and the common ones are the conditional (Koenker & Bassett Jr 1978, Koenker 2004, Machado & Mata 2005, Canay 2011) and unconditional quantile regressions (Firpo 2007, Firpo et al. 2009, Powell 2016). The underlying differences in the two approaches have to do with the computation and interpretation of the marginal effect of the estimated coefficients. The conditional quantile techniques are difficult to estimate and cannot be extended to account for

[7] See Black et al. (2005), Michaels (2010), Marchand (2012), Paredes et al. (2015), Buonanno et al. (2015), Jacobsen & Parker (2016), Kumar (2017).

changes or a shift in the location of explanatory variables on the outcomes (Firpo et al. 2009). Thus, the approach by Koenker & Bassett Jr (1978) only accounts for the within-group variation of the outcome variable conditional on the covariates. The unconditional approach by Firpo et al. (2009) on the other hand estimates the within-group and between-group effects, thus, it accounts for the distribution of the outcome and explanatory variables.

We, therefore, use an unconditional quantile regression following Firpo et al. (2009) in a difference-in-differences framework following Havnes & Mogstad (2015). The approach adopts the Influence Function (IF) in estimating the unconditional quantiles of the distribution of the outcome variable for a shift in location of an explanatory variable. The Influence Function, which shows the influence a particular observation has on the distributional statistic of the outcome variable, is stated as

$$IF(Y; v, F_Y) \tag{4.1}$$

where Y is the outcome variable, v is any given statistic and F_Y is the distribution of the outcome variable. Adding the distribution of the statistic, $v(F_Y)$, to the IF gives the Recentered Influence Function (RIF). The key idea of RIF is to transform the dependent variable and allow the coefficient on the variable of interest to recover the effect of the natural resource on some aggregate statistic of the distribution of the outcome variables.

Estimation of the quantile of our outcome variables is possible given the IF and RIF of the forms;

$$IF(Y; q_\tau, F_Y) = (\tau - \mathbb{1}\{Y \leq q_\tau\})/f_Y q_\tau \tag{4.2}$$

$$RIF(Y; q_\tau, F_Y) = q_\tau + IF(Y; q_\tau, F_Y). \tag{4.3}$$

where $\mathbb{1}\{Y \leq q_\tau\}$ is an indicator that a value of the outcome variable is below the quantile, τ. $f_Y q_\tau$ is the marginal density of Y at the point q_τ. The conditional expectation of the RIF($Y; v, F_Y$) as a function of the covariates is the RIF regression in equation (4.4). In the case of the unconditional quantile regression the equation will be (4.5).

$$E\left[RIF(Y;v,F_Y)|X\right] = m_v(X). \tag{4.4}$$

$$E\left[RIF(Y;\tau,F_Y)|X\right] = m_\tau(X). \tag{4.5}$$

To compute the unconditional quantile of the outcome variables, we first estimate the sample quantile, q_τ, an indicator for the quantile, $\mathbb{1}\{Y \leq q_\tau\}$, and the marginal density at the point of the quantile, $f_Y q_\tau$, using kernel density estimator of the form in equation (4.6) where b is a positive scalar bandwidth (Firpo et al. 2009).

$$\hat{f}_Y(\hat{q}_\tau) \quad = \quad \frac{1}{N \cdot b} \cdot \sum_{h=1}^{N} \kappa_Y\left(\frac{Y_h - \hat{q}_\tau}{b}\right) \tag{4.6}$$

We then estimate the new transformed outcome variable with a set of covariate by OLS to derive the marginal effect of our variable of interest which provides consistent estimates given $Pr\left[Y > q_\tau|X = x\right]$ is linear in x.

Adopting this estimation approach, we examine the effect of oil extraction on household expenditure by presenting our model as the following:

$$RIF(Y_h, v(F)) = (Districts_h \times PostOil_t)'\beta + X_h'\gamma + d_h + a_t + e_h \tag{4.7}$$

where $RIF(Y_h, v(F))$ is the Recentered Influence Function (RIF) of a given statistic, v of the outcome variables, Y; log annual expenditure of household, h. $Districts_h$ and $PostOil_t$ are indicators for households residing in the treated districts and post oil extraction period respectively. $Districts_h$ captures the difference in the outcome variables between treated and control districts over the sample period and $PostOil_t$ shows the difference in the outcome variables before and after oil extraction. The interaction term, therefore, captures the effect of oil extraction on the outcome variables of the treated households. X_h is a vector of household demographic controls; dummies for ethnic composition, marital status and religion of household head, and socio-economic controls; household size, household heads' age, square of age and their completed years of education. d_h and a_t account for the district and time fixed effects with e_h capturing the idiosyncratic shocks. We follow the literature and use the logarithm of the outcome variables in the sample and bootstrap the standard errors with 500 replications.

The coefficient of interest, β, measures the impact of oil extraction on the expenditure of households in the treated districts. The identification of our parameter of interest is that changes in expenditure in the treated districts post 2010 are as a result of the new oil extraction. This means that any difference in expenditure between the treated and control districts prior to extraction should be same or statistically insignificant. To aid identification, the study controls for some household factors.

These household factors may influence expenditure other than the shock. The age, years of education, household size and the marital status of the household head has a higher possibility of affecting how much a given household may spend over a period. Not accounting for these may result in a biased estimate of the oil extraction effect.

The inclusion of district fixed effects also aids identification as they capture any economic development that may influence the expenditure of households other than the increased economic activity made possible by the extraction of oil in Ghana.

The year fixed effects on the other hand, account for any changes or decisions impacted on the expenditure of households by actions of national or local governments. Politicians in an attempt to win political power may embark on several possible initiatives which could impact household wellbeing. Not accounting for these factors may wrongly attribute their effects to the new oil boom.

4.4 Results

4.4.1 Oil Effect on Household Expenditure

Table 4.3 presents the estimates based on equation (4.7) for two models - without and with covariates. For comparison, we present the OLS results in addition to the quantile estimates. The model without and with covariates are on upper and lower panels respectively. The upper model shows a positive and not statistically significant impact of oil extraction, on average. Across quantiles, the effect is only significant at the 75th quantile of the distribution. The model with covariates, on the other hand,

Table 4.3: Oil effect on household expenditure

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
		Household Expenditure				
No Controls (N=13,801)						
Districts × Post Oil	0.358	1.275	1.581	0.265	-0.201*	-0.0402
	(0.331)	(1.702)	(0.965)	(0.175)	(0.111)	(0.0623)
Controls	No	No controls for all quantiles				
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				
With Controls (N=12,433)						
Districts × Post Oil	-0.059	0.895***	-0.133**	-0.256***	-0.268***	-0.423***
	(0.045)	(0.319)	(0.057)	(0.046)	(0.048)	(0.057)
Controls	Yes	Similar controls for all quantiles				
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				

Note: The demographic controls include dummies for ethnic composition, marital status and religion of household head, whereas socio-economic controls include household size, household head's age and square of age, completed years of education. Bootstrapped standard errors with 500 replications in parentheses for quantiles. Clustered standard errors at the district level for OLS.***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

shows a negative and not statistically significant impact on average but a significant impact across the distribution. There are positive and negative significant effects below and beyond the 25th quantile. We find that oil extraction off the coast of the Western region increased expenditure by a 0.9 percentage points for poor households' in the treated district, thus households in the 10th quantile. A graphical presentation of the oil extraction effects is shown in Figure 4.6. The y-axis of the figure indicates the oil extraction effect and the x-axis shows the quantiles at which these effects are estimated. The positive impact of the extraction is largely for households below the 20th quantile.

The insignificance of the average estimate shows the essence of employing a quantile technique to examine oil extraction impact on household expenditure. Additionally, the estimates from the unconditional quantile approach differs from the conditional approach by Koenker & Bassett Jr (1978) which is presented in Table C.4 in the Appendix. The former examines the impact by accounting for not only the within but also between variation in the distribution. Importantly, the estimates from the Firpo et al. (2009) are unconditional. [8]

We decompose the oil extraction impact by households' expenditure share on food and non-food items. Table 4.4 presents the difference-in-differences estimate of oil extraction impact on expenditure share of food and non-food items. The impact on food items is downward sloping but upward sloping for non-food items. These results indicate that rich households increase their consumption of non-food items more when there is a shock whereas poor households increase their consumption of food items. The overall impact is therefore dominated by the expenditure on food items.

