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Relatedness and the Resource Curse
Is there a liability of relatedness?

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Abstract
The literature on relatedness emphasizes the benefits of co-location with related industries, as knowledge spillovers promote innovation and regional branching. However, resource competition between industries which rely on related capabilities has not largely been considered. The resource curse literature argues that resource competition produces adverse effects for other industries when extractive industries expand. However, this literature has not considered whether this depends on the relatedness between the resource industry and these other industries. This paper brings together these two strands of literature. We examine the relationship between the oil and gas industry in Norway and its related industries during a period of rising oil prices and an expansion of the oil and gas industries. We conduct the analysis at the national scale, as well as in the most oil-specialised region of Stavanger, in order to examine how these dynamics play out at a regional, as well as national level. An analysis of the labor flow between the petroleum and related industries using a Norwegian linked employer-employee database reveals that higher wages increase the likelihood of moving from related industries into petroleum, but reduce the likelihood of moving in the opposite direction. The petroleum industry recruits the most productive workers from related industries and returns its least productive workers. Consequently, we argue that relatedness is not an even playing field: There may be losers, as well as winners, from relatedness.

Keywords: Relatedness, resource curse, petroleum, labour mobility, Norway

INTRODUCTION

The question of how industries within a region affect each other is central in evolutionary economic geography, in particular in the literature regarding relatedness. Regional industries may benefit from cross-industry knowledge spillovers, in particular when they build on related skills. Such knowledge spillovers may be more important than intra-industry spillovers, as the cross-fertilization of ideas across industries may give rise to Schumpeterian new combinations and innovation, provided they are sufficiently related to enable effective communication (Nooteboom 2000). This in turn gives rise to regional branching, as new industries emerge from existing capabilities in areas technologically related to the region's existing strengths (Boschma and Frenken 2009).

The near-consensus on the positive contributions of relatedness to regional economic growth (Frenken et al 2007), resilience (Diodato and Weterings 2015), and the performance of individual firms (Eriksson 2011; Timmermans and Boschma 2014) has made this perspective central in regional economic policies (McCann and Ortega-Argilés 2015). However, relatedness between industries is often identified from the application of similar resources and technologies, for example, by analysing the flow of resources or the co-occurrence of technologies (Neffke and Henning 2013; Essletzbichler 2015). This implies that related industries also compete on factor markets. Such competition, however, has not received much attention within evolutionary economic geography. While relatedness might facilitate inter-industry knowledge spillovers, it might also entail inter-industry competition which can make it harder for related industries to access important input. This is particularly a risk when there are large asymmetries in power

between industries (for example, if dominant industries divert resources away from smaller ones). This can potentially lead to a decline in the related industries by decreasing regional diversification and subsequently lowering inter-industry knowledge spillovers.

How dominant industries, specifically natural resource industries, affect other industries in an economy is a core issue within the resource curse literature. This literature paints a bleaker picture of this relationship by highlighting the negative effects of dominant resource industries on other tradable sectors. These negative effects are related to macro-economic and political-institutional dynamics and also to labor-market competition due to the higher wages in natural resource industries (Venables 2016). Rather than regional branching, this typically leads to de-branching and an increase in the specialization in resource economies, making them vulnerable to sudden shifts in the market prices of the natural resources.

This paper integrates these two bodies of literature and examines how the growth of a dominant resource-based industry affects other industries. In doing so, it aims to contribute to both relatedness and resource curse literature. The former has tended to overlook the potential liabilities of being related to growing industries, in particular in terms of labor-market competition, and the resulting potential for de-branching. The latter has not considered whether the negative effects highlighted might play out differently for industries which are related or unrelated to the resource industry. It has also only to a limited extent examined how resource curse dynamics play out at a regional, rather than national level. If competition for skilled labor is an issue, this should be more severe for industries that rely on related skills than for those that rely on unrelated skills. It should also be more visible at the regional level, considering that labor is not perfectly geographically mobile.

