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Uncovering Norway's regional disparities with respect to natural riches*

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Abstract. This study investigates regional development differences in the natural resource-based activities that take place in Norway's NUTS 3 regions. Norway's natural riches range from agricultural and forest resources to fisheries, mines, petroleum, and gas. Considering the possible spatial links among regional characteristics of the Norwegian economy, this study not only reveals the wide-ranging distribution of resource-based activities, but also sheds light on divergent income and population patterns in the Norwegian regions. These patterns are investigated through a number of fixed and random effects panel data models that test the impact of employment, investment, and value added in natural resource sectors on regional differences for the period 1997–2007. The main findings suggest that mining and quarrying, as well as oil and gas extraction activities, generate significant advantages for regional income generation and population density depending on employment, investment, and value added of the industries. Additional analysis indicates that oil and gas extraction activities also have some influence on the growth of population density – unlike other resource-based activities in Norway.

JEL classification: Q32, O13, R12, C23

Key words: natural resources, panel data analysis, regional development, resource curse

1 Introduction

The role of natural resources in economic development and sustainability has gained increasing scholarly attention in recent decades due to the diverging experiences of resource-based economies. While some resource-rich countries such as Australia, Canada, Norway, and New Zealand succeed in utilizing their resource revenues efficiently and have achieved high levels of per capita income, others remain less developed and have ended up in the "resource curse".

The "resource curse" signifies a situation where a resource-rich country is subject to slow economic growth rates in comparison to a resource-poor country. This primarily stems from three factors (Auty 1993): the volatility of resource revenues (especially in

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the case of point-source resources), crowding out of manufacturing due to Dutch Disease effects, and institutional defects (e.g. corruption, political instability, lack of rule of law). Furthermore, the influence of misused natural resource wealth is visible both on income-related measures and on other socioeconomic indicators, such as employment patterns, population distribution, inequality and, democratization. Additionally, these effects can be region-wide and countrywide. Nevertheless, the regional development implications of natural resource-richness within a country have been less of a concern than cross-country comparisons (Auty 1993, 2001, 2007, Sachs, Warner 1997, 1999).

Within the above context, this study sets to unbundle regional development differences in Norway by utilizing a set of panel data models. It accounts for varying levels of natural resource activity in each Norwegian region for the period of 1997–2007. Having escaped the resource curse, Norway is frequently cited as one of a few successful examples among natural resource-abundant countries. This success is usually attributed to its favorable institutions, which are deeply rooted in the country's history. Nonetheless, it is worth examining whether the oil- and resource-rich regions perform better in economic terms than their non-oil (non-resource) counterparts in the rest of the country. The presence of a regional resource curse might bear negative outcomes for local economies, triggering divergence between regions. To the best of our knowledge, Norwegian regional development has not been comprehensively investigated with respect to regional resource activities.

In line with these arguments, we aim to answer whether the abundance of and/or reliance on specific resources in Norwegian regions brings along special advantages or disadvantages for each region's development. For instance, what consequences does the oil-related economy in the Vestlandet generate for regional income growth, diversity of economic sectors, employment patterns, and investment? Do the rich fish resources and related fishing activity in Nord-Norge enable a sustainably functioning economy in the region without bearing any resource curse symptoms? Are all resource types equally important and effective in promoting regional development, and successful in constructing industrial linkages, or are there specific resources in the Norwegian economy that facilitate higher income growth? These central research questions are first investigated through descriptive analysis. Given the possible links for various regional characteristics of the Norwegian economy, we believe that observing the spatial distribution of resource-related activities will challenge earlier remarks on regional disparities and shed light on the externalities and spatial spillovers realized within the territory of Norway. Next, these patterns are examined by estimating a number of models that test the impact of natural resources on regional differences in Norway.

The outline of the paper is as follows: Section 2 summarizes theoretical debates and the literature regarding the link between natural resource abundance and level of economic activity. Following this, Section 3 scrutinizes how regional economic activity and population is dispersed in Norway, and to what extent this pattern is similar to the spatial dispersion of resource-based production. Here, employment potential, investment, and value added in the related sectors will be investigated at the local level. The initial notion of regional differences in economic activity level and natural resource dispersion leads to Section 4. This section provides the results of the panel data models testing the impact of natural resources on regional differences in Norway. Finally, Section 5 concludes the study.

2 Theory and literature review

A vast scholarly literature investigates the implications of resource abundance for economic development. Earlier studies focus on the resource abundance-economic growth nexus that links to the development of staple economies – which relied heavily on the trade of raw materials and staples. In an effort to understand Canadian economic development, Innis (1930, 1956) argues that it was the export of codfish, fur, lumber, agricultural products, and minerals to European countries that accelerated the country's economic growth in the 1920s and 1930s because of the spread effects of the export sectors.[1] In time, high reliance on commodity exports was criticized. Because commodity prices and raw material supplies are highly volatile, a resource-dependent country might fall into a development trap that may be difficult to escape unless strong linkages with the rest of the economy are formed (Watkins 1963).

In a similar vein, export base theory regards economic development as a process of diversification around an export base, looking into interdependencies among production sectors of a local economy. This theory argues that input and output relationships among sectors are crucial for export base development. Baldwin (1956) explains differential growth in regions with respect to differing natural resource endowments, examining the US in the nineteenth century. Accordingly, when the economy specializes in staples production (such as sugar, cotton, or mines), backward and forward linkages remain limited. There are two reasons for this limited scope: First, inputs other than labor are generally imported. Second, staples are usually processed outside the country, leaving less room for diversification.

Examining the diverging economic performances of Latin American countries, Prebisch (1950) finds that "peripheral" countries are impoverished relative to developed "center" countries. This relative impoverishment arose from the rising trade imbalance that occurred because of the export of agricultural products and natural resources from developing countries to the developed world. During that time, developed center countries continued exporting finished industrial goods to the developing world. Prebisch (1950) identifies the need for industrialization in the periphery as a solution to this imbalance. Similarly, Singer (1950) attributes the long-term trade deterioration in underdeveloped countries to the relatively declining prices of their primary product exports compared to the prices of manufactured imported goods. Additionally, the demand for primary products did not rise as rapidly as the demand for manufactured goods. Thus, Prebisch (1950) and Singer (1950) argue that a deviation from exporting only minerals and other primary products was necessary to establish a basis for the production of manufactured goods. This secular decline in the prices of internationally traded primary commodities against manufactured goods is known as the Prebisch-Singer hypothesis (Ocampo, Parra 2003).

In the 1970s, oil exporters' experiences that followed the first oil shock attracted attention. Windfall profits from oil exports were no longer considered good for exporters' economic development (Mabro, Monroe 1974, Neary, van Wijnbergen 1986). Furthermore, the Dutch Disease experience of the Netherlands following the discovery of Groningen gas raised concerns on the effects of a huge currency inflow. This inflow, due to gas exports, lead to the appreciation of the national currency, making non-resource sectors less competitive than the resource sector, and also resulting in the contraction of manufacturing sectors (Corden, Neary 1982).

More recent explanations on the resource curse relate to the decline of resource-dependent countries and to institutional mechanisms, such as the role of corruption, rent-seeking, and lack of democratic governance (Auty 2001, Brunnschweiler 2008).[2] Resource-rich countries tend to have relatively autonomous governments, do not have to generate other sources of income, and are less accountable to their citizens. There are few exceptions (such as Norway and Botswana), which have experienced desirable economic outcomes and avoided the resource curse. In addition, scholars note that not all types of resources bear similar outcomes. For instance, Auty (1997) argues that "point source" resources (i.e. plantation crops and minerals) are more likely to have negative impacts than "diffuse" natural resources (i.e. rice, wheat, and animals) have on economic performance. In return, this relates to reasons such as "the landholding system, the type of political state, the choice of development strategy and economic performance" (Auty 1997, 651). Furthermore, Woolcook et al. (2001) stress that the state has to rely on a small

[1] A key characteristic of the staples theory (in its original Canadian context) was that Canada was/is a large country, with many regionally distinct resource clusters. Therefore, not only did exports to Europe foster economic growth, but they also firmly established regional resource-based economies in a fairly decentralized way. This has both defined and developed the Canadian regions, which in turn shaped the country's institutions.

[2] For comprehensive surveys on the resource curse, see Deacon (2010) and Frankel (2010).

fraction of owners, i.e. rentier capitalists, while trying to generate income and collect taxes within the context of highly concentrated ownership of oil, hard minerals, and plantation crops. Moreover, the production of point source resources is generally capital-intensive, and has the potential to increase the polarization of a society along the allocation of capital and labor. Analyzing the export structure of various economies, Isham et al. (2005) highlight that "point source- and coffee and cocoa-exporting countries do relatively poorly across an array of governance indicators" (Isham et al. 2005, 141). This result is attributed to three channels: 1) the relationship between the structure of economic production and quality of government; 2) natural resource production characteristics, such as the geographic pattern and the degree of diversification of natural resource exports; 3) institutional quality and vulnerability to shocks. In line with these characteristics, the authors regard point source resources as "far more susceptible to capture" (Isham et al. 2005). In sum, it is argued that countries relying on diffuse natural resource exports, such as livestock and agricultural production in small family farms, are less prone to the adverse effects and thus, they are more likely to have better growth performances.

In particular, abundance in oil is worth examining due to great volatility in oil prices and global oil supply-demand relations, creating implications for states'/countries' economic performances. Volatility might be detrimental for economies due to a number of reasons. First, cyclical shifts of factors of production (i.e. labor and capital) across different sectors, such as the petroleum sector and other manufactured goods sectors, pave the way for high transaction costs (Frankel 2010). Accordingly, it is also costly to adjust monetary and fiscal policies. Second, oil has given rise to violence and conflict among and within many oil-rich countries. A number of studies demonstrate that a high dependence on oil proceeds correlates with civil war (see Collier, Hoeffler 2004, Humphreys 2005, Collier 2007). In addition, Sala-i Martin, Subramanian (2003) argue that "oil and minerals give rise to massive rents in a way that food or agricultural resources do not." Thus, they indicate a robust negative impact of oil on growth via its detrimental effect on institutional quality.

From a regional development perspective, Goldberg et al. (2008) and Freeman (2009) link the economic development of individual states in the US with natural resource intensity in order to investigate the existence of a resource curse. Both studies demonstrate that higher resource dependence results in poorer economic growth, worse developmental performance, and less competitive politics in the US states. These results not only indicate an economic resource curse but also a political one. Similarly, Carson (2009) looks at the relationship between regional development/underdevelopment and natural resource reliance. He studies Australia's Northern Territory as a highly resource-abundant region and Australia as a whole. His findings show that the Northern Territory suffers more due to a lower concentration of employment and higher levels of population mobility than Australia as a whole. A study conducted by Acar, Zola (2012) questions how and why the northern part of Sweden has been lagging behind other Swedish regions in terms of income growth and population growth. This study illustrates the existence of a regional curse, when the effects of employment shares in agricultural resources on gross regional product (GRP) are considered. However, they find limited evidence on the negative impact of mining and quarrying on GRP. They attribute the possible causes of the regional curse to lower degree of diversification in the resource-reliant regions, lower linkages with the other sectors in the regional economies and over-confidence of political bodies in natural resources. Furthermore, they find that mining has a negative impact on regional attractiveness, measured by population growth. This finding may stem from the fact that in Sweden, the mining industry is highly capital-intensive and less labor demanding.