Table 4.4: Oil effect on household food, non-food expenditure and real expenditure

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Food (N=12,433)						
Districts × Post Oil	-0.315***	0.508***	-0.0035	-0.451***	-0.564***	-0.555***
	(0.0293)	(0.110)	(0.7483)	(0.0397)	(0.0398)	(0.0392)
Non-food (N=10,641)						
Districts × Post Oil	0.0730	-0.467	0.0826	0.205***	0.236***	0.0884
	(0.0955)	(0.538)	(0.129)	(0.0581)	(0.0562)	(0.0745)
Real expenditure (N=12,433)						
Districts × Post Oil	-0.117	-0.463***	-0.539***	-0.695***	-0.135	1.332***
	(0.109)	(0.051)	(0.045)	(0.048)	(0.229)	(0.273)
Controls	Yes	Similar controls for all quantiles				
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				

Note: Bootstrapped standard errors with 500 replications in parentheses for quantiles. Clustered standard errors at the district level for OLS. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

4.4.2 Oil Effect on Real Expenditure

Table 4.4 shows the oil effect after accounting for general price levels in regions. Surprisingly, only treated households in higher quantiles, specifically beyond the 80th quantile (see Figure 4.8), have a positive increase in real expenditure. This shows that the increased income and for that matter increased expenditure on items of all forms were purchased at a relatively higher price for poor households. Given rich

[8] Stata user-written command *rifreg* is used in estimating unconditional quantile estimates.

households spent a higher share of their increased income on non-food items, we observe that the increased food prices as shown in the Appendix (Figure C.2), have a higher effect on poor households' welfare.[9]

4.4.3 Heterogeneous Effects

A. By gender

The extraction impact, though heterogeneous across quantiles, has the possibility of varying by gender of household heads given differences in characteristics. For this, we estimate oil effect separately for male and female household heads in the treated district. Figure 4.6 shows the oil effect for the two sub-samples. We find female household heads to be more affected by the oil extraction than males at lower quantile of expenditure. The impact beyond the 20^{th} quantile is higher for male heads than female heads.

Decomposing the impact into expenditure share on food and non-food items shows varying effects along the distribution with female household head being affected less at lower quantiles and more at higher quantiles as shown in Figures 4.7b. Moreover, the oil effect on expenditure share on non-food items is positive for male household heads beyond the 15^{th} quantile and only positive for female household heads below this quantile as shown in Figure 4.7d. This means most female household heads are burdened by the need to provide food for their households and have less to purchase other items. However, the negative oil extraction effect on real expenditure is lower for female household heads as shown in Figure 4.8b.

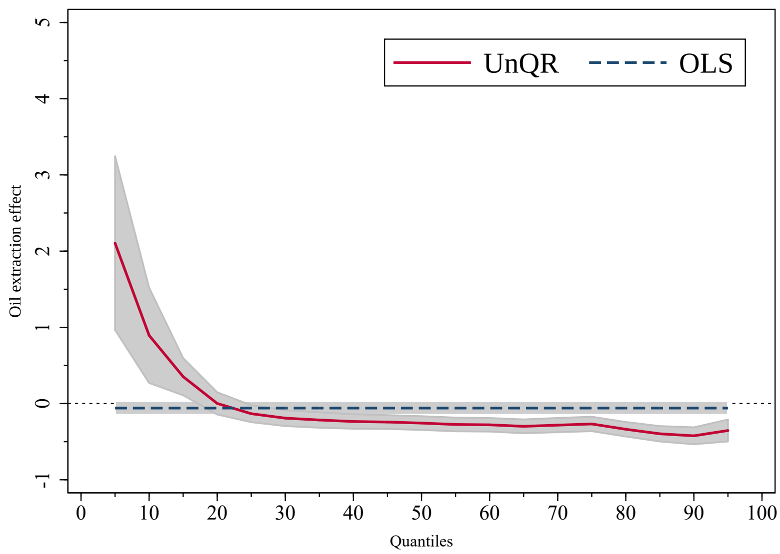
B. By localities

We estimate the impact separately for households living in rural and urban areas. There is a possibility oil extraction impact may differ depending on the location of a household in the treated districts. Majority of rural dwellers are farmers who are net consumers of their produce hence will spend relatively less on food items

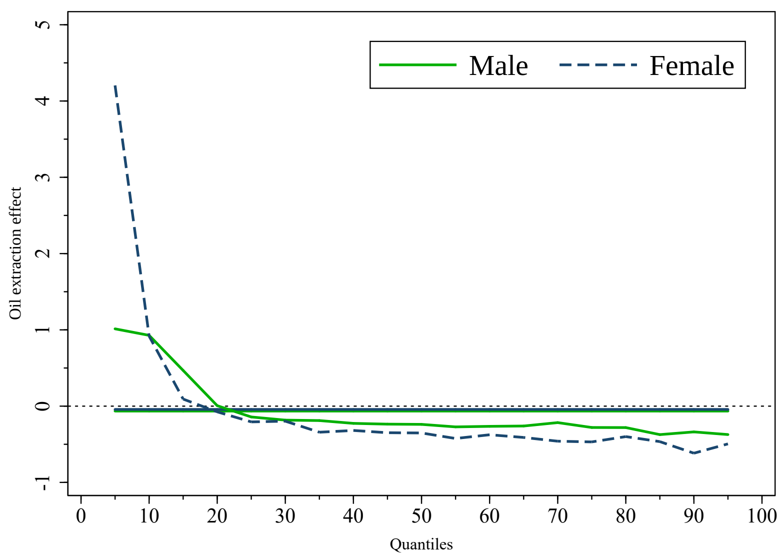
[9]There is a limitation in the available data, thus there is no data on price index for food and non-food items, making it difficult to examine oil extraction effect on real food and non-food expenditure

compared to rural dwellers. Figure C.5 in the Appendix ascertains this reasoning given a similar pattern of the oil impact on rural households expenditure share on food items. However, there are no significant difference between rural and urban dwellers with household expenditure share on non-food items, though the effect is higher for rural households.

Figure 4.6: Oil effects on expenditure

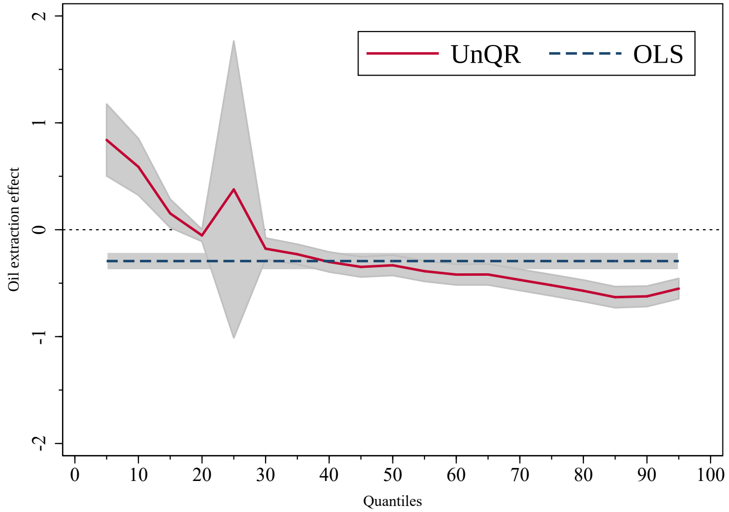


(a) Oil effect on expenditure

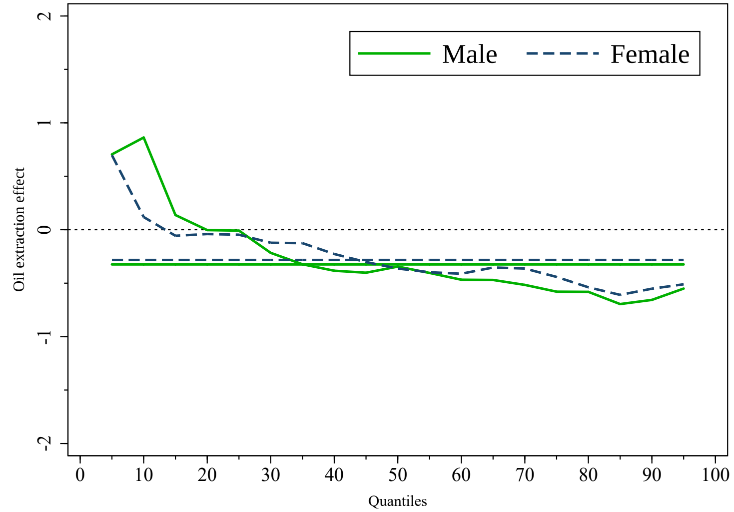


(b) Male vs. female headed households

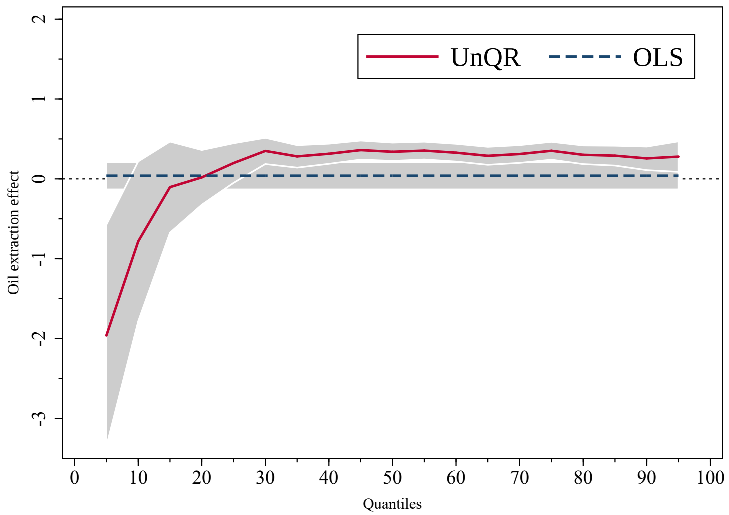
Figure 4.7: Oil effects on food (a and b) and non-food expenditure (c and d)