We examined the petroleum industry in Norway, in its main petroleum hub of Stavanger, during the period 2001-2007. During this period, we distinguished between the years with unchanged petroleum prices (2001-2003) and the years with increasing prices (2004-2007). Norway is frequently highlighted as a country that has largely managed to escape the resource curse, in particular in terms of the macro-economic and political-institutional dynamics, due to its strong institutions and the establishment of a sovereign wealth fund that shields the national economy from macro-economic impacts (Larsen 2006; Mehlum et al. 2012). This allows us to isolate the labor-market implications of resource extraction as much as possible. We conducted the study during a period of rising oil prices in an already oil-intensive national and regional economy. This enabled an analysis of what happens to other industries as the petroleum industry expands. We identified industries related to the oil industry based on labor mobility patterns, using linked employer-employee data from Norwegian registers. Subsequently, we examined employment levels and mobility patterns between the petroleum and other industries, distinguishing between petroleum-related and petroleum-unrelated tradable industries, as well as non-tradable industries. We were particularly interested in the mobility between petroleum and petroleum-related industries.

In the following section, we present an overview of the literature regarding relatedness and the resource curse. Subsequently, we bring the two literatures together by discussing a potential curse of relatedness for industries which are related to resource industries. Next, we present our empirical research strategy by describing the available data, our relatedness measure and the Norwegian petroleum industry. In Section 4, we examine labor mobility patterns between the petroleum and other industries, followed by a regression analysis of the characteristics of workers moving between industries in Section 5. Section 6 concludes the study.

THEORY

Relatedness and regional economic development

Within a relatively short time-span, the concepts of related variety and relatedness have achieved a central position in evolutionary economic geography and its connected disciplines. The concepts combine features of Marschall-Arrow-Romer (MAR) and Jacobian externalities (Frenken et al 2007), while simultaneously being heavily inspired by the work of Nooteboom (2000) and Boschma (2005) on the role of (cognitive) proximity in supporting interactive learning. Studies investigating the effects of related variety on regional economic performance have focused on various regions within Europe (Frenken et al 2007; Boschma & Iammarino 2009; Boschma et al 2012; Hartog et al 2012; Bishop & Gripaios 2010; Van Oort et al., 2015) and the United States (Boschma et al 2014; Essletzbichler 2015) and have covered nearly all industries. The overall conclusion is that related variety positively affects employment growth. However, there is considerable heterogeneity between industries.

In addition to investigating how skill relatedness affects regional economic development, these concepts have also been applied to describing, understanding, and even predicting changes in the regional industrial composition (Frenken & Boschma, 2007; Neffke et al., 2011; Boschma & Gianelle, 2013). The process underlying such industrial change has been referred to as regional branching, where the existing industry composition creates opportunities for the entry of new related sectors (Boschma & Frenken 2009). The existing industrial structure consists of a set of competences, which can form a fertile ground for the establishment of new industries (Neffke et al., 2011; Boschma et al., 2013). Given these properties, the concept of relatedness has increasing policy relevance, in particular in relation to smart specializations (McCann & Ortega-Argiles 2015).

More recently, studies of industry decline (Holm et al 2017; Eriksson et al 2016) have used relatedness to explain why certain areas cope better with economic shocks than others (Diodata & Weterings 2015; Holm & Østergaard 2015). Holm et al (2017) investigate how the presence of related industries in the region affects the level of job re-allocation and skill destruction. They demonstrate that related industries not only positively affect the likelihood of displaced workers finding new employment, but also mitigate skill destruction, as wage levels are hardly affected. Eriksson et al (2016) show similar patterns. At the economy-wide level, Diodato & Weterings (2015) demonstrate that Dutch regions with high levels of related variety recover faster from economic shocks. These regions absorb laid off workers faster due the demand for similar skills by these related industries. However, the effect does not seem to hold universally (Holm & Østergaard 2015).

Notwithstanding these positive externalities of being located in the proximity of related industries, there are also situations where negative externalities might occur. After all, there are rarely any free lunches in economics, and the costs and benefits of relatedness may be unequally distributed across industries. Strong interdependencies among related industries could cause labor market friction. Related industries, due to their overlap in products and technologies, rely on employees with similar skills. In the human capital literature, this is referred to as industry-specific human capital, i.e. human capital is neither general nor firm-specific, but rather specific to an industry or line of work (Neal 1995; Parent 2000). Consequently, to the same extent that displaced workers can find new employment in related industries when an industry is declining, there will be rivalry for (skilled) labor between related industries when an industry is growing. This is particularly the case for co-located industries, as social forces limit the extent to which employees are willing to move to pursue a career somewhere else (Dahl & Sorenson 2010).