Few studies focus on Norwegian regional inequalities. Among those, Rattsø, Stokke (2011) focus on regional income growth in Norway and investigate dynamic agglomeration effects during the period of 1972–2008. They claim that the regional differences in income growth are rooted in the heterogeneity of economic activities in each local municipality. They argue that small regions with resource-based activities such as oil extraction, electricity production, and salmon production have experienced substantial growth. From another perspective, Borge et al. (2012) highlight the close affinity between local resource curse and institutional bottlenecks. They test the paradox of plenty hypothesis (i.e. resource curse hypothesis) and rentier state hypothesis by examining the Norwegian municipalities in terms of their income derived from hydropower. Their main argument is that exploitation of natural resources may have different implications for efficiency. Here, they use the ratio of six service sectors' available resources as an efficiency indicator. Their results signify that there is a natural resource curse in places, where the municipalities with more hydro potential devote less income for better local services. This mismanagement leads to lower efficiency in the use of resources. However, they reject the rentier state hypothesis, which argues that income earned from hydropower does not damage efficiency more than other income sources (Borge et al. 2012, 8).

3 Regional economic activity and natural resources in Norway

3.1 Spatial distribution of economic activity

During the 2010s, Norway has been one of the most developed countries classified as a high-income OECD country with a gross domestic product (GDP) and per capita GDP amounted up to $ 331,430,811,020 and $ 65,188 respectively (both in constant 2005 US$) as of 2013. The OECD average of GDP per capita stood to be around $ 31,700 in the same year. Additionally, life expectancy at birth was as high as 81 in 2012, which is slightly higher than the OECD average of 80 years (World Bank 2014).

Given the developed Norwegian economy, this study will consider economic activity related with natural resources as one of the significant aspects of the country. The shares of various natural resource rents in total GDP between 1970 and 2010 provides a better understanding of the contribution of natural resources to Norwegian GDP. Data obtained from the World Bank (2014) reveals that oil and natural gas rents make up most of the natural resource rents in Norwegian GDP, whereas the shares of forest, coal, and mineral rents remain marginal. As of 2010, total natural resources rents were as high as around 13% of GDP, departing from a ratio of 0.6% in 1970.

Norway's natural riches range from forestry, fisheries, and hydropower to oil and gas resources. In the early 1970s, Norway started to extract oil from its North Sea coast. Henceforth, the country has leaned on the petroleum sector, which is comprised of the extraction of crude oil and natural gas as well as the service industry – including drilling – and the pipeline transport industry. The oil industry first developed in Stavanger area, which became the center for oil activities in a very short period. In the twenty-first century, it has spread towards the northern territory, with the advent of new drilling techniques and accumulation of knowledge in the sector. Various firms started to engage in oil and gas related business along with the state-owned company, Statoil. As such, the oil sector has become a challenge for the previously existing Norwegian industrial sectors in a way to boost innovation and transmit new technologies (Engen 2007). Besides, in line with environmental and social concerns, oil and gas extraction has accompanied complementary policies to ensure intergenerational equality. For this reason, Norway has constituted a government fund, which invests abroad to utilize oil revenues efficiently and to ensure the well being of future generations.

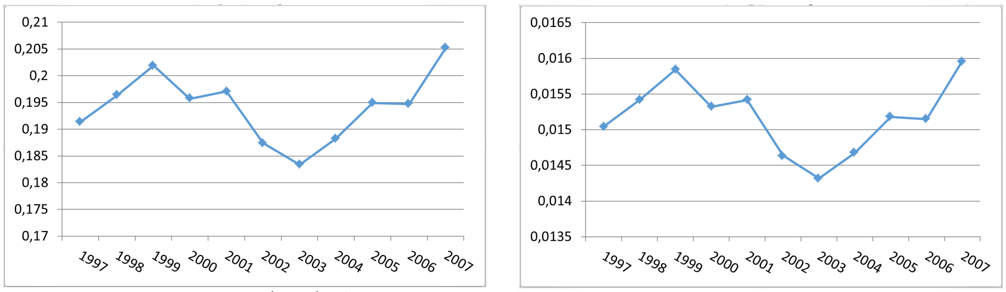
Before evaluating the spatial dispersion of the economic activities tied to natural resources, some descriptive figures on regional accounts are informative in understanding the regional differences in Norway. Figure 1 highlights the path of regional inequalities in Norway. There are 19 regions classified with respect to the Nomenclature of Territorial Units for Statistics 3 (NUTS 3) in the country (see Appendix A.1 for the list of the regions).[3] The standard deviation of per capita income and the mean corrected coefficient of variation of per capita income pinpoint the rise in regional inequalities. In other words, Figure 1 indicates that there is some sort of a U-shaped pattern in Norway: a fall in inequalities towards 2003 followed by an acceleration towards 2007. Although the data prevents one to comment on possible inequalities that may arise in the long run, it contains information on the path and trend of the regional imbalances in Norway.

[3]Nomenclature of Territorial Units for Statistics 3 (NUTS 3) is the acronym for "Nomenclature des Unites Territoriales Statisques".

Figure 1: Regional Inequality, 1997–2007

(a) Standard Deviation
(Log Per Capita Income – NUTS3)

(b) Coefficient of Variation
(Log Per Capita Income – NUTS3)



Source: Statistics Norway (SSB), Authors' own calculations

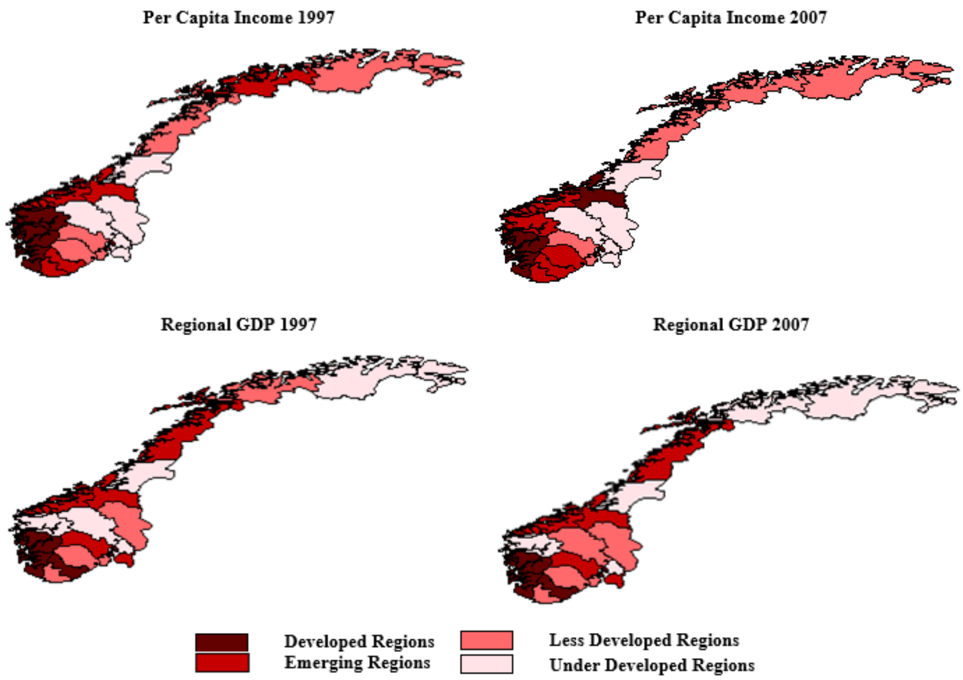
This first set of descriptive analyses gives some clues about the trajectory of regional inequalities in Norway; however, it suffers from a lack of information on the exact spatial inequalities. In other words, we need to observe the spatial dispersion of the level of economic activity so as to understand to what extent and in what sense Norwegian regions differ from each other. Considering the level of economic activity, we use two different measures: per capita GDP and population density. While the dispersion of per capita GDP reflects the level of economic activity by expressing how regional income gaps evolve, population density aims at explaining the ability of regions to generate various externalities through agglomeration. These effects range from physical infrastructure to human capital based benefits, both of which are heavily discussed within the new firm birth (start-ups) literature and urban growth literature. In that sense we use per capita GDP as a tool to understand the trends in regional inequalities of economic activity, whereas the use of population density does not only reflect economic activity from a broad income accumulation viewpoint, but also digs into the roots of income generation tied to agglomeration economies as well as urbanization. While early evidence from Reynolds et al. (1994) underlines the power of population density to represent the level of economic activity that stimulates firm formation, more recent evidence from Naude et al. (2008) and Cala et al. (2014) validates that population density can form agglomeration economies that clearly exemplify the high level of economic activity. Furthermore, early discussions of Carlino, Mills (1987) confirm that population and employment densities represent a true indicator of growth for the US case. That is to say, population density indicates higher urbanization, which boosts the level of economic activity via both demand and supply forces (Tiffen 1995). Bloom et al. (1998) also underline this by stating that an increase in population density is associated with urbanization that strongly increases the level of the economic activity.[4]

Figures 2 and 3 demonstrate the spatial distribution of per capita income as well as population density among the 19 regions of Norway. In general, southern Norway seems to outperform the northern geography. Lower population density and lower regional GDP figures point to low levels of economic activity in northern Norway, although per capita figures of all the Norwegian regions display a more homogenous distribution. These patterns seem to be consistent from 1997 to 2007.

One interesting aspect of the spatial distribution of economic activity in Norway is tied to the general debates of regional imbalances in Europe. As Lopez-Bazo et al. (1999) and Chorianopoulos (2002) mention, there is an increasing polarization in the European region. Geographically speaking, high prosperity countries are located in Northern Europe

[4]Population density as an indicator of economic activity is subject to debates as it can also create congestion-based diseconomies for regions. For instance, Duranton, Puga (2001) emphasize that population density does not necessarily represent economic activity and may sometimes create diseconomies. However, within this study, we are inspired by the discussions of agglomeration economies as well as urbanization dynamics since both, we believe, are expected to be tied to regional economic activity to some remarkable extent. Therefore we delay a detailed analysis of discussing the population density within this study, which we believe could be better handled in a consequent research.

Figure 2: Spatial Distribution of Regional Income, 1997–2007



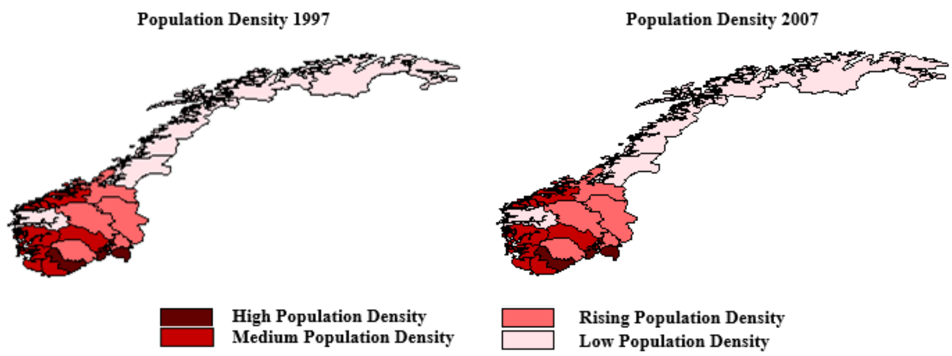
Source: Statistics Norway (SSB)

and relatively low-income countries are dispersed toward Southern Mediterranean Europe. Moreover, once within country inequalities are examined, interesting geographical location patterns can be detected. Southern countries generally experience "rich north" and "poor south" within their own territories. Yet, this may not be the case in the northern countries. Monastiriotis (2009) and Karahasan, Lopez-Bazo (2013) investigate the regional heterogeneities within Greece and Spain as two southern European countries. While these studies emphasize the south-north dualities, Eckey et al. (2007) discuss spatial instabilities in Germany, which are observed to be non-stationary and divergent compared to southern European countries. At the same time, Figures 2 and 3 in our analysis reveal that northern locations of Norway lag behind the Norwegian average in terms of regional income dispersion. While three big regions in the northern geography may be considered middle-income regions, the low population density in these locations is a sign of the relatively low levels of economic activity. These figures show the agglomeration of income and clustering of the population mostly around the southwest locations of Norway. Thus, they also signal that a geographical pattern that resembles Central-Northern Europe exists in Norway. It should be noted that this divergent pattern is unlike the overall distribution of economic activity in some parts of Europe (specifically in the south). Nevertheless, it still makes sense once Krugman-based New Economic Geography (NEG) models are considered: economic activity spills over towards high market potential areas with higher level of economic activity (see Krugman 1991).