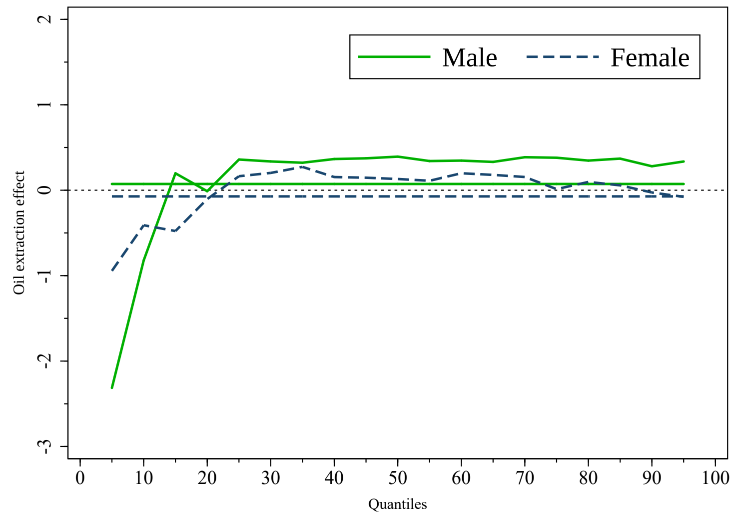
(a) Oil effect on food expenditure



(b) Male vs. female headed households

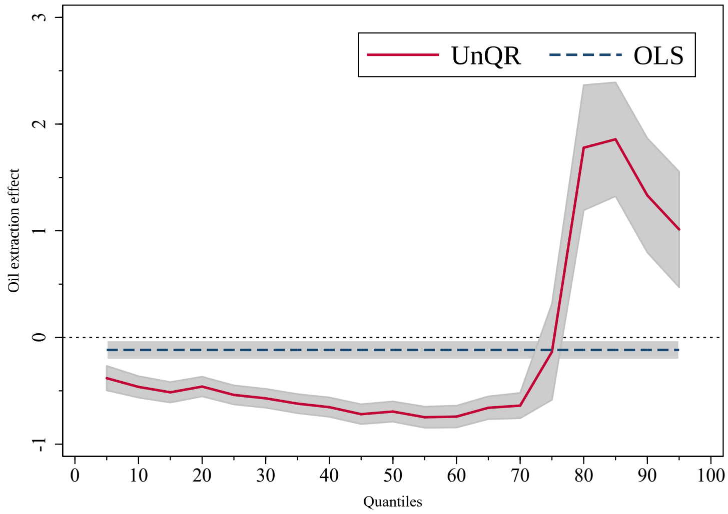


(c) Oil effect on non-food expenditure

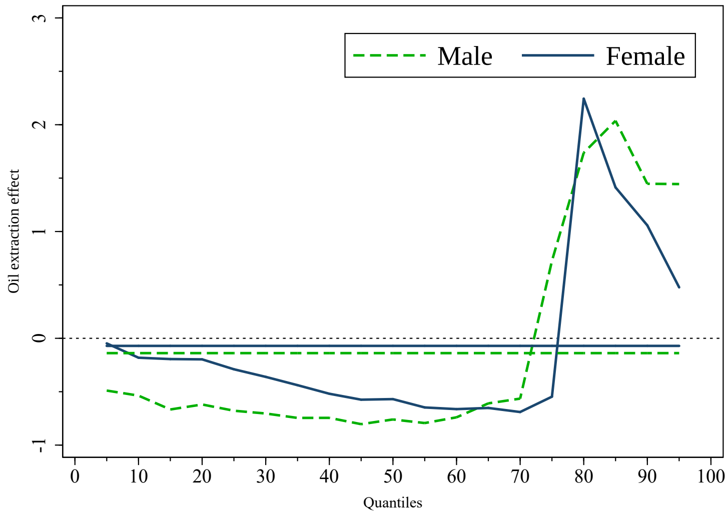


(d) Male vs. female headed households

Figure 4.8: Oil effects on real expenditure



(a) Oil effect on real expenditure



(b) Male vs. female headed households

4.5 Robustness Checks

4.5.1 Placebo Test

Identification of the oil extraction effect on the outcome variables rests on the parallel trend assumption. We test this using the surveys (1998 and 2006) prior to oil extraction. We use 2006 as a post-oil extraction year, interact it with our treated district indicator and estimate the oil effect on the outcome variables. Our expectation is that, with no oil, there should not be a significant difference between the treated and control districts or a significant difference but in same direction as the estimate post oil extraction. Table 4.5 presents the results and shows a

Table 4.5: Parallel trend test

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Expenditure (N=3,150)						
Districts X Post Oil_{2006}	-0.061	-0.340	0.156	0.106	-0.099	-0.277
	(0.054)	(0.150)	(0.132)	(0.081)	(0.082)	(0.193)
Real exp (N=3,150)						
Districts X Post Oil_{2006}	0.034	0.081	0.140	0.106	0.079	-0.073
	(0.052)	(0.099)	(0.085)	(0.074)	(0.071)	(0.098)
Controls	Yes	Similar controls for all quantiles				
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				

Note Bootstrapped standard errors with 500 replications in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

statistically insignificant placebo effect on average and at various quantiles of the outcome variables.

4.5.2 Intensive and Extensive Margins

We decompose the impact into extensive and intensive margin to find out whether the effect is largely driven by immigrants or natives in the treated districts. We examine 2 subsets of our sample; household that have stayed at most three (3) years and those stayed over three (3) years in a district. This decomposition is based on the fact that the post oil extraction survey is taken after 3 years. The estimates, presented in Table 4.6 show that households with at most three (3) years stay in the treated district had a less oil extraction impact on their expenditure than households with over 3 years stay. This shows that native households in the treated sample were largely affected than immigrants.

4.5.3 Accounting for Omitted Variables Bias

The omission of an important variable can affect the results. For example, the expenditure of households might depend on the industry in which the household head belong. Household head in agriculture sector may tend to spend differently

Table 4.6: Intensive and extensive margins of oil extraction impact

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Expenditure						
Baseline (N=12,433)						
Districts×Post Oil	-0.059	0.895***	-0.133**	-0.256***	-0.268***	-0.423***
	(0.045)	(0.319)	(0.057)	(0.046)	(0.048)	(0.057)
Stayed over 3 years (N= 11,316)						
Districts×Post Oil	-0.033	0.372	0.146	-0.082**	-0.131***	-0.241***
	(0.131)	(0.251)	(0.089)	(0.038)	(0.039)	(0.046)
Stayed within 3 years (N=774)						
Districts×Post Oil	-0.103	1.361	0.002	-0.358**	-0.511***	-0.490**
	(0.131)	(0.940)	(0.272)	(0.146)	(0.165)	(0.202)
Real expenditure						
Baseline (N=12,433)						
Districts×Post Oil	-0.117	-0.463***	-0.539***	-0.695***	-0.135	1.332***
	(0.109)	(0.051)	(0.045)	(0.048)	(0.229)	(0.273)
Stayed over 3 years (N= 11,316)						
Districts×Post Oil	-0.208*	-0.314***	-0.352***	-0.442***	-0.471**	0.401**
	(0.103)	(0.0464)	(0.0417)	(0.0416)	(0.198)	(0.181)
Stayed within 3 years (N=774)						
Districts×Post Oil	-0.263**	-0.459**	-0.292*	-0.403**	0.672**	-0.0633
	(0.0950)	(0.190)	(0.155)	(0.176)	(0.320)	(0.688)
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				
Controls	Yes	Similar controls for all quantiles				

Note: Each model includes each of the specified variable in addition to the baseline model. Stay length is the duration for which the household have been living in the district. We estimate separately for households with more than 3 years length stay and those with only 3 years. Bootstrapped standard errors with 500 replications in parentheses for quantiles. Clustered standard errors at the district level for OLS. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

from those in education or health sectors. We account for the reported industry of the household head and re-estimate our model. Table 4.7 presents the results and shows similar pattern as the baseline model after accounting for the industry in which the household head works.

Additionally, the place of birth of an individual may influence their expenditure which may not necessarily be as a result of the oil extraction. Individuals born in an area of relatively high living standard may spend more, and have the tendency to react differently to shocks. We account for this variable in our model with the industry control and re-estimate our equation. We find similar pattern as the baseline model though with a slight change in the magnitude of the estimates as presented in Table 4.7. These robustness checks show that different shocks pick up relevant variation but these are uncorrelated with variation across the distribution of our outcome variables from the oil extraction.