Such friction is not uncommon, especially in the situation where an industry is dominant or booming. Moreover, this friction might heavily influence not only related industries, but also the development of new economic activities. For example, Sørensen (2004) investigates how new venture creation is limited in industries that have a dominant position in their respective regions. Nascent entrepreneurs have difficulties mobilizing labor, as all available labor in the region is already allocated to the incumbent firms within the industry.

The resource curse

Indeed, friction between industries is central in the literature concerning the resource curse. An important claim in this literature is that economies dominated by a resource-intensive industry will experience reduced competitiveness in other tradable industries. A recent estimate holds that $1 of resource revenue is associated with a decrease of 74 cents in non-resource exports, with a stronger effect of 91 cents in high-income countries (Harding and Venables 2016). This is partly due to macro-economic effects, notably that resource exports will lead to currency overvaluation, making the products of other tradable industries more expensive on the world market (Sachs and Warner 2001). It is partly also because of political and institutional effects, as natural resources may breed conflict and delay institutional development (Karl 1997; Collier and Hoeffler 2004). However, a third aspect of the resource curse hypothesis is that the factors of production are drawn into resource extraction. They are also drawn to non-tradable sectors, which tend to expand in response to increased domestic spending due to activities in the resource sector (Corden and Neary 1982). This makes it more difficult for other tradable industries to get access to capital and labor. These effects are more severe when employment levels are high (Venables 2016). More generally, the resource curse literature is the story of how the prosperity of one sector damages other sectors in the

economy. Due to increasing revenues, the dominant (or booming) industry is able to attract capital and labor at the expense of the other sectors (Corden 1984).

While the resource curse literature highlights an aspect of industrial dynamics that the relatedness literature largely overlooks, it retains blind spots of its own. For instance, the central element in relatedness, namely knowledge spillovers between different industries, has until recently not been considered (Bjørnland and Thorsrud 2016). Relatedness between industries has also not been analysed, as the literature has focused on the implications of resource extraction for other tradable industries in general. However, industries which are related to resource-based industries would, based on the insights from the relatedness literature, be expected to be more strongly affected than the unrelated industries, both in terms of the positive externalities from knowledge spillovers and the negative externalities from resource competition, as they depend on more similar input, for example, employees with related skills.

The resource curse literature has also mainly examined dynamics at a national level. While the macro-economic implications of resource extraction, as well as political-institutional effects[1], play out mainly at the national level, this is not the case for resource competition. The competition for labor has a strong regional dimension when geographical mobility is limited. The economic geography literature would thus predict stronger effects for related industries which are co-located with the petroleum industry, while geographical distance would imply that industries in less petroleum-specialised regions are partly shielded from this impact.

Integrating the perspectives: A curse of relatedness?

[1] Although on political and institutional implications of oil extraction at the regional level, see e.g. Fitjar (2010; 2013).

This paper brings the two perspectives together by focusing on resource competition in the labor-market. Building on the relatedness literature, we hypothesize that tradable industries which are related to the petroleum industry will face greater difficulties recruiting skilled labor. These industries are more at risk of losing key employees to the petroleum industry and will have a harder time recruiting new employees. They will need to pay higher salaries than unrelated industries in order to face the competition from the petroleum industry for skilled labor. However, they will still not be able to match the salaries in the petroleum industry itself, where resource rents allow firms to pay premium salaries. Consequently, the most productive employees in the related industries will be more prone to leave their related industries for the petroleum industry, and less prone to move the other way. These dynamics will be stronger for industries which are co-located with the petroleum industry.

This process can be summarized as follows: Let's say a resource-based industry experiences increasing demand for its products and services, both nationally and internationally. The increased demand results in an increase in production capacity, which requires additional capital and human resources. Given that the size of local labor markets are relatively stable in the short run (and, in general, individuals are reluctant to move), prime candidates for these positions are individuals that work in related industries in the region. Unemployed individuals may be less appealing, as their labor market status sends a negative signal to prospective employers. Some related industries will have supplier relations to the resource-based industry, in which case their demand will also increase. However, because they lose employees to the resource-based industry, they not only need to hire new staff, but also replace those employees who they lost to the booming industry. Related industries that are only skill-related, but otherwise do not have a supplier relationship, face similar challenges, except that their market does not grow.