3.2 Spatial distribution of natural resource sectors

Upon evaluating the general tendency of regional differences in Norway, we focus on the specific sectors related to natural resource activity. Dispersion of natural resource-oriented economic activities are investigated by examining employment, gross fixed capital formation and gross value added in major sectors of natural resource-based (NR-based) production (as % of regional population). Considered sectors are as follows: 1) Agriculture, forestry and hunting; 2) fishing and fish farming; 3) mining and quarrying; 4) oil and gas extraction (with and without related service activities). All data is gathered from the

Figure 3: Spatial Distribution of Population Density, 1997–2007



Source: Statistics Norway (SSB)

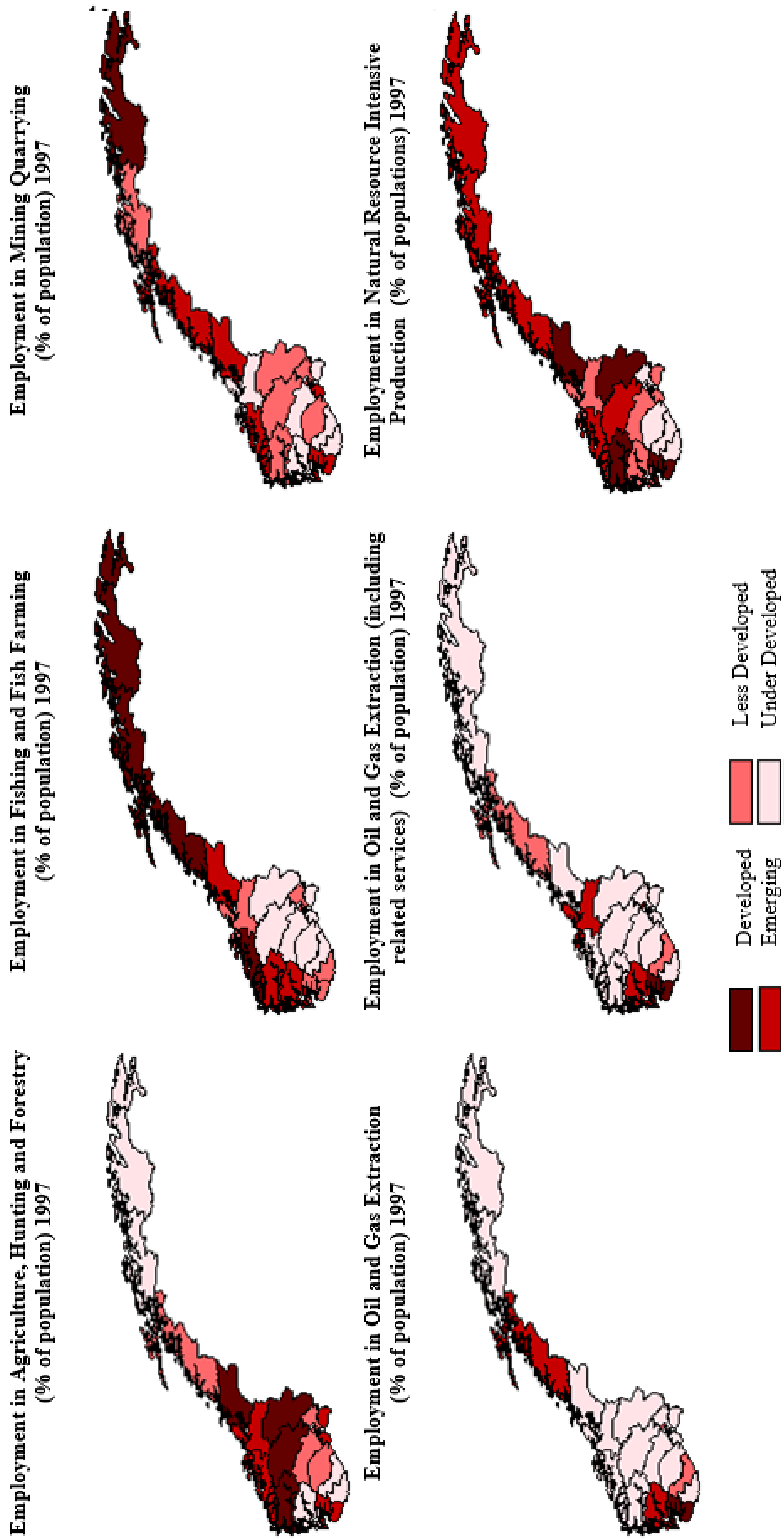
National Statistics Institute of Norway (SSB) for the period 1997–2007 at NUTS 3 level (See Appendix A.2 and A.3 for a brief summary of the variables). We acknowledge that Norway is among the highest per capita hydropower producers in the world, producing around 98% of total electricity through hydro resources (Borge et al. 2012, 4). However, hydropower is excluded from our scope in order to ensure the compatibility of data in the analysis. SSB also includes water-related industrial activities in the accounts for "electricity and gas supply" and "water supply". Since it is not possible to sort out hydropower from electricity and gas supply, we do not account for the investment, value-added and employment indicators related to hydropower in the analysis. Similarly, we are not able to distinguish between oil-fired power, gas-fired power, wind power, and other types of power in the same database and hence omit them in our comparisons. Besides, we focus on resource extraction activities rather than electricity generation, which utilizes various resources.[5]

Starting with the dispersion of employment, Figures 4 and 5 indicate that with the exception of agriculture, forestry, and hunting, dispersion of employment seems to have a persistent pattern during the investigated period. Additionally, the regions with higher shares of employment in oil and gas extraction (with and without related services) have per capita incomes above the Norwegian average. Fishing and fish farming also take place in other high-income locations. Keeping in mind the divergent pattern of oil and gas extraction, there is a strong co-movement behavior with regional economic activity, both measured by regional per capita income and population density.

Next, once gross fixed capital formation in natural resource activity in the regions is considered in Figures 6 and 7, the most remarkable pattern is observed in oil and gas extraction (with and without services). There is a spillover of the investments from southern core oil and gas extraction locations towards the northern locations during the 1997 and 2007 period. Given the geographical stability of investment in other NR-based production, this should signal out other regions' desire to increase their ability in adopting oil and gas extraction related production. It is worth mentioning that there is a high

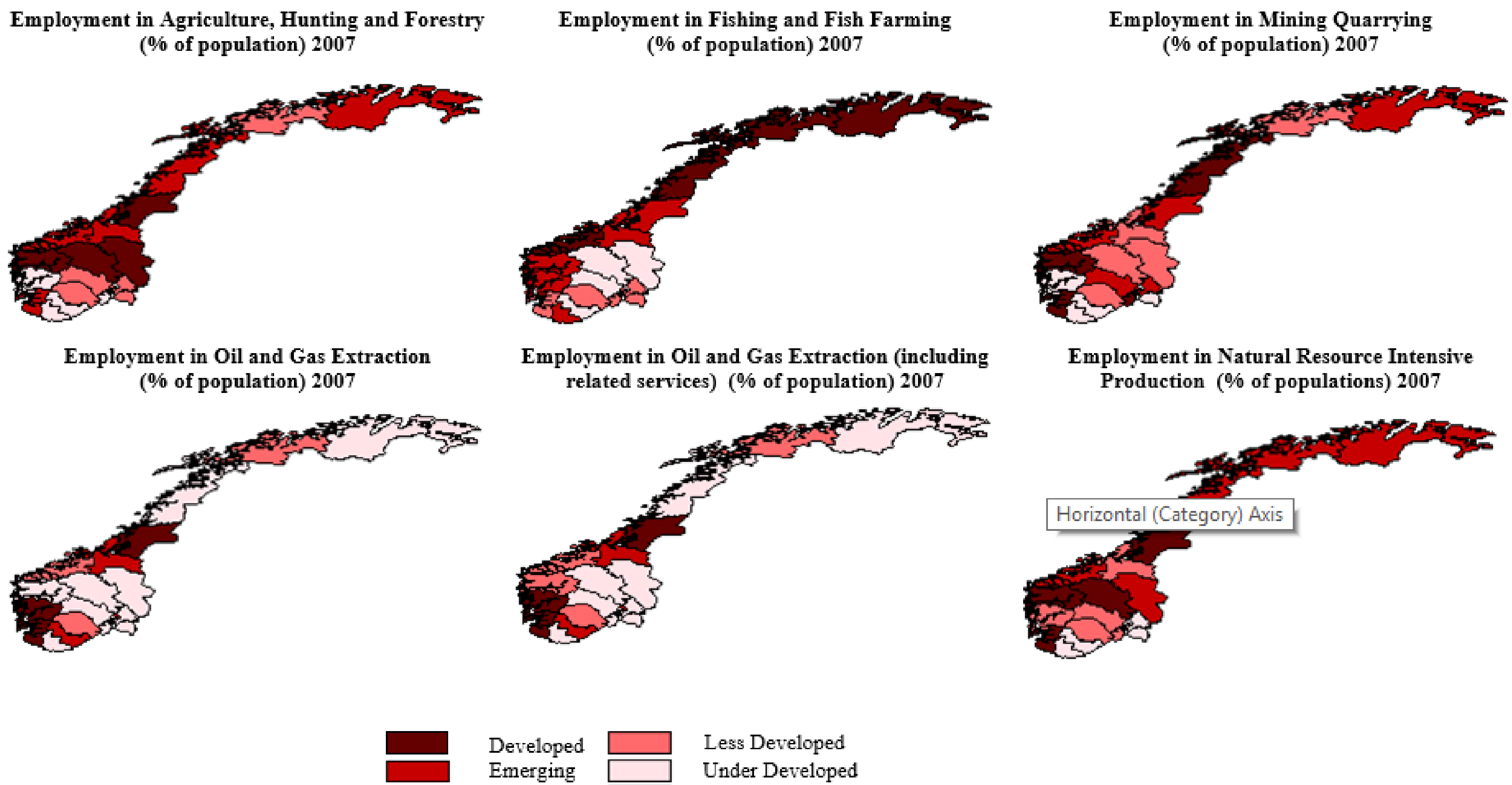
[5]Borge et al. (2012) examine different sources of hydropower revenue ranging from taxes and concession fees to business development funds in search for the impact of hydropower on productivity in Norwegian local governments. Even though this impact may add productivity and related concerns to regional differences discussions in Norway, we believe excluding hydropower will have negligible effect on our results within the construction of this piece, as our central aim is to focus on primary resource extraction and production rather than power generation, which is a secondary production process that utilizes renewable or nonrenewable resources as inputs. Therefore, we believe the impact of power generation from various resources on regional development could be investigated in a different context with a specific focus on spatial spillovers from the hydropower sector and others, which is beyond the scope of this study. Besides, we do not take into account local government revenues from natural resource activities; but consider investment, value-added and employment in these sectors instead.