Table 4.7: Accounting for omitted variable bias

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Expenditure						
Baseline (N=12,433)						
Districts×Post Oil	-0.059	0.895***	-0.133**	-0.256***	-0.268***	-0.423***
	(0.045)	(0.319)	(0.057)	(0.046)	(0.048)	(0.057)
+Industry (N=12,433)						
Districts×Post Oil	-0.087	0.889***	-0.168***	-0.296***	-0.307***	-0.440***
	(0.083)	(0.318)	(0.058)	(0.046)	(0.048)	(0.056)
++Birth place (N=12,433)						
Districts×Post Oil	-0.0317	0.395*	0.116	-0.101***	-0.132***	-0.227***
	(0.124)	(0.240)	(0.083)	(0.036)	(0.037)	(0.044)
Real expenditure						
Baseline (N=12,433)						
Districts×Post Oil	-0.117	-0.463***	-0.539***	-0.695***	-0.135	1.332***
	(0.109)	(0.051)	(0.045)	(0.048)	(0.229)	(0.273)
+Industry (N=12,433)						
Districts×Post Oil	-0.149	-0.516***	-0.604***	-0.734***	-0.232	1.324***
	(0.103)	(0.052)	(0.046)	(0.048)	(0.225)	(0.273)
++Birth place (N=12,433)						
Districts×Post Oil	-0.201*	-0.344***	-0.319***	-0.383***	-0.089	0.269*
	(0.100)	(0.045)	(0.037)	(0.038)	(0.197)	(0.162)
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				
Controls	Yes	Similar controls for all quantiles				

Note: Each model includes each of the specified variable in addition to the baseline model. Industry controls specify where household head work and Birth place is a dummy indicating if the head is born in a district or not. Bootstrapped standard errors with 500 replications in parentheses for quantiles. Clustered standard errors at the district level for OLS. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

4.5.4 Migration

The oil boom has a possibility of not only affecting residents in the treated district but also in-migrants from across Ghana into the Western region. The identification threat to our estimate is when most migrants into the treated district, post oil extraction, are from the control group. This will contaminate our identification strategy. It is worth mentioning that we observe a high level of migration into the Western region prior to the oil extraction; about 40 percent but a reduction to 11 percent in the 2013 survey, with only 0.8 percent of households reporting to have migrated from the Greater Accra region. This indicates a smaller proportion of migrants from the larger control group (Ghana Statistical Service 2016).

Nonetheless, the findings are not influenced by a post oil extraction migration as we follow Guryan (2004) and examine a possible systematic effect of migration on our estimates. We use an indicator for migration status as a dependent variable and estimate a linear probability model with our difference-in-differences framework. As presented in Table C.9 in the Appendix, we find positive selection of households into our treated district but these are small in magnitude and not statistically different from zero. These results show that migration does not play any role in influencing the oil extraction effect on our outcome variables.

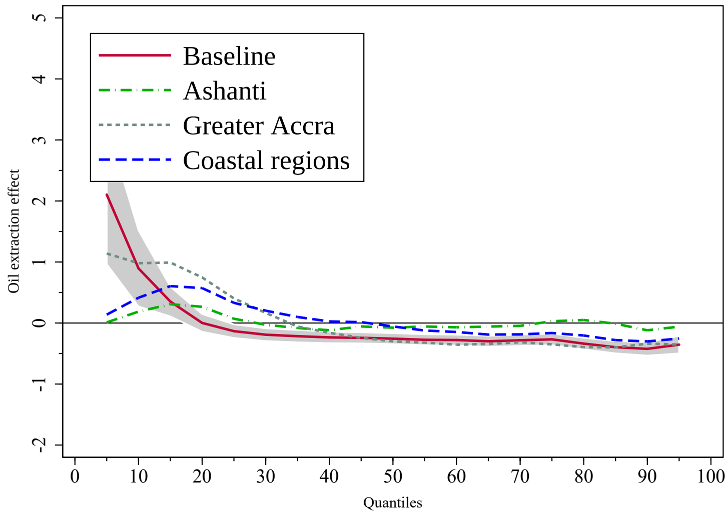
4.5.5 Alternative Treated and Control groups

Although a similarity of trends in both the treated and control districts before the extraction of oil is a necessary condition for the validity of our identification strategy, a growing Ghanaian economy would result in wrongly attributing the changes in the outcome to the oil extraction, therefore invalidating our strategy. Moreover, the choice of control group can influence the estimates above. We hereafter, estimate the oil effect using different control groups. We use the Greater Accra region as an independent control because it is considered as the most populous and has expenditure levels higher than other parts of Ghana. We also use households in districts in the Ashanti region given the commonalities in terms of occupation, ethnicity and linguistics to the treated districts as noted in the GLSS reports. We therefore re-estimate equation (4.7) with households in all districts of Greater Accra as a control group and also for Ashanti region. Figure 4.9 shows similar trend across quantiles qualitatively as the baseline estimates.

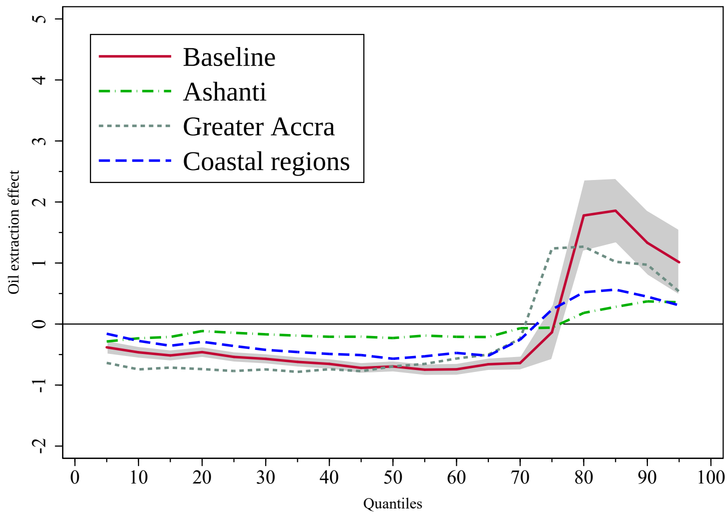
Considering treatment status is to households in districts at the coast of the Western region, we use other coastal regions- Greater Accra and Volta- as control group given a possible similarities in the pattern of expenditure. We re-estimate our model and present the results in Table C.7 and graphically in Figure 4.9. Qualitatively, we find similar results for the oil effect on expenditure as earlier but a significant positive effect only at the 25^{th} quantile.[10]

[10] We use all districts in the Western region as treated sample and re-estimate the model and find the estimates to be similar to the baseline model. This is presented in Figure C.6 in the appendix.

Figure 4.9: Oil effects to alternative treated and control districts



(a) Expenditure



(b) Real expenditure

4.6 Discussion and Conclusion

In this paper we examined oil extraction effect on the expenditure of households in Ghana. Using data from the Ghana Living Standard Survey, we assign treatment status to districts along the coast of Western region and use districts further away as control group. Employing an unconditional quantile estimation within a difference-in-differences framework, we find oil extraction effect on expenditure to be positive and significant for households at lower tails of the distribution (below the 20^{th} quantile). We also find negative oil extraction effects for households at higher tail of the distribution. Additionally, we find that the oil extraction impact on food share of expenditure is downward sloping but upward sloping for non-food share of expenditure. This shows that with a given shock, rich households perceive food items as inferior goods and non-food items as normal goods. With increasing price levels, the general wellbeing of poor households in the treated districts deteriorated with only the rich benefiting from the oil extraction. Our estimates show that examining the oil effect at the quantiles is much informative and aids in answering some theoretical questions pertaining to a shock on household expenditure.

The possibility of households increasing their expenditure as a result of the oil extraction shock stems from the possibility of an increase in income. Figure C.7 in the Appendix shows that income increased on average and also along the distribution beyond the 10^{th} quantile. However, the impact on income is noisy for poor households. Additionally, the variation along the distribution is not significantly different from the increase in average.

The mechanism through which we observe these impacts is the increased economic activity in the treated districts. With oil extraction in the area, residents find it as an opportunity to accrue wealth and engage in other beneficial activities. We test this mechanism by estimating the impact of oil extraction on household likelihood of having electricity and changes in their wealth status using the Demographic Health Survey (DHS) for Ghana. We use the 4^{th},5^{th} and 6^{th} rounds of the survey conducted in 2003, 2008 and 2014 respectively. Table 4.8 presents the difference-in-differences estimate using the same treated and control districts as the baseline model. Electricity is an indicator for whether households are connected to the national grid. Wealth index is a rank variable from 1 (poorest) to 5 (richest), which measures households' wealth. We redefine this index as Poor, Middle and Rich so as to observe the heterogeneous effect for these sub-groups.

Table 4.8: Oil extraction impact using DHS Data

			Wealth Index		
	Electricity	Wealth index	Poor	Middle	High
	(1)	(2)	(3)	(4)	(5)
Districts × Post Oil	0.097***	0.482***	-0.135***	-0.012	0.147***
	(0.024)	(0.041)	(0.007)	(0.005)	(0.007)
Observations	8,177	8,177	8,177	8,177	8,177
Controls	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes	Yes	Yes

Note: Electricity is an indicator for households connected to the national power grid. Wealth index is a rank variable from 1 (poorest) to 5 (richest). *Districts* and *PostOil* are indicators for Treated districts and post oil extraction period as defined in the baseline model. Controls include household size, type of residence of household, education and gender of household head. Robust standard errors clustered at district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

The new oil boom increased the likelihood of a household in the treated district getting connected to the national grid (column (1)). Th extraction also increased the wealth status of households, with a reduction in poor households to an increase of rich ones (columns (2-5)). These estimates compliments the heterogeneous impacts in the baseline model and show households were impacted positively as a result of the oil extraction.

The narrative from the baseline estimate shows that the extraction of oil had a positive impact on the wellbeing of richer households in districts closer to the extraction area but also came with it challenges for poor households. The unusual characteristics of the oil being light and sweet did not only result in an increase in income but also pollution of the water bodies resulting in increased cost of production for farmers, especially fish farmers.[11] The increased cost of production resulted in increase prices of mostly food items and lowered the welfare of residents in the districts. The effect of pollution from natural resource extraction is well documented

[11]See Deutsche Welle (2017)

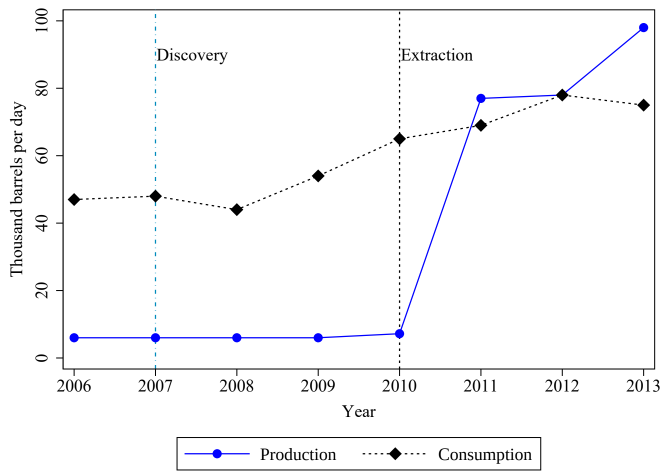
in Aragón & Rud (2015) who using the GLSS data found farmers in gold mining communities in Ghana to have lost almost 40% in total factor productivity. With the recent discovery of further oil deposits in Ghana, it is required that certain policies be put in place to ensure the wellbeing of residents are highly considered. The ability of the government to ensure extracting firms follow the needed regulations to actually reduce the amount of waste made and minimize the use of toxic inputs will help to ensure the wellbeing of residents.

The policy implication of the negative natural resources impact is that the increasing level of prices if not managed will consistently wipe away any significant benefit that will be gained from the natural resources. The government should put in place measures to maintain a stable currency such as regulating the level of importation, which largely contribute to the decrease in the value of the local currency.

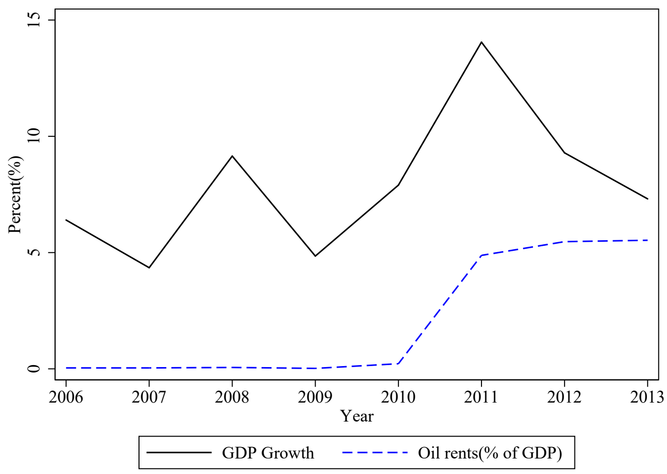
Notwithstanding our findings, there is a limitation to our study. The data used does not have information on household saving habit making it difficult to examine how much of the share of income was saved. Knowledge of this information will give a clearer understanding of household behaviour as a result of a shock.

Appendix C

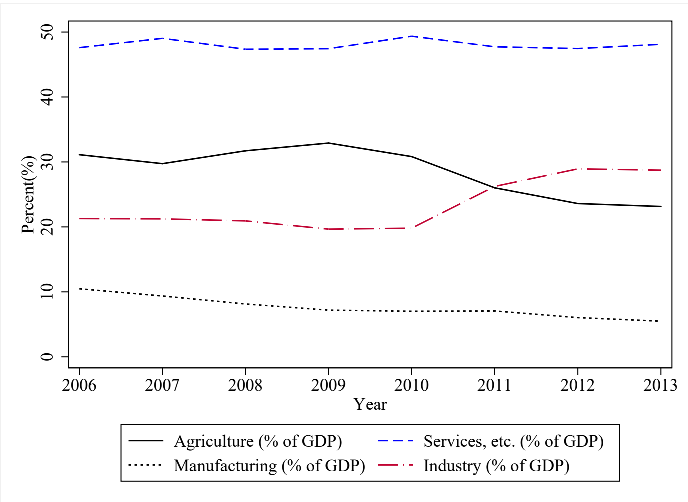
Figure C.1: Crude oil production, GDP growth and sector performance



(a) Crude oil production in Ghana

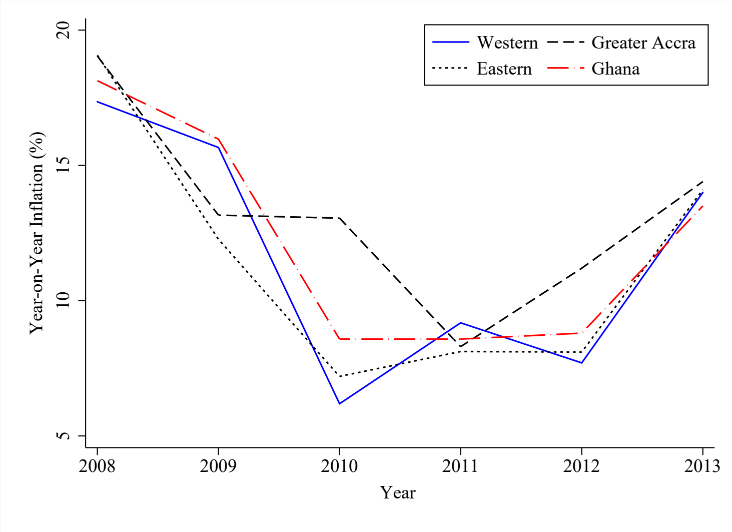


(b) GDP Growth and Oil rent Share

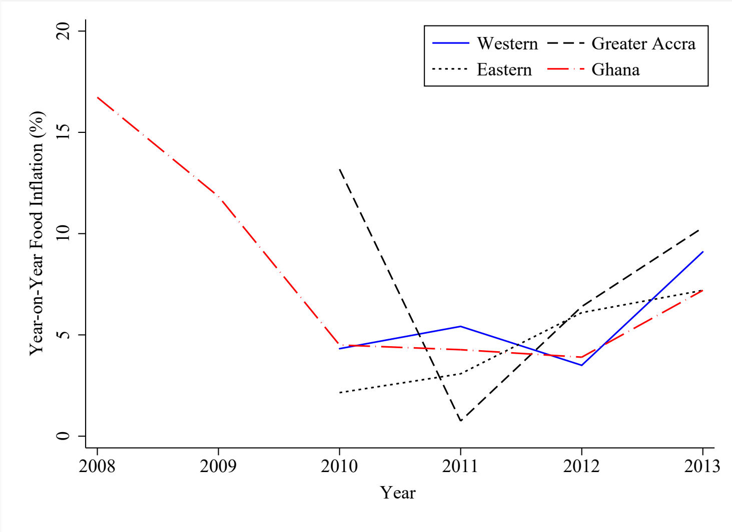


(c) Sector Share of GDP

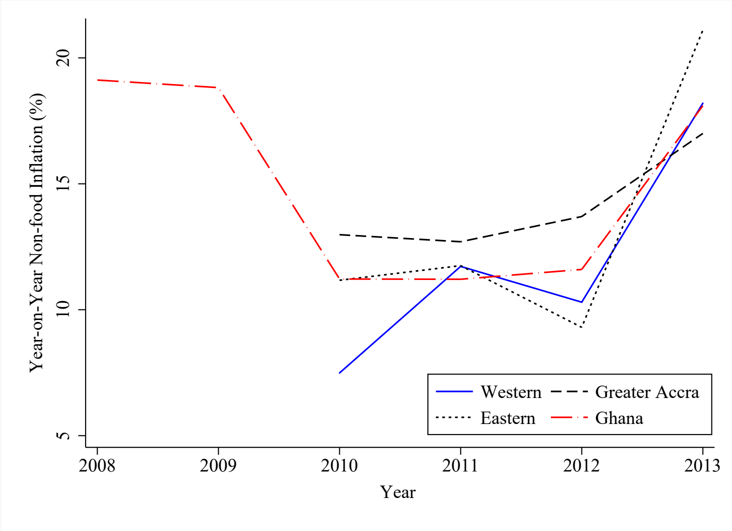
Figure C.2: Year-on-Year Inflation in Ghana