Figure 4: Spatial Dispersion of Employment in Natural Resources 1997



Source: Statistics Norway (SSB)

Figure 5: Spatial Dispersion of Employment in Natural Resources 2007



Source: Statistics Norway (SSB)

interconnection between oil and gas extraction investments and level of economic activity.

Finally, Figures 8 and 9 display the comparison of gross value added generated from the NR-based economic sectors during the 1997 and 2007 period. Findings are more or less the same compared with the previous observations. Similar to the dispersion of employment, gross value added of regions in natural resources seems to be rather constant. Again, the highest interconnection seems to be running from oil and gas extraction.

To trace a historical pattern of inequalities, a second important task is to investigate how regional natural resource activities differ with respect to the Norwegian average (see Tables 1, 2, and 3). For agriculture, forestry, and hunting, regions like Hedmark, Nord-Trøndelag, Oppland, and Sogn og Fjordane deviate (positively) from the Norwegian average. In fishing and fish farming, Finnmark Finnmárku, Møre og Romsdal, Nordland, Sogn og Fjordane and Troms Romsa are regions, which outperform the Norwegian average. When mining and quarrying is considered, it is visible that Finnmark Finnmárku, Møre og Romsdal, Nordland, Nord-Trøndelag, Rogaland, Sogn og Fjordane, Telemark, and Vestfold exceed the average at least once in the investigated years. Finally, for oil and gas extraction, figures highlight the dominance of Rogaland well above the average of Norway.

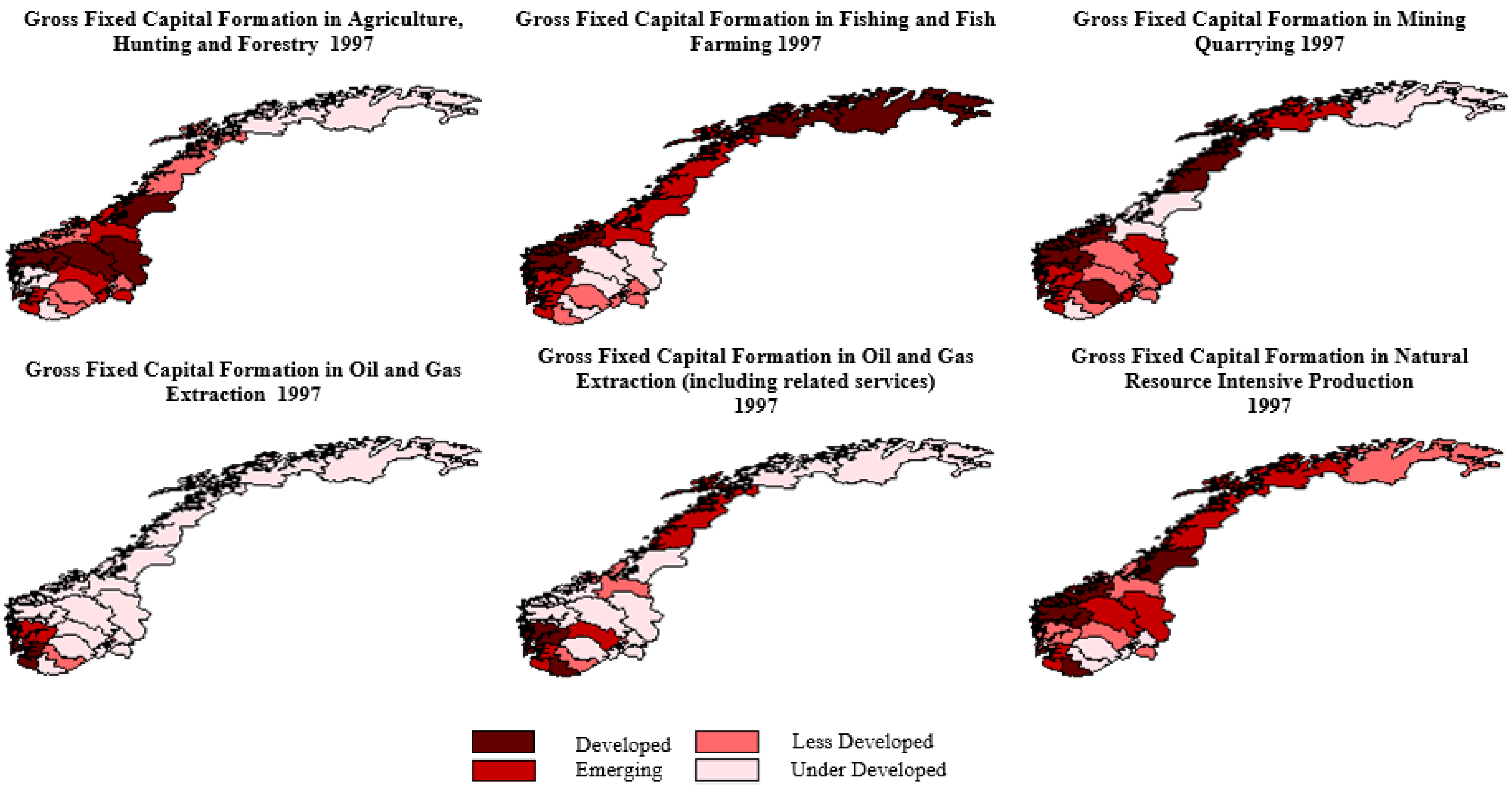
Our findings so far suggest that there seems to be a homogenous and constant pattern in almost all regions of Norway between 1997 and 2007 once aggregated natural resource intensive production is considered. This underlines the importance of NR-based production for all regions of the country. However, once natural resource activity is disaggregated, we realize that oil and gas extraction seem to deviate significantly from the others showing high clustering behavior as well as increasing similarities with regional income differences. A careful interpretation highlights that regions specializing in oil and gas extraction-related activities are placed at the forefront, acting as significant outliers that deviate from other regions.

4 Relating regional differences to economic activity based on natural resources

Having examined the general structure of spatial dispersion of economic activity and NR-based production, our final set of analyses aims to construct an analytical framework to explore the causal link between regional resource-related activities and regional economic performance. Following the disaggregation explained in the previous section, four different economic sectors are considered: 1) agriculture, hunting and forestry; 2) fishing and fish farming; 3) oil and gas extraction; 4) mining and quarrying. Natural resource activity of a region is controlled by employment, gross fixed capital formation, and gross value added as a percent of regional population. First, regional economic activity is indicated by per capita GDP and population density. Second, growth rates of per capita GDP and population density are considered so as to investigate the economic activity of regions and its link with natural resource abundance. The abbreviations, units, and descriptive statistics for the natural resource and economic activity variables are listed in Appendix A.2 and A.3. The data set covers the 1997–2007 period and 19 Norwegian NUTS 3 regions.

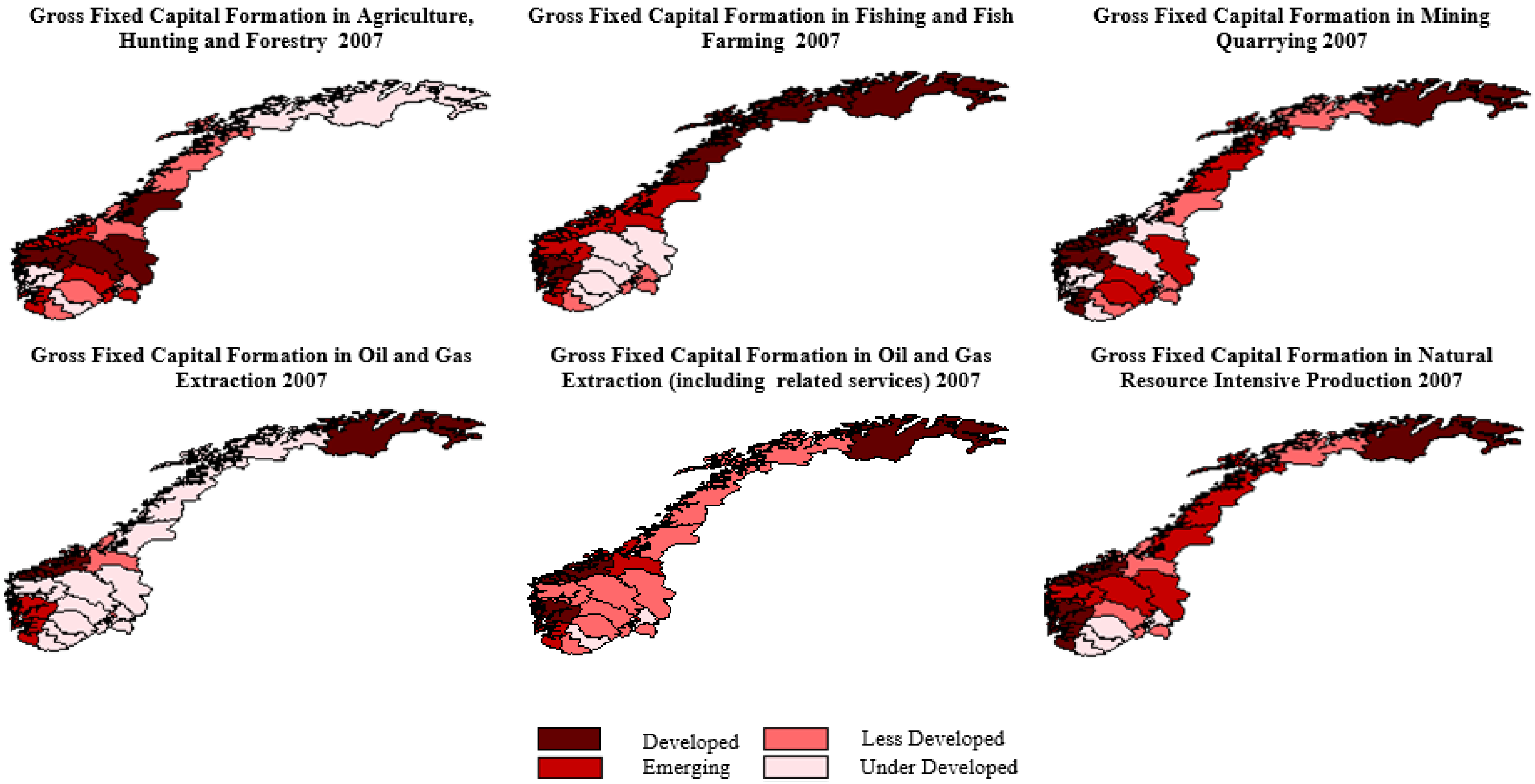
Equation 1 summarizes the general form of the model, where y represents economic activity of each region and NR represents natural resources. Note that in the initial set of models, y is the level of regional per capita GDP and population density, whereas in the second set, these indicators are included as growth variables. In addition to the impact of natural resource abundance, we also control two additional factors that may influence the regional differences in Norway: human capital (HK) and climate factors (HDD). As discussed by Lucas (1988), Romer (1990) and Mankiw et al. (1992) human capital enters the production function in a way to explain how innovative ideas evolve and foster technological change and economic growth. While human capital differences can explain cross-country differences (Barro 1991), human capital endowments of regions can explain regional imbalances (see, for instance, Rodriguez-Pose, Vilalta-Bufi 2005, Di Liberto 2008, Lopez-Bazo, Moreno 2008, Bronzini, Piselli 2009, Faggian, McCann 2009, Gennaioli et al. 2013). Additionally, climatic factors have significant effects on geographical and regional