(a) Combined inflation

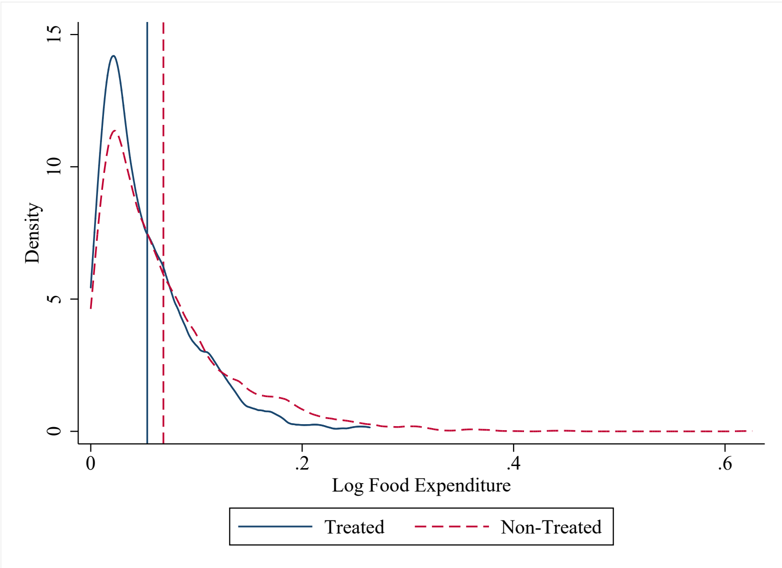


(b) Food Inflation

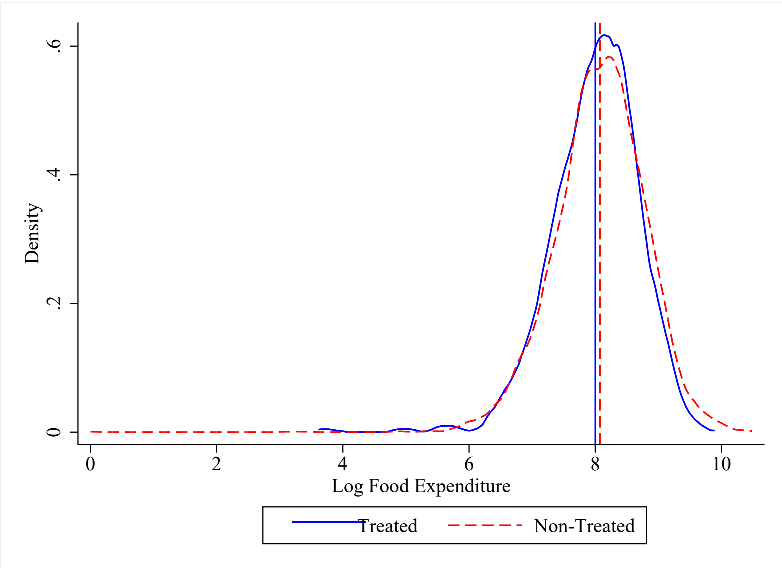


(c) Non-food Inflation

Figure C.3: Density of Food Expenditure Before and After Extraction



(a) Food Expenditure Before Extraction



(b) Food Expenditure After Extraction

Figure C.4: Distribution of Household Non-food Expenditure Before and After Oil Extraction

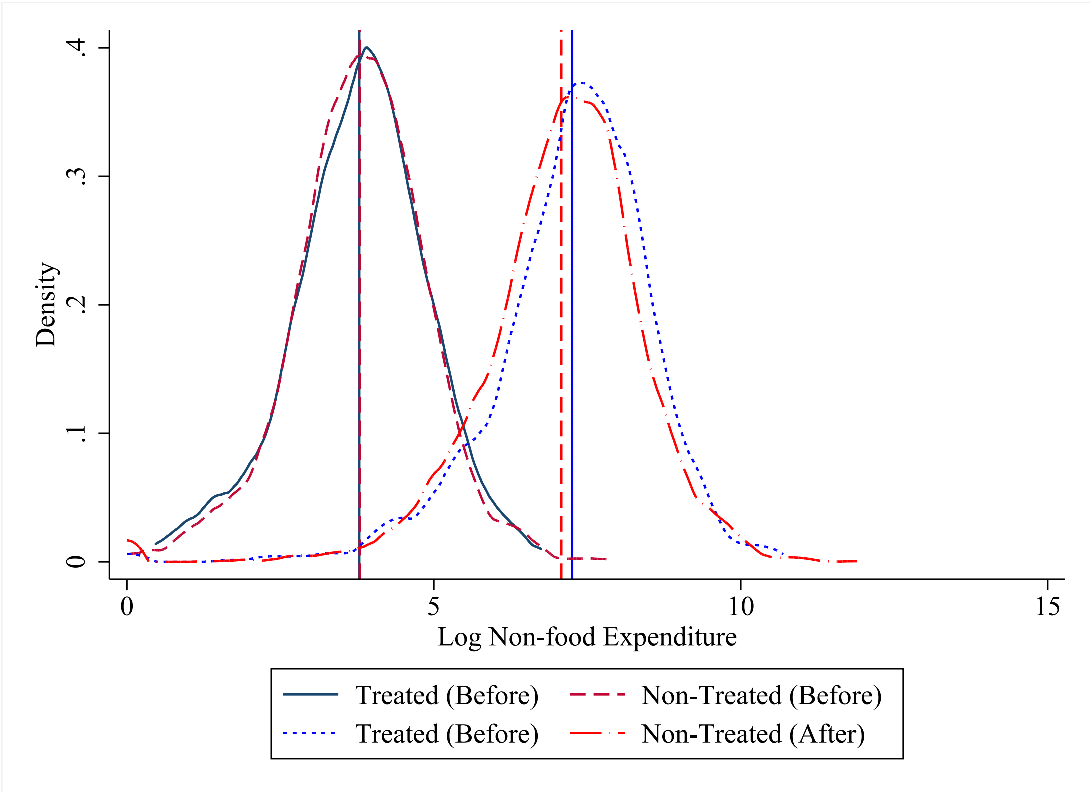
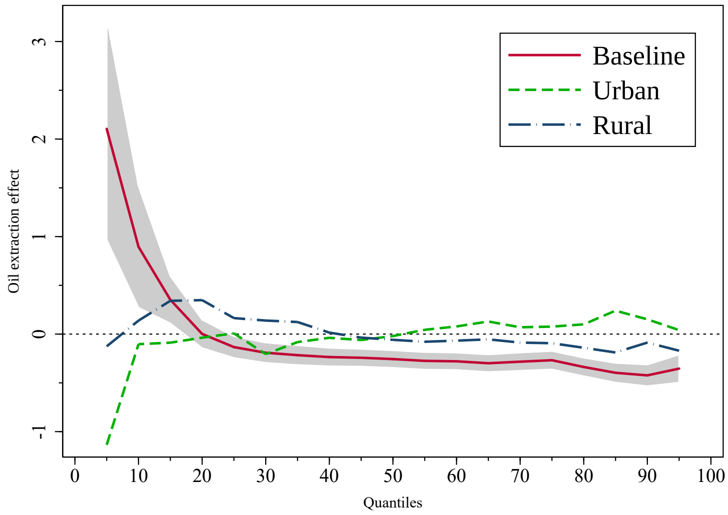
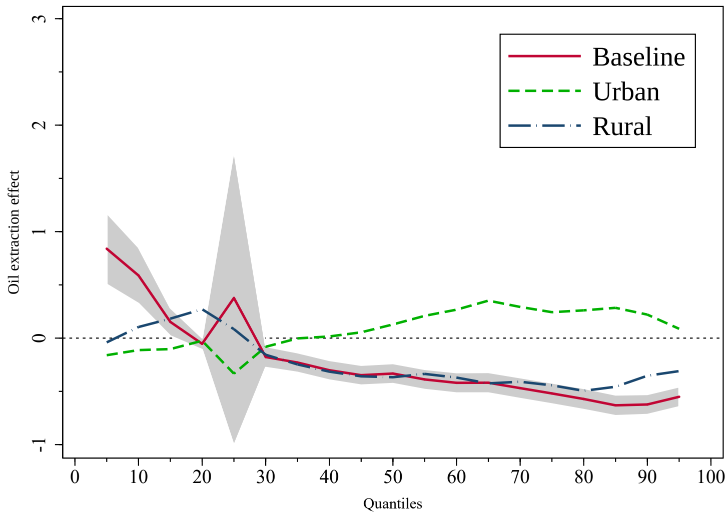


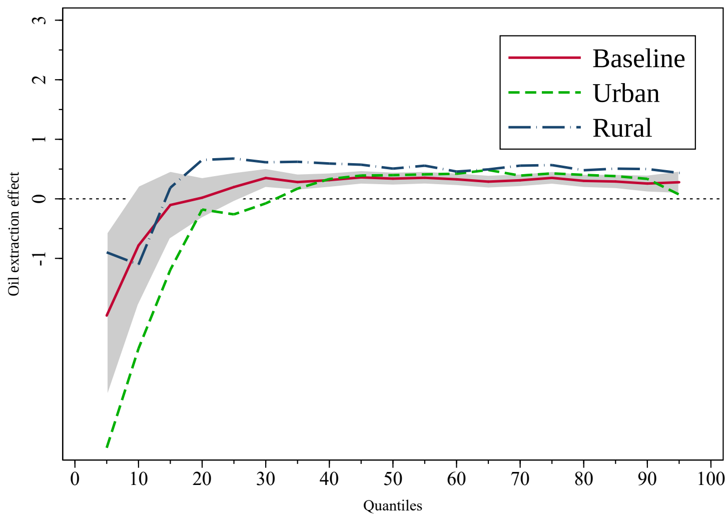
Figure C.5: Oil extraction effect across localities



(a) Oil Effect on Expenditure

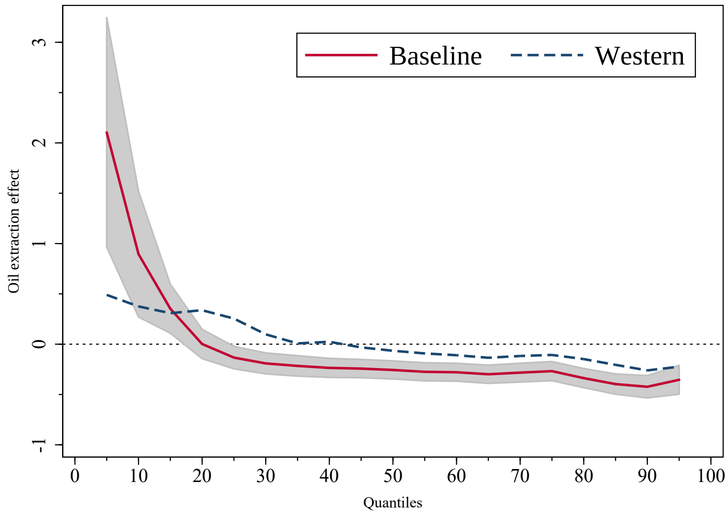


(b) Effects across food expenditure

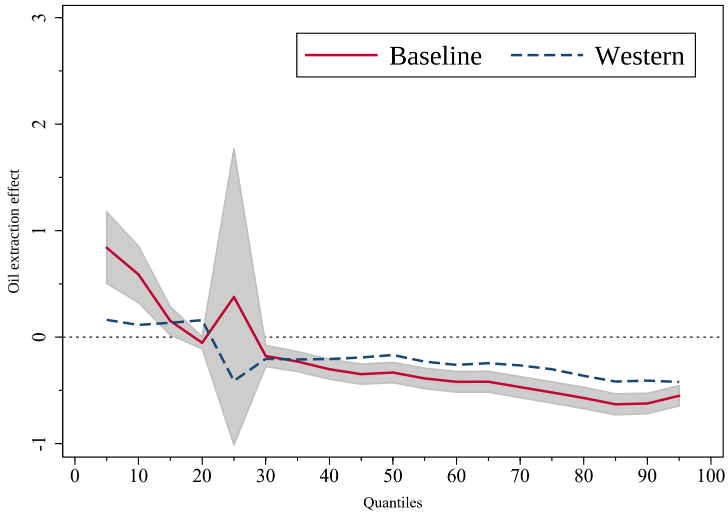


(c) Effects across non-food expenditure

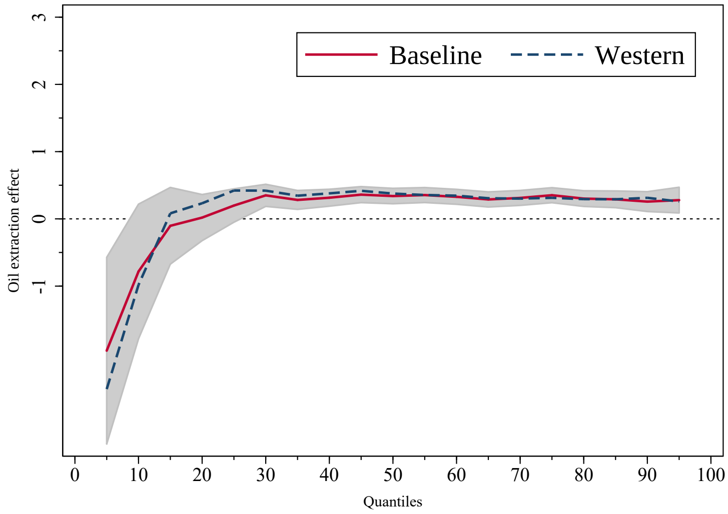
Figure C.6: Oil extraction effect in the Western region



(a) Oil Effect on Expenditure



(b) Effects across food expenditure



(c) Effects across non-food expenditure

Figure C.7: Oil effects on household income

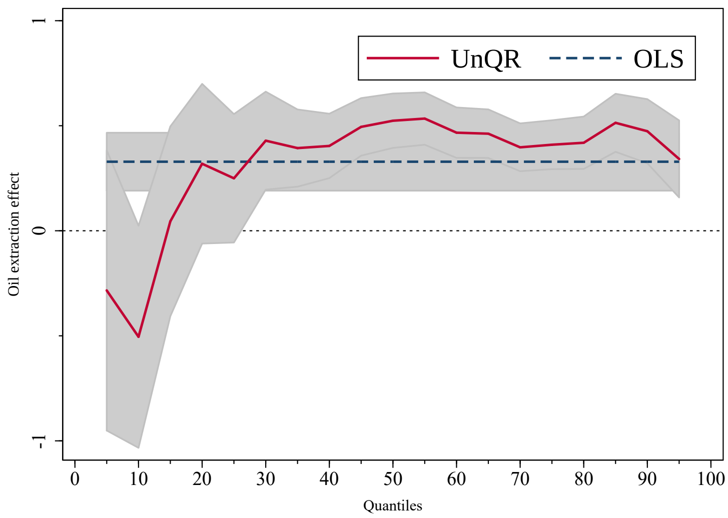


Table C.1: Key indicators of regions in Ghana

Indicators	Western	Eastern	Greater Accra	Central	Volta	Ashanti	Brong Ahafo	Northern	Upper East	Upper West
Pre-Oil extraction										
Mean household income (Ghc)	1,222	1,145	1,529	1,310	913	1,149	1,202	1,452	616	606
Sources of Household income (%)										
Wage	24.3	21.1	56.6	27.2	17.2	26.5	19.8	10.4	11.0	20.1
Agricultural	45.1	42.4	5.0	37.7	40.4	20.9	56.5	68.5	56.9	50.1
Sel-employment	21.1	28.1	24.3	26.1	29.9	34.3	15.5	13.8	26.1	20.8
Other	9.4	8.4	14.2	9.0	12.5	18.3	8.2	7.3	6.0	9.0
Mean household expenditure per capita (Ghc)	393	379	544	464	272	410	443	296	124	106
Proportion of educated adults (%)	78.0	77.0	88.5	78.1	72.3	80.6	68.9	28.0	30.9	29.9
Proportion of Household expenditure (%)										
Food	53.4	58.0	38.7	53.7	57.7	46.6	55.4	64.4	63.5	55.9
Non Food	44.7	40.3	57.1	44.3	40.2	51.4	42.8	33.8	34.3	41.4
Other	1.9	1.7	4.2	2.0	2.1	2.0	1.8	1.8	2.2	2.7
Mean Household size	3.9	3.7	3.4	3.6	4.0	3.9	4.1	5.5	5.3	6.5
In Migration (%)	23.7	21.3	28.9	28.9	31.45	31.65	22.4	17.7	8.25	12.95
Return Migrant (%)	28.25	30.45	29.65	29.65	27.9	23.6	27.6	20.9	32.2	16.35
Non Migrants (%)	48.05	48.3	41.4	41.4	40.65	44.8	50	61.4	59.5	70.65
Post-Oil extraction										
Mean household income (Ghc)	9,529	7,838	13,303	8,133	8,217	9,489	8,154	7,153	6,210	5,991
Sources of household income (%)										
Wage	25.2	22.4	27.2	59.7	16.6	39.8	31.7	8.5	24.4	23.3
Agricultural	11.1	30.8	7.5	6.6	7.6	4.1	11.9	31.8	14.4	4.6
Sel-employment	43.6	33.4	51.2	22.1	39.8	43.2	35.0	33.2	19.9	57.7
Other	20.1	13.4	14.1	11.6	54.7	12.9	21.4	26.5	41.3	14.4
Mean Household expenditure (Ghc) per capita	3,119	2,555	4,875	2,825	2,508	3,318	2,511	1,790	1,753	1,476
Proportion of educated adults (%)	84.3	83.9	90.4	79.1	74.1	84.7	72.7	38.2	50.4	51.7
Proportion of Household expenditure (%)										
Food	45.3	47.8	42.0	50.9	54	45.9	46.7	52.5	55.3	50.5
Non Food	45	41.5	41.6	38.4	36.3	42.7	42.8	32.9	35.3	38.7
Other	9.7	10.7	16.4	10.9	9.7	11.4	10.5	14.6	9.4	10.8
Mean Household size	4.0	4.1	3.8	3.8	4.3	3.7	4.3	5.4	4.5	5.5
In Migration (%)	11.1	11.3	38.9	24.3	15.6	10.8	18.5	5.8	5.4	4.6
Return Migrant (%)	41.7	39.7	20.7	20.3	39.7	38.6	31.4	29.3	24.7	27.5
Non Migrants (%)	47.2	50.3	40.4	55.4	49	50.6	50.1	64.9	69.9	67.9

Note: Figures are from the 1998, 2006 and 2013 rounds of the GLSS reports by the Ghana Statistical Service. Pre-Oil extraction figures are averages of 1998 and 2006 rounds. Non food expenditure include expenditure on clothing, housing, water, electricity and gas, furnishing, household equipment and maintenance, health, transport, communication, education, recreation and culture.