Figure 6: Spatial Distribution of Gross Fixed Capital Formation in Natural Resources 1997



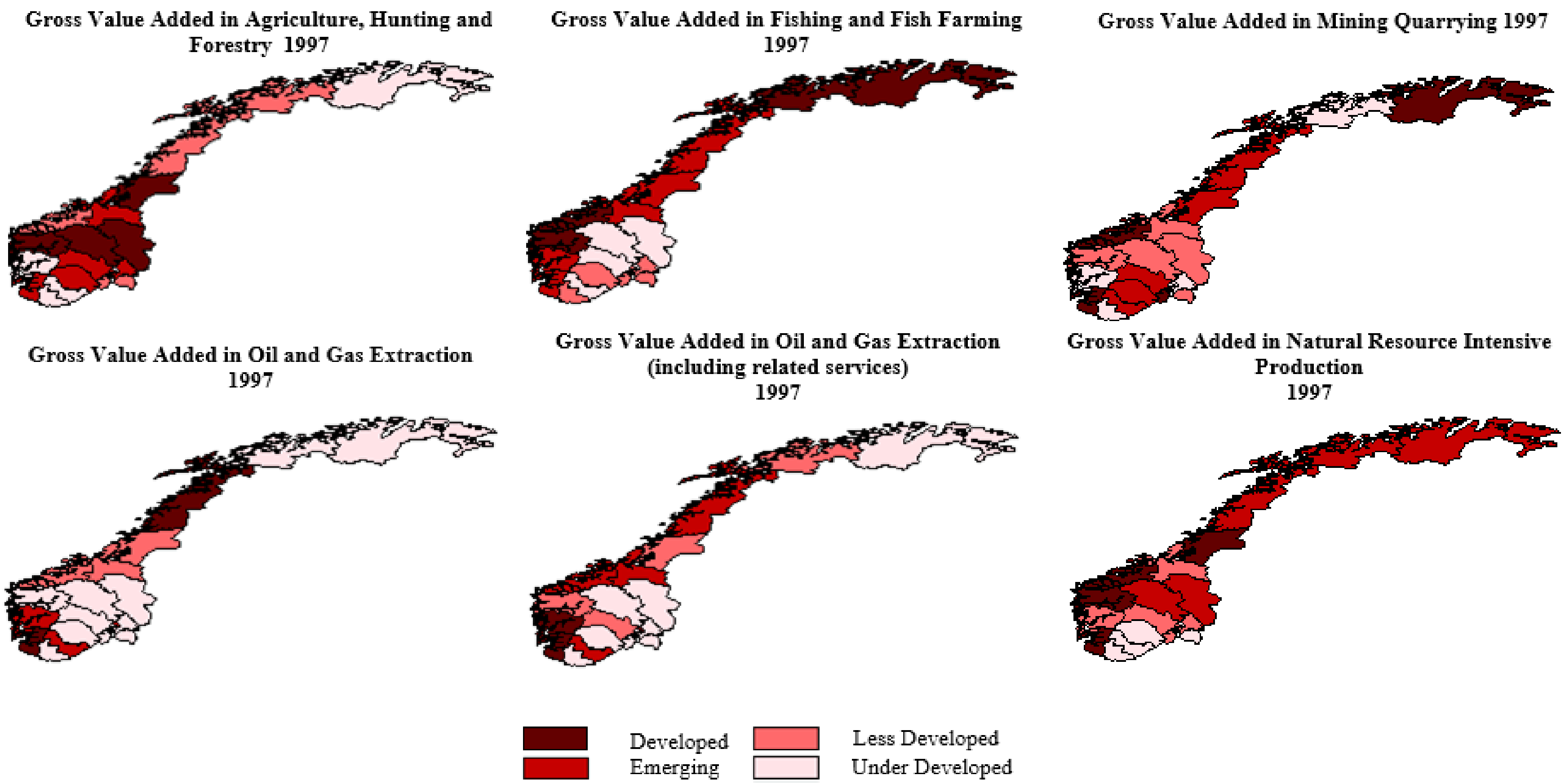
Source: Statistics Norway (SSB)

Figure 7: Spatial Distribution of Gross Fixed Capital Formation in Natural Resources 2007



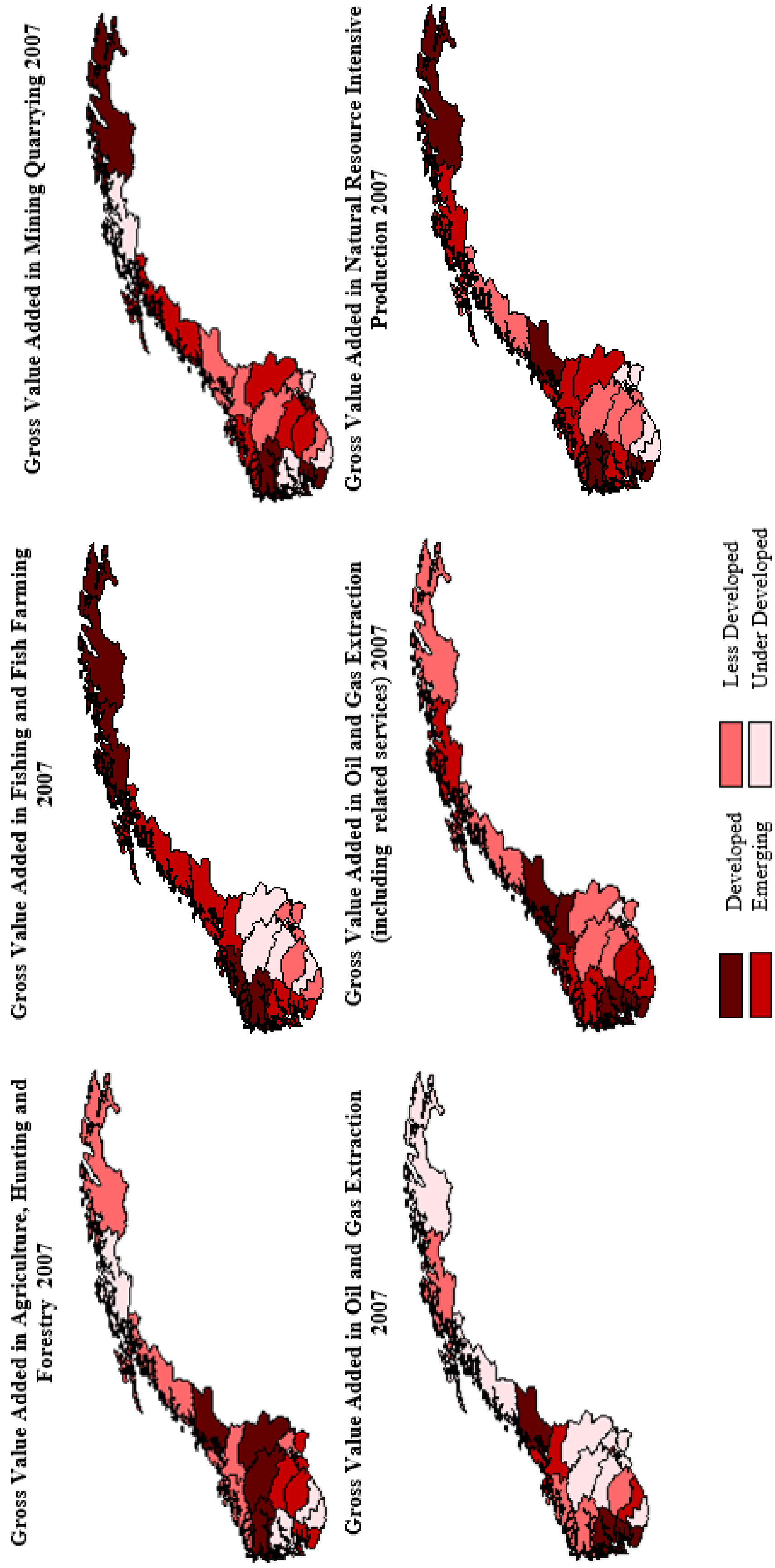
Source: Statistics Norway (SSB)

Figure 8: Spatial Distribution of Gross Value Added in Natural Resources 1997



Source: Statistics Norway (SSB)

Figure 9: Spatial Distribution of Gross Value Added in Natural Resources 2007



Source: Statistics Norway (SSB)

Table 1: Regional Dispersion of Employment in Natural Resources

	Agriculture, Forestry and Hunting		Fishing and Fish Farming		Mining and Quarrying		Oil and Gas Extraction		Oil and Gas Extraction (inc Services)		Total	
	1997	2007	1997	2007	1997	2007	1997	2007	1997	2007	1997	2007
Akershus	0.53	0.25	0.00	0.00	0.43	0.43	1.41	1.16	0.19	1.05	0.42	0.39
Aust-Agder	0.65	0.54	0.18	0.24	0.95	1.05	0.00	0.00	0.00	0.00	0.54	0.40
Buskerud	0.89	0.66	0.00	0.00	0.42	0.89	0.00	0.00	0.00	0.00	0.66	0.43
Finnmark Finnmárku	0.31	1.03	3.77	3.76	2.54	1.52	0.00	0.00	0.00	0.00	1.03	1.25
Hedmark	2.10	1.62	0.00	0.00	1.03	0.58	0.00	0.00	0.00	0.00	1.57	1.00
Hordaland	0.42	0.51	1.21	0.82	0.45	0.24	1.47	2.98	2.44	2.74	0.66	1.03
Møre og Romsdal	0.94	1.09	3.83	2.73	1.59	1.35	0.00	0.37	0.00	0.24	1.47	1.18
Nordland	0.70	1.03	2.67	3.38	1.99	1.87	2.62	0.00	0.36	0.00	1.12	1.20
Nord-Trøndelag	2.74	2.52	0.70	0.96	1.51	1.71	0.00	2.11	0.00	1.38	2.19	2.08
Oppland	1.94	2.25	0.00	0.00	0.53	0.60	0.00	0.00	0.00	0.00	1.43	1.38
Oslo	0.01	0.01	0.00	0.00	0.19	0.20	1.27	1.07	2.46	0.81	0.12	0.21
Østfold	1.12	0.59	0.07	0.09	0.40	0.42	0.00	0.00	0.00	0.00	0.84	0.39
Rogaland	1.51	1.10	0.49	0.43	1.60	1.91	12.22	8.63	12.53	10.3	1.81	2.82
Sogn og Fjordane	1.55	2.53	2.47	2.10	0.89	2.08	0.00	0.00	0.00	0.28	1.63	1.95
Sør-Trøndelag	0.97	0.92	0.55	0.71	0.37	0.79	0.00	0.98	1.01	1.07	0.87	0.91
Telemark	0.60	0.60	0.00	0.15	1.17	0.66	0.00	0.82	0.00	0.54	0.48	0.54
Troms Romsa	0.52	0.73	2.71	3.06	0.63	0.72	0.00	0.88	0.00	0.58	0.92	1.08
Vest-Agder	0.52	0.50	0.35	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.37
Vestfold	0.99	0.53	0.00	0.11	2.32	1.97	0.00	0.00	0.00	0.00	0.81	0.40

Source: Statistics Norway (SSB), Authors' own calculations

Note: Norwegian Average = 1.00

Table 2: Regional Dispersion of Gross Fixed Capital Formation in Natural Resources