Table C.2: Proportion of Household

	Male	Female	Total
Expenditure	8,956	3,658	12,614
Food Expenditure	8,956	3,658	12,614
Non Food Expenditure	7,472	3,169	10,641

Table C.3: Descriptive Statistics

	Obs.	Mean	Std dev	Min	Max
Pre-Oil extraction					
Outcome variables					
Log expenditure	14,633	6.6250	1.0686	1.0986	11.0045
Log food expenditure	14,633	0.0487	0.0488	0	0.625737
Log non-food expenditure	5,973	3.4725	1.0786	0	7.8776
Controls					
Log age$_{head}$	14,633	3.7607	.3441	2.7081	4.5951
Log age sq.$_{head}$	14,633	14.2611	2.5816	7.3334	21.1151
Log completed years of education$_{head}$	8,975	0.7950	0.7512	0	2.7725
Log household size	14,633	1.2121	0.7248	0	3.3673
Marital status$_{head}$	14,633	0.62421	0.4843	0	1
Post-Oil extraction					
Outcome variables					
Log expenditure	33,460	8.7467	0.7664	4.7740	11.9178
Log food expenditure	33,460	7.7700	0.8421	0	10.4848
Log non-food expenditure	33,544	6.8645	1.3510	0	13.9006
Controls					
Log age$_{head}$	33,460	3.7653	0.3486	2.7081	4.5951
Log age sq.$_{head}$	33,460	14.2994	2.6211	7.3335	21.1151
Log completed years of education$_{head}$	33,460	1.9942	0.4213	1.6094	2.7725
Log household size	33,460	1.2191	0.7217	0	3.3672
Marital status$_{head}$	33,460	0.6749	0.4684	0	1

Note: Expenditure values in the 1998 and 2006 surveys were divided by 10,000 in order to make them comparable to the re-denominated currency in 2013. see Bank of Ghana (2007). Marital status is a dummy of 1 if household head is married and zero if otherwise.

Table C.4: Conditional quantile estimate of oil extraction impact on outcome variables

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Expenditure						
Districts X Post Oil	-0.059	1.244***	1.381	1.367	1.393	1.494
	(0.045)	(0.096)	(0.063)	(0.054)	(0.058)	(0.088)
Observations	12433	12433	12433	12433	12433	12433
Real exp						
Districts X Post Oil	-0.117**	-0.017**	0.003	0.057	0.096	0.225***
	(0.046)	(0.087)	(0.068)	(0.061)	(0.062)	(0.086)
Observations	12433	12433	12433	12433	12433	12433
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				
Controls	Yes	Similar controls for all quantiles				

Note: Conditional quantile estimates following Koenker & Bassett Jr (1978). Bootstrapped standard errors with 500 replications in parentheses ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table C.5: Using Districts in Greater Accra as Control

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Expenditure						
Districts X Post Oil	0.019	0.980***	0.404***	-0.300***	-0.350***	-0.339***
	(0.159)	(0.244)	(0.097)	(0.039)	(0.038)	(0.043)
Observations	8,163	8,041	8,041	8,041	8,041	8,041
Real exp						
Districts X Post Oil	-0.211	-0.743***	-0.769***	-0.694***	1.238***	0.972***
	(0.130)	(0.053)	(0.044)	(0.042)	(0.196)	(0.148)
Observations	8,163	8,163	8,163	8,163	8,163	8,163
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				
Controls	Yes	Similar controls for all quantiles				

Note: Bootstrapped standard errors with 500 replications in parentheses ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table C.6: Using Sekondi-Takoradi and Accra as Treated and Control group

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Expenditure						
Sekondi-Takoradi × Post Oil	-0.296***	0.892	1.192***	-1.457***	-1.021***	-0.710***
	(0.000)	(0.806)	(0.164)	(0.117)	(0.085)	(0.079)
Observations	3277	3277	3277	3277	3277	3277
Real exp						
Sekondi-Takoradi × Post Oil	-0.288***	-2.821***	-1.600***	-0.819***	4.202***	2.214***
	(0.001)	(0.153)	(0.098)	(0.077)	(0.567)	(0.203)
Observations	3277	3277	3277	3277	3277	3277
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				
Controls	Yes	Similar controls for all quantiles				

Note: Sekondi-Takoradi district is the treated group with Accra as the control group. Bootstrapped standard errors with 500 replications in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table C.7: Using Districts in Central, Greater Accra and Volta as control group

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Expenditure						
Districts X Post Oil	-0.013	-0.077	0.216**	0.024	-0.013	-0.198***
	(0.119)	(0.265)	(0.090)	(0.037)	(0.035)	(0.042)
Observations	16,227	16,227	16,227	16,227	16,227	16,227
Real exp						
Districts X Post Oil	-0.136	-0.178***	-0.187***	-0.312***	-0.193	0.177***
	(0.086)	(0.042)	(0.039)	(0.040)	(0.169)	(0.159)
Observations	16,227	16,227	16,227	16,227	16,227	16,227
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				
Controls	Yes	Similar controls for all quantiles				

Note: Control group includes districts in Central, Greater Accra and Volta regions. Bootstrapped standard errors with 500 replications in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table C.8: Using districts in Ashanti as control group

		Quantiles				
	OLS	0.1	0.25	0.5	0.75	0.9
Expenditure						
Districts X Post Oil	0.004	0.187	0.070	-0.076**	0.030	-0.119***
	(0.114)	(0.250)	(0.104)	(0.038)	(0.039)	(0.044)
Observations	8,409	8,409	8,409	8,409	8,409	8,409
Real exp						
Districts X Post Oil	-0.085	-0.233***	-0.143***	-0.299***	-0.059	0.372**
	(0.060)	(0.047)	(0.044)	(0.043)	(0.162)	(0.155)
Observations	8,409	8,409	8,409	8,409	8,409	8,409
Year fixed effects	Yes	Yes, for all quantiles				
Districts fixed effects	Yes	Yes, for all quantiles				
Year*Region fixed effects	Yes	Yes, for all quantiles				
Controls	Yes	Similar controls for all quantiles				

Note: Districts in Ashanti region are control group. Bootstrapped standard errors with 500 replications in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table C.9: Accounting for Migration

	(1)	(2)	(3)	(4)
Districts×Post Oil	0.0908	0.0402	0.0383	0.00402
	(0.101)	(0.0491)	(0.0409)	(0.0246)
Districts	-0.0136	0.00249	-0.00568	-0.00142
	(0.0622)	(0.0346)	(0.0346)	(0.0244)
Post Oil	-0.0738**	-0.0540**	-0.0662**	0.0437***
	(0.0344)	(0.0239)	(0.0251)	(0.00961)
Control	Baseline	Add industry	Add Place of Birth	Add length of stay
Year fixed effects	Yes	Yes	Yes	Yes
Districts fixed effects	Yes	Yes	Yes	Yes
Year*Region fixed effects	Yes	Yes	Yes	Yes
Observations	12614	12614	12614	5908
Adjusted R^2	0.121	0.502	0.529	0.046

Note: Column (1) includes the baseline controls. We add industry control in column (2), place of birth and length of stay in districts in columns (3) and (4) rspectively. Clustered standard errors at the district level in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

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Chapter 5

Concluding Remarks

Do oil extraction have socio-economic impact on developing economies? This thesis aimed to establish this fact by using a recent oil extraction in Ghana. The thesis comprises of three chapter each of which aims to answer the aforementioned question.

The first chapter examines the Single Spine Pay Policy, which was made possible by the revenue received from the oil extraction. The policy aimed to reduce the wage disparity in the public sector and increase productivity. The findings from this study are that the policy reduced public-private wage differential but only at low end of the distribution. These gains are largely for women and workers in the education and health sectors. However, the beneficiaries of the gains rather reduced their productivity, measured as hours supplied.

The second chapter investigates the spillover effects from oil extraction to non-oil local labour markets. The study finds positive spillovers on income of residents and migration to districts closer to the extraction site. However, there is a negative spillover on employment. These spillover effects decrease with the distance an individual is from the oil extraction area. The effects are also heterogeneous across gender and sector of the residents. Men and agriculture workers had a high positive income spillovers while migrants were mostly women and retail workers. Employment were largely negative but positive in the manufacturing sector.

The third chapter examines the oil extraction effect on the well-being of households. The study uses household expenditure as a proxy measure of well being and find poor households to have a positive oil effect on their expenditure whereas rich households had a negative oil extraction effect. The heterogeneity in these effects is also observed for household expenditure share on food and non-food items. Poor household expenditure were largely on food items whereas rich households spent largely on non-food items. The effects are only recognisable for rich households when price is accounted for in the estimation.

These findings show that there is a heterogeneous effect of oil extraction in developing economies and examining the effect at the micro level show socio-economic impact on individuals and households.