	Agriculture, Forestry and Hunting		Fishing and Fish Farming		Mining and Quarrying		Oil and Gas Extraction		Oil and Gas Extraction (inc Services)		Total	
	1997	2007	1997	2007	1997	2007	1997	2007	1997	2007	1997	2007
Akershus	0.54	0.43	0.00	0.00	0.72	0.41	1.19	0.00	0.55	-0.01	0.41	0.14
Aust-Agder	0.70	0.54	0.12	0.02	1.06	0.52	0.00	0.00	0.00	0.00	0.49	0.15
Buskerud	0.92	0.96	0.00	0.00	0.92	1.23	0.00	0.00	1.10	0.00	0.73	0.27
Finnmark Finnmárku	0.31	0.33	3.44	3.54	-16.95	2.35	0.00	12.38	0.00	11.46	1.06	7.66
Hedmark	2.16	2.14	0.00	0.00	1.15	0.68	0.00	0.00	0.00	0.00	1.37	0.60
Hordaland	0.41	0.43	0.67	1.92	1.50	-0.05	5.79	0.72	3.09	1.52	0.79	1.34
Møre og Romsdal	0.91	0.87	3.87	1.50	5.19	1.66	0.00	4.91	0.00	4.55	1.59	3.25
Nordland	0.68	0.76	2.42	2.49	4.33	1.29	0.00	0.00	0.76	0.00	1.13	0.36
Nord-Trøndelag	2.71	2.73	0.57	1.52	0.42	0.61	0.00	0.00	0.00	0.00	1.80	0.85
Oppland	1.94	2.15	0.00	0.00	1.02	0.33	0.00	0.00	0.00	0.00	1.21	0.60
Oslo	0.01	0.01	0.00	0.02	0.27	0.20	0.56	0.01	0.69	0.00	0.09	0.02
Østfold	1.13	0.91	0.04	0.05	0.55	0.56	0.00	0.00	0.00	0.00	0.71	0.26
Rogaland	1.48	1.32	0.74	1.57	3.70	2.15	11.46	0.99	2.46	1.47	1.43	1.64
Sogn og Fjordane	1.51	1.83	3.46	1.75	4.94	3.90	0.00	0.00	0.00	0.00	1.76	0.61
Sør-Trøndelag	0.95	0.80	0.44	1.53	0.41	0.11	0.00	0.00	0.14	0.01	0.71	0.32
Telemark	0.62	0.84	0.04	0.00	6.69	0.81	0.00	0.00	0.00	0.00	0.42	0.23
Troms Romsa	0.52	0.49	2.85	2.84	1.59	0.63	0.00	0.00	0.00	0.00	1.00	0.30
Vest-Agder	0.51	0.57	0.30	0.16	0.18	-0.04	0.00	0.00	10.22	0.00	1.60	0.17
Vestfold	1.00	0.87	0.03	0.08	1.29	1.63	0.00	0.00	0.00	0.00	0.70	0.25

Source: Statistics Norway (SSB), Authors' own calculations

Note: Norwegian Average = 1.00

Table 3: Regional Dispersion of Gross Value Added in Natural Resources

	Agriculture, Forestry and Hunting		Fishing and Fish Farming		Mining and Quarrying		Oil and Gas Extraction		Oil and Gas Extraction (inc Services)		Total	
	1997	2007	1997	2007	1997	2007	1997	2007	1997	2007	1997	2007
Akershus	0.47	0.40	0.01	0.00	1.53	0.61	1.26	0.63	0.67	0.75	0.45	0.40
Aust-Agder	0.97	0.75	0.12	0.12	0.22	0.77	0.00	0.00	0.00	-0.04	0.52	0.34
Buskerud	1.09	1.32	0.00	0.01	0.56	0.83	0.00	0.00	0.00	0.00	0.56	0.52
Finnmark Finnmárku	0.31	0.50	3.42	4.18	4.63	2.97	0.00	0.00	0.00	0.00	1.32	1.63
Hedmark	2.70	2.99	0.00	0.00	0.45	0.86	0.00	0.00	0.00	0.00	1.34	1.10
Hordaland	0.33	0.36	0.34	0.88	0.19	0.26	1.63	3.98	2.09	2.97	0.66	1.25
Møre og Romsdal	0.83	0.74	3.75	3.22	1.76	1.36	0.47	0.14	0.24	0.08	1.53	1.32
Nordland	0.63	0.64	2.22	2.15	0.99	1.48	2.66	0.00	1.40	0.00	1.21	0.96
Nord-Trøndelag	2.46	2.50	0.56	0.82	1.17	0.77	0.35	1.46	0.19	0.89	1.45	1.41
Oppland	2.04	2.05	0.00	0.00	0.40	0.75	0.00	0.00	0.00	0.00	1.02	0.76
Oslo	0.02	0.02	0.00	0.00	0.15	0.01	0.98	0.76	1.81	0.96	0.37	0.28
Østfold	0.84	0.78	0.03	0.04	0.37	0.37	0.00	0.00	0.00	0.00	0.44	0.31
Rogaland	1.04	1.14	0.88	1.36	1.90	2.43	11.25	0.32	11.72	10.35	3.12	3.93
Sogn og Fjordane	1.39	1.52	4.02	2.58	0.52	1.48	0.00	0.11	0.11	0.10	1.77	1.42
Sør-Trøndelag	0.87	0.78	0.40	0.52	0.43	0.42	0.40	0.75	0.75	2.41	0.70	1.14
Telemark	0.89	0.86	0.04	0.03	0.73	0.95	0.00	0.34	0.00	0.22	0.49	0.44
Troms Romsa	0.83	0.38	2.87	2.76	0.32	0.26	0.00	0.51	0.02	0.28	1.17	1.04
Vest-Agder	0.51	0.46	0.30	0.29	0.14	0.22	0.00	0.00	0.00	0.04	0.33	0.27
Vestfold	0.76	0.83	0.04	0.02	2.54	2.20	0.00	0.00	0.00	0.00	0.53	0.46

Source: Statistics Norway (SSB), Authors' own calculations

Note: Norwegian Average = 1.00

differences. In general, the impact of climate on regional differences may work from various channels ranging from health conditions to production processes (Mellinger et al. 1999, Gallup et al. 1999). As discussed by Gallup et al. (1999), transport costs, disease burdens, and agricultural productivity are the most dominant factors shaping the impact of climate on regional differences.

Human capital is measured by the share of population with secondary education in each region. Meanwhile, climatic conditions are investigated via the Heating Degree Days (HDD) measure provided by Eurostat. HDD is calculated by computing the energy demand that is necessary to heat a building. There are other potential factors that might affect regional disparities; however, our choice of the control variables is constrained by the available data for the period under concern. All data is compiled for the period 1997–2007. Data on natural resource-abundant production, population density, per capita GDP, and share of population with secondary education data are obtained for 19 NUTS 3 regions of Norway from National Statistics Institute of Norway (SSB). For the HDD measure, Eurostat provides information at NUTS 2 level for the Norwegian economy (HDD data is from JRC-IPSC/Agrifish Unit/MARS-STAT Action and compiled by Statistical Office of European Union, ESTAT). Since we believe the impact of climate on regional differences is crucial for the case of Norway, we prefer to use the NUTS 2 data as a representative measure for each of the NUTS 3 regions within NUTS 2 boundaries.

$$y_{it} = \alpha + \beta NR_{it} + \gamma HK_{it} + HDD_{it} + \epsilon_{it} \tag{1}$$

Equation 1 is estimated through fixed and random effects models and the results are demonstrated in Tables 4 to 8. Note that we also control for any spatial dependence in the variables of interest. Traditional spatial auto-correlation test results indicate the lack of significant spatial dependence at the NUTS 3 level.[6] This may be due to the relatively large surface of the spatial units at the NUTS 3 level in Norway. There may be inevitable intra-region spatial links; however, such an analysis calls for an investigation with a more disaggregated data set, which is unavailable at this stage. In general, fixed effects panel models control for the time-invariant variables using time-variant effects, and seem to be more appropriate for the case of 19 regions of Norway. On the other hand, random effects models assume that unobserved region-specific variables are uncorrelated with the observed variables. This is invalid for our analysis. However, both fixed and random effects panel models are reported to demonstrate the robustness of the results in terms of estimation procedures. Initial set of results is for per capita GDP and population density are reported in Tables 4 and 5. Findings indicate negligible differences among the fixed and random effects models. Yet, our general evaluations focus on the fixed effects model, which is more appropriate as it controls for regional heterogeneities.

First, starting with employment in natural resource-oriented production, employment in oil and gas extraction influences per capita income dispersion positively. Meanwhile, agriculture and employment in fishing are negatively related with regional income per capita, whereas mining employment seems to have no effect. Regarding agriculture, one possible reason could be that there are limited lands for agriculture in consideration of Norway's mountainous topography is considered. Besides, high mechanization levels in Norwegian agriculture and forestry do not require a large labor force in this area. With respect to the impact of employment in natural resources on population density, only oil and gas extraction, and mining and quarrying activities, are found to increase population density. While fishing does not bear any significant effects, higher agricultural employment leads to lower population densities. Increased productivity in agriculture could be an explanation to lower population densities in agricultural lands. Additionally, agricultural production is relatively land-intensive in its nature; that is, it is less likely that agricultural employment will be concentrated in more urbanized areas where dense populations promote agglomeration economies. Thus, these areas are not suitable for the accumulation of agricultural employment.[7]

[6] The test results can be provided upon request.

[7] It is likely that structural change in agricultural production characteristics and some demographic factors might result in rural-urban migration. We believe such a movement represents not only a location-based but also industry-based mobility (across both natural resource-based industries and some others),

Table 4: Panel Fixed and Random Effects Model Results (I)

Dependent Variable: Per Capita Income	(A)		(B)		(C)	
	FE	RE	FE	RE	FE	RE
Employment in Agriculture, Hunting & Forestry	-31.496*** (4.212)	-21.852*** (3.008)	-	-	-	-
Employment in Fishing and Fish Farming	-62.846*** (11.789)	-18.203** (8.842)	-	-	-	-
Employment in Mining and Quarrying	-18.208 (58.138)	-65.586 (50.706)	-	-	-	-
Employment in Oil and Gas Extraction	17.731** (6.773)	24.659*** (5.769)	-	-	-	-
Gross Fixed Investment in Agric., Hunting & Forestry	-	-	0.056 (0.042)	0.019 (0.032)	-	-
Gross Fixed Investment in Fishing and Fish Farming	-	-	0.022 (0.042)	0.028 (0.033)	-	-
Gross Fixed Investment in Mining and Quarrying	-	-	0.488** (0.189)	0.451*** (0.152)	-	-
Gross Fixed Investment in Oil and Gas Extraction	-	-	0.002** (0.001)	0.002* (0.001)	-	-
Gross Value Added in Agriculture, Hunting & Forestry	-	-	-	-	-0.162** (0.044)	-0.048*** (0.016)
Gross Value Added in Fishing and Fish Farming	-	-	-	-	0.028** (0.007)	0.017* (0.009)
Gross Value Added in Mining and Quarrying	-	-	-	-	0.484*** (0.092)	0.286*** (0.058)
Gross Value Added in Oil and Gas Extraction	-	-	-	-	0.013 (0.009)	0.009 (0.006)
Share of Population with upper Secondary Education	0.067* (0.035)	0.064 (0.051)	0.036 (0.053)	0.016 (0.061)	0.035 (-0.04)	-0.001 (0.055)
Heating Degree Days	-1.188*** (0.141)	-0.828*** (0.299)	-2.403*** (0.177)	-1.692*** (0.300)	-1.356*** (0.252)	-1.573 (0.283)
R-squared	0.2	0.28	0.12	0.15	0.13	0.15
F/Wald Stat (p-value)	44.27 (0.00)	147.9 (0.00)	76.17 (0.00)	50.77 (0.00)	98.89 (0.00)	104.53 (0.00)
# of observations	189	189	189	189	189	189

Note: ***, **, * represents significance at 1%, 5% and 10% respectively, Robust standard errors in ()

Second, results for the effects of gross capital formation in natural resource-abundant production again suggest that investment in mining, quarrying, oil, and gas extraction seems to influence regional income per capita positively. Conversely, while the investment in mining and quarrying's positive influence continues, the impact of oil and gas extraction turns out to be the opposite once impact on population density is considered. Third, for the case of gross value added in natural resource-abundant production, our findings indicate that the most notable positive impact comes from mining and quarrying activities. While agriculture and related activities affect regional income per capita negatively, gross value added in mining, fishing, and fishing-related activities imply increasing income. The significance of fishing and fish farming vanishes once regional population densities are considered. Interestingly, gross value added in oil and gas extraction has no significant effect on regional differences measured by either income or population density. Regarding the control variables, the impact of climate is highly significant in all of the fixed effects models in line with the initial concerns; the higher the energy demand to heat a building (HDD), the lower the level of regional development (signaling the negative impact of bad climate conditions). On the other hand, the impact of human capital differences of regions is observed to be significant only for the models explaining regional differences with respect to employment in natural resource-related activity. This finding is vital, as it emphasizes that the impacts of employment in natural resource activities and the skill

which we regard as a valuable future research topic.

Table 5: Panel Fixed and Random Effects Model Results (II)

Dependent Variable: Population Density	(A)		(B)		(C)	
	FE	RE	FE	RE	FE	RE
Employment in Agriculture, Hunting & Forestry	-3.049*** (1.023)	-3.078*** (0.483)	-	-	-	-
Employment in Fishing and Fish Farming	-2.163 (1.635)	-2.392 (1.673)	-	-	-	-
Employment in Mining and Quarrying	13.395** (6.402)	13.680* (7.381)	-	-	-	-
Employment in Oil and Gas Extraction	3.634** (1.263)	3.609*** (0.772)	-	-	-	-
Gross Fixed Investment in Agric., Hunting & Forestry	-	-	-0.002 (0.003)	-0.003 (0.006)	-	-
Gross Fixed Investment in Fishing and Fish Farming	-	-	0.003 (0.002)	0.003 (0.004)	-	-
Gross Fixed Investment in Mining and Quarrying	-	-	0.042** (0.033)	0.042** (0.021)	-	-
Gross Fixed Investment in Oil and Gas Extraction	-	-	-0.0001* (0.0001)	-0.0001 (0.0001)	-	-
Gross Value Added in Agri- culture, Hunting & Forestry	-	-	-	-	-0.009 (0.006)	-0.010** (0.004)
Gross Value Added in Fishing and Fish Farming	-	-	-	-	-0.0001 (0.001)	-0.0006 (0.0016)
Gross Value Added in Mining and Quarrying	-	-	-	-	0.037** (0.016)	0.036** (0.01)
Gross Value Added in Oil and Gas Extraction	-	-	-	-	0.001 (0.001)	0.001* (0.0009)
Share of Population with upper Secondary Education	0.005** (0.002)	0.005 (0.006)	-0.0001 (0.003)	-0.0001 (0.007)	0.002 (0.003)	0.002 (0.007)
Heating Degree Days	-0.124*** (0.027)	-0.126*** (0.043)	-0.243*** (0.033)	-0.251*** (0.054)	-0.164*** (0.04)	-0.171*** (0.052)
R-squared	0.43	0.45	0.42	0.43	0.19	0.2
F/Wald Stat (p-value)	8.15 (0.00)	118.96 (0.00)	13.4 (0.00)	26.03 (0.00)	17.45 (0.00)	48.96 (0.00)
# of observations	189	189	189	189	189	189

Note: ***, **, * represents significance at 1%, 5% and 10% respectively, Robust standard errors in ()

level of the labor force seem to work together. Probably owing to this, we do not detect any significant impact of human capital development in the models that utilize gross fixed capital formation and gross value added in natural resource sectors.

Finally, the same set of models are re-estimated to see whether employment, investment, and value added of the regions have any influence on the regional differences measured by the annual growth rate of per capita GDP and population density. The results are illustrated in Tables 6 and 7.

The results indicate that employment in oil and gas extraction activities has a significant positive effect on population density growth, whereas employment in agriculture and related activities has a significant positive influence on per capita GDP growth. Meanwhile, we detect no significant impact of the influence of gross fixed capital formation in NR-related production on per capita GDP growth or population density growth. Finally, regarding gross value added in NR sectors, the results determine that fishing and related activities trigger per capita GDP growth, while oil and gas extraction-related activities accelerate population density. In other words, NR-based sectors do not have a homogenous effect on the regional imbalances measured by the growth of the variables.

An alternative way to test regional imbalances is by regional attractiveness, which can be assessed by observing population growth patterns in the regions (see Glaeser et al. 1995, McGranahan, Wojan 2007, Florida et al. 2008, Florida 2010). The results displayed in Table 8 show the limited influence of NR-based activities on the attractiveness of the

Table 6: Panel Fixed and Random Effects Model Results (III)

Dependent Variable: Growth in Per Capita Income	(A)		(B)		(C)	
	FE	RE	FE	RE	FE	RE
Employment in Agriculture, Hunting & Forestry	3.155** (1.459)	0.642 (0.530)	-	-	-	-
Employment in Fishing and Fish Farming	8.353 (5.454)	2.379* (1.369)	-	-	-	-
Employment in Mining and Quarrying	-8.041 (20.992)	-4.6 (10.792)	-	-	-	-
Employment in Oil and Gas Extraction	1.561 (2.012)	0.371 (1.646)	-	-	-	-
Gross Fixed Investment in Agric., Hunting & Forestry	-	-	0.004 (0.013)	0.006 (0.004)	-	-
Gross Fixed Investment in Fishing and Fish Farming	-	-	0.01 (0.009)	0.005 (0.007)	-	-
Gross Fixed Investment in Mining and Quarrying	-	-	0.015 (0.069)	-0.002 (0.041)	-	-
Gross Fixed Investment in Oil and Gas Extraction	-	-	0.0001 (0.0003)	0.0004* (0.0002)	-	-
Gross Value Added in Agriculture, Hunting & Forestry	-	-	-	-	0.006 (0.01)	0.003 (0.001)
Gross Value Added in Fishing and Fish Farming	-	-	-	-	0.007** (0.003)	0.004** (0.001)
Gross Value Added in Mining and Quarrying	-	-	-	-	-0.011 (0.025)	0.001 (0.008)
Gross Value Added in Oil and Gas Extraction	-	-	-	-	0.001 (0.002)	-0.0007 (0.0011)
Share of Population with upper Secondary Education	0.009 (0.016)	0.012 (0.016)	0.01 (0.017)	0.005 (0.015)	0.006 (0.017)	0.002 (0.015)
Heating Degree Days	-0.928*** (0.112)	-0.210*** (0.062)	-0.835*** (0.109)	-0.137*** (0.045)	-0.776*** (0.114)	-0.186*** (0.049)
R-squared	0.05	0.05	0.04	0.06	0.05	0.07
F/Wald Stat (p-value)	12.31 (0.00)	14.11 (0.02)	10.79 (0.00)	11.33 (0.08)	11.87 (0.00)	15.75 (0.02)
# of observations	172	172	172	172	172	172

Note: ***, **, * represents significance at 1%, 5% and 10% respectively, Robust standard errors in ()

regions over the oil and related types of production only for the random effect models. We approach this with caution due to the uncontrolled heterogeneity of the regions, as explained before. In addition, the human capital indicator appears to be insignificant for population growth. While climatic factors maintain their significant impact on the growth of per capita GDP, its influence on the growth of population density diminishes. Note that as the models become some sort of regional growth model, one could also consider controlling for the initial conditions of the regions.[8] Yet, augmenting the model in such a manner will divert the attention of the study towards a different discussion, which will include the question of convergence or divergence. This will be a future piece of work on our research agenda.

5 Conclusion and discussion

Displaying a widespread distribution of varying natural resources, Norwegian regions exhibit spatial differences in terms of economic development. This study undertakes an analysis of these spatial differences by focusing on per capita income and population density in the NUTS 3 regions, both in levels and growth rates through an examination of agriculture, forestry, and hunting; fishing and fish farming; mining and quarrying, and

[8] We also estimated models in which initial conditions of each region are controlled for. The results are available upon request. They are found to be very similar to the previous models, however.

Table 7: Panel Fixed and Random Effects Model Results (IV)

Dependent Variable: Growth in Population Density	(A)		(B)		(C)	
	FE	RE	FE	RE	FE	RE
Employment in Agriculture, Hunting & Forestry	0.176 (0.154)	-0.165*** (0.04)	-	-	-	-
Employment in Fishing and Fish Farming	0.04 (0.577)	-0.232** (0.102)	-	-	-	-
Employment in Mining and Quarrying	-0.128 (2.222)	-0.694 (0.84)	-	-	-	-
Employment in Oil and Gas Extraction	0.714*** (0.213)	0.500*** (0.138)	-	-	-	-
Gross Fixed Investment in Agric., Hunting & Forestry	-	-	-0.0008 (0.001)	-0.001*** (0.0004)	-	-
Gross Fixed Investment in Fishing and Fish Farming	-	-	-0.0009 (0.001)	-0.001** (0.0006)	-	-
Gross Fixed Investment in Mining and Quarrying	-	-	0.0009 (0.007)	0.001 (0.004)	-	-
Gross Fixed Investment in Oil and Gas Extraction	-	-	-0.0000 (0.000)	-0.0000 (0.000)	-	-
Gross Value Added in Agriculture, Hunting & Forestry	-	-	-	-	0.0000 (0.001)	-0.0006*** (0.0001)
Gross Value Added in Fishing and Fish Farming	-	-	-	-	-0.0005 (0.0004)	-0.0005*** (0.0001)
Gross Value Added in Mining and Quarrying	-	-	-	-	-0.001 (0.002)	0.0003 (0.0007)
Gross Value Added in Oil and Gas Extraction	-	-	-	-	0.0006** (0.0002)	0.0002** (0.0001)
Share of Population with upper Secondary Education	-0.002 (0.001)	-0.002 (0.001)	-0.002 (0.001)	-0.002* (0.001)	-0.002 (0.001)	-0.001 (0.001)
Heating Degree Days	-0.015 (0.011)	-0.011** (0.004)	-0.017 (0.011)	-0.019*** (0.004)	-0.022* (0.012)	-0.014*** (0.004)
R-squared	0.11	0.42	0.38	0.39	0.33	0.43
F/Wald Stat (p-value)	2.68 (0.02)	122.59 (0.00)	0.94 (0.47)	102.63 (0.00)	2.69 (0.02)	122.43 (0.00)
# of observations	172	172	172	172	172	172

Note: ***, **, * represents significance at 1%, 5% and 10% respectively, Robust standard errors in ()

oil and gas extraction sectors.

Our initial set of descriptive analyses indicates that the regional imbalances in Norway exhibit a historically U-shaped pattern, leaving the northern regions relatively less developed throughout the period 1997–2007. Meanwhile, the second set of descriptive analyses provides evidence that the regional dispersion of NR-based activities is quite trivial. While aggregated total NR-based economic sectors do not have any similarities in regards to regional imbalances (due to their homogenous dispersion), the disaggregated data shows that mining and quarrying, and strongly oil- and gas-related activities, have similar patterns with regional inequalities.

Observing the similar tendency between spatial patterns of regional differences and NR-based production, our initial set of analyses is supported by an analytical framework to better understand the causal links between NR-based production and regional disparities. Evidence from different econometric specifications illustrates that oil and gas extraction best explains the regional disparities measured by per capita GDP once employment and investment dispersion in the sector is considered. While the impact of oil and gas extraction employment continues to explain regional population density differences, the impact of investment in oil and gas extraction vanishes. At the same time, mining and quarrying activities explain per capita GDP once investment and value added are considered. Significant effects of employment, investment, and value added in mining and quarrying activities are proven in the population density dispersion. Models estimated to

Table 8: Panel Fixed and Random Effects Model Results (V)

Dependent Variable: Growth in Population	(A)		(B)		(C)	
	FE	RE	FE	RE	FE	RE
Employment in Agriculture, Hunting & Forestry	0.142* (0.071)	-0.165*** (0.04)	-	-	-	-
Employment in Fishing and Fish Farming	-0.218 (0.266)	-0.232** (0.102)	-	-	-	-
Employment in Mining and Quarrying	0.222 (1.024)	-0.694 (0.84)	-	-	-	-
Employment in Oil and Gas Extraction	0.158 (0.098)	0.500*** (0.138)	-	-	-	-
Gross Fixed Investment in Agric., Hunting & Forestry	-	-	0.0002 (0.0006)	-0.0008* (0.0004)	-	-
Gross Fixed Investment in Fishing and Fish Farming	-	-	0.0007 (0.0004)	0.0001 (0.0004)	-	-
Gross Fixed Investment in Mining and Quarrying	-	-	0.001 (0.003)	-0.002 (0.002)	-	-
Gross Fixed Investment in Oil and Gas Extraction	-	-	0.000 (0.000)	0.000 (0.000)	-	-
Gross Value Added in Agriculture, Hunting & Forestry	-	-	-	-	0.0004 (0.0005)	-0.0006*** (0.0001)
Gross Value Added in Fishing and Fish Farming	-	-	-	-	0.0001 (0.0001)	-0.0005*** (0.0001)
Gross Value Added in Mining and Quarrying	-	-	-	-	0.0001 (0.0012)	0.0003 (0.0007)
Gross Value Added in Oil and Gas Extraction	-	-	-	-	0.000 (0.0001)	0.0002** (0.0001)
Share of Population with upper Secondary Education	0.0003 (0.0008)	-0.002 (0.001)	0.0005 (0.0008)	-0.0001 (0.0008)	0.0004 (0.0008)	-0.001 (0.0014)
Heating Degree Days	-0.007 (0.005)	-0.011** (0.004)	-0.007 (0.005)	-0.0185*** (0.004)	-0.0062 (0.005)	-0.014** (0.004)
R-squared	0.13	0.43	0.03	0.49	0.14	0.42
F/Wald Stat (p-value)	1.49 (0.19)	122.59 (0.00)	1 (0.43)	30.53 (0.00)	0.86 (0.52)	122.43 (0.00)
# of observations	172	172	172	172	172	172

Note: ***, **, * represents significance at 1%, 5% and 10% respectively, Robust standard errors in ()

evaluate the impact of agriculture, hunting and forestry-based natural resource production (on per capita GDP and population dispersion) are contradictory with no common pattern that would allow us to make a generalization.

From a descriptive point of view, however, our initial set of analyses suggests that agriculture, hunting, and forestry are detrimental rather than beneficial for regional development. By focusing on regions such as Hedmark and Oppland, where agricultural activity is conducted more intensively, it is evident that these regions lag the most in terms of regional per capita income.

To complement the first set of empirical analysis, additional analysis is used to see the impact of the NR sectors on per capita GDP growth and population density growth. In addition, "urban growth" is estimated to test regional attractiveness using the population growth rate. Significant relationships between employment and value added in oil and gas extraction with regional population density growth are identifiable. In the case of population growth, we fail to detect any significant influence arising from oil and gas extraction, or from mining and quarrying activities.

In light of these findings, implications of resource-based activity in Norway are instructive both for national as well as regional matters. In resource curse literature, many oil rich countries use their oil revenues in unproductive activities (e.g. Nigeria or Angola). Norway, however, successfully developed a government fund where oil and gas proceeds are deposited, and only around 4% is withdrawn annually to be used for public services. Although oil in Norway is concentrated in production, this fund helps diffuse revenues in a manner that distributes it back to the public. As such, the expansion of public spending from oil revenues favors the majority of the population. In a similar vein, considering the non-existence of rent-seeking elites or other interest groups, the country has been enjoying an equitable distribution of oil revenues (Mehlum et al. 2012). Meanwhile, backward and forward linkages established by the oil and gas, and mining sectors with other industries potentially create benefits for regional incomes. For instance, iron is essential for the steel industry and iron extraction provides inputs for those industries that have to integrate iron or steel into their production. Similarly, oil and gas sectors are highly capital-intensive sectors, which generate spillover effects for the rest of the economy. Although renewable energy is on the rise in Norway, oil and gas are likely to be used as energy sources for some industries in the easily reachable regions. Since the early 1990s, manufacturing has mainly occurred in oil-related sectors, such as oil refineries, and ship and petroleum exploration equipment (Mehlum et al. 2012).

Another aspect of the discussion in Norway comes from a technological advancement point of view. Innovation systems are constructed to exploit offshore oil and gas, attaching roles to different actors such as Statoil – the national oil company – foreign petroleum companies, research bodies, and the Petroleum Directorate (Sæther et al. 2011). The key points in improving these innovation systems have been first, the flow of knowledge from non-resource sectors to resource-based industries and second, technology transfer from foreign sources (Fagerberg et al. 2009). Nevertheless, the efficiency of these systems depends on the operation of the institutional framework, which is also favorable in Norway. Sæther et al. (2011) put forward the idea that the shift of labor and capital towards resource extraction, such as minerals, oil, and gas, stimulates better-educated workers, when higher wages are offered in the extractive sector.

Given the findings reported in this study, as well as the contemporary developments in Norway to better construct and operate oil, gas, and related sectors, we believe the dynamic relationship between NR-based production and regional development will become even more prominent in the future. In that sense, this will not only directly occur in the oil and gas extracting areas, together with mining and quarrying activities, but also in areas investing in related industries, which may bring along some degree of improvement. That is to say, policy-wise, results of this study point out the necessity of forming linkages between NR-based (especially oil, gas, and mining related) and other sectors in the less developed regions of the country. Besides, employment effects in NR activities should be coupled with human capital improvements, such as increased levels of education.

As mentioned above, our attempt to examine the impact of natural resources on regional income and population density might be developed further. We have accounted for human capital levels (education) and energy demand (heating degree days) in the Norwegian regions, but the effects of other factors could also be checked depending on data availability. For instance, sectorial diversification and existing linkages between resource-related industries, and technological improvements might influence regional income as well as alter population distribution across regions. We believe increasing availability of detailed regional data in the future will increase the power and the robustness of the results obtained in this study.

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A Appendix

Table A.1: Regions of Norway

NUTS 2	NUTS 3
NO01 Oslo og Akershus	NO011 Oslo
	NO012 Akershus
NO02 Hedmark og Oppland	NO021 Hedmark
	NO022 Oppland
NO03 Sør-Østlandet	NO031 Østfold
	NO032 Buskerud
	NO033 Vestfold
	NO034 Telemark
NO04 Agder og Rogaland	NO041 Aust-Agder
	NO042 Vest-Agder
	NO043 Rogaland
NO05 Vestlandet	NO051 Hordaland
	NO052 Sogn og Fjordane
	NO053 Møre og Romsdal
NO06 Trøndelag	NO061 Sør-Trøndelag
	NO062 Nord-Trøndelag
NO07 Nord-Norge	NO071 Nordland
	NO072 Troms
	NO073 Finnmark

Source: Statistics Norway (SSB)

Table A.2: List of Variables

Variable	Unit
population density	*Persons per sq. kilometer*
per capita GDP, current prices	*Current prices (NOK)*
employment in agriculture etc.	*Employed persons (1 000 persons)*
employment in fishing etc.	*Employed persons (1 000 persons)*
employment in mining etc.	*Employed persons (1 000 persons)*
employment in oil and gas etc.	*Employed persons (1 000 persons)*
gross fixed capital formation in agriculture etc.	*Current prices (mill. NOK)*
gross fixed capital formation in fishing etc.	*Current prices (mill. NOK)*
gross fixed capital formation in mining etc.	*Current prices (mill. NOK)*
gross fixed capital formation in oil and gas etc.	*Current prices (mill. NOK)*
gross value added in agriculture etc.	*Current prices (mill. NOK)*
gross value added in fishing etc.	*Current prices (mill. NOK)*
gross value added in mining etc.	*Current prices (mill. NOK)*
gross value added in oil and gas etc.	*Current prices (mill. NOK)*
human capital	*Share of population with secondary education*
heating degree-days	*Actual heating degree-days*

Source: Statistics Norway (SSB)

Table A.3: Descriptive Statistics

Variable	Mean	Median	Minimum	Maximum
Per Capita GDP	326149	303539	187152	909172
Population Density	89.5517	15	1.6	1301.8
employment in agriculture etc.	0.0187348	0.0152504	0.000182277	0.0589516
employment in fishing etc.	0.004857	0.0018842	0.000000	0.0216044
employment in mining etc.	0.000909707	0.000717267	0.000000	0.00272057
employment in oil and gas etc.	0.00114833	0.000000	0.000000	0.0193665
gross fixed capital formation in agriculture etc.	1.54816	1.21355	0.00557195	5.09805
gross fixed capital formation in fishing etc.	0.564127	0.223225	0.000000	4.89965
gross fixed capital formation in mining etc.	0.112916	0.0777114	-0.635131	0.640337
gross fixed capital formation in oil and gas etc.	3.4297	0.000000	0.000000	142.781
gross value added in agriculture etc.	4.03502	3.33958	0.0747334	12.8145
gross value added in fishing etc.	2.96257	0.609624	-0.441516	17.426
gross value added in mining etc.	0.719262	0.465311	0.0109366	2.93404
gross value added in oil and gas etc.	1.64315	0.000000	0.000000	26.3882
Variable	**Std. Dev.**	**C.V.**	**Skewness**	**Ex. kurtosis**
Per Capita GDP	109197	0.334808	2.25189	7.42758
Population Density	268.468	2.99791	3.93302	13.7238
employment in agriculture etc.	0.0129105	0.689115	1.04326	0.200275
employment in fishing etc.	0.00635761	1.30896	1.20868	0.018764
employment in mining etc.	0.00064035	0.703907	1.00731	0.509613
employment in oil and gas etc.	0.00322789	2.81094	4.4032	20.5246
gross fixed capital formation in agriculture etc.	1.08261	0.699286	1.21986	0.937858
gross fixed capital formation in fishing etc.	0.823237	1.45931	2.12201	5.117
gross fixed capital formation in mining etc.	0.129942	1.15078	0.34501	6.12033
gross fixed capital formation in oil and gas etc.	16.8829	4.92257	6.42479	43.3187
gross value added in agriculture etc.	2.95463	0.732246	1.2893	0.957145
gross value added in fishing etc.	4.15708	1.4032	1.31294	0.498238
gross value added in mining etc.	0.679665	0.944948	1.62535	1.90718
gross value added in oil and gas etc.	4.38638	2.66949	3.73153	14.0502