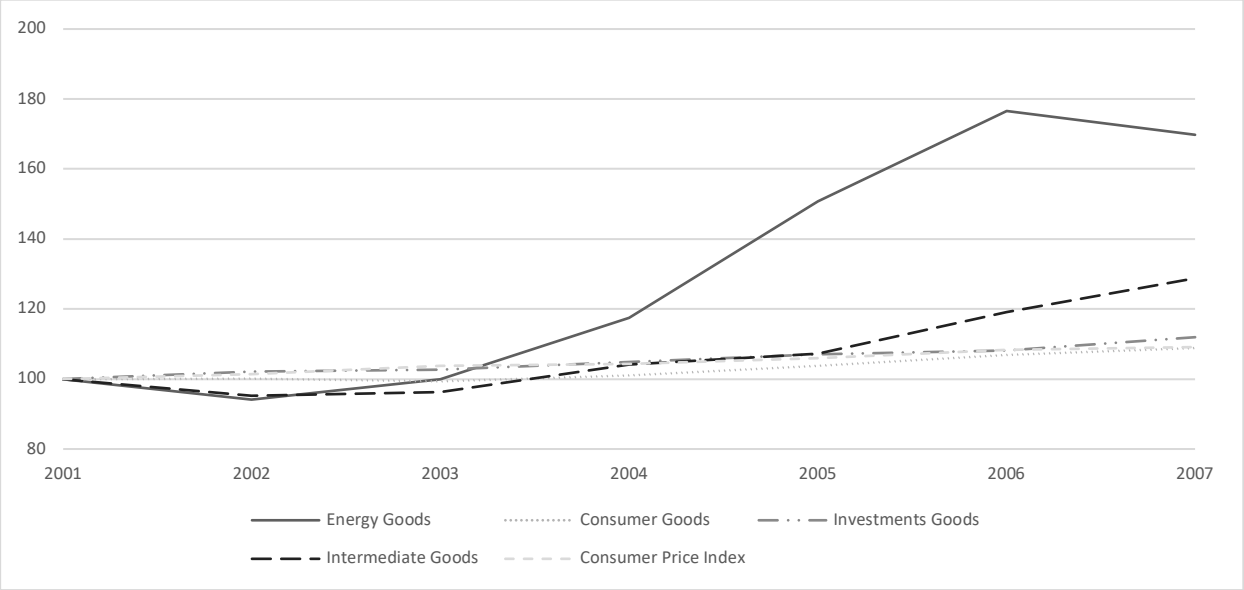
An implication of this is that relatedness may not only be conducive to regional branching, but in some contexts also to regional debranching, depending on how the costs and benefits of relatedness are distributed. If the dominant industry benefits more from relatedness, while the related industries experience higher costs due to competition for skilled labor, the outcome could be path dependent regional development with a gradual withering away of related variety in the region.

RELATEDNESS AND THE NORWEGIAN PETROLEUM INDUSTRY

To investigate this issue and demonstrate some of the mechanisms, we present a case study of the petroleum industry in Norway, in its main oil hub Stavanger. This is a useful example for illustrating the above mechanisms due to the presence of several key characteristics: First, petroleum is a dominant industry in Norway. In 2006, at the end of our investigation period, it accounted for more than half of the country's exports and 25 percent of its GDP (Mohn 2008), and Norway was the world's fifth largest net exporter of petroleum. The industry is concentrated in Stavanger, where the location quotient for the petroleum industry was 5.7 in 2001. Second, the petroleum industry is a tough competitor in the labor market due to resource rents that allow it to pay premium prices for labor. Norway had a very low level of unemployment throughout this period and there was thus high competition for labor among employers. From 2003 to 2007, the unemployment rate declined from 4.5 to 2.5 percent. In Rogaland County, where Stavanger is located, the unemployment rate dropped from 4.1 percent at the start of 2003 to 1.0 percent at the end of 2007. Third, investments and hence labor demand in the petroleum industry is heavily affected by the price of oil, which grew faster than the prices of most other goods in the period from 2004 to 2007 (see Figure 1). Consequently, the demand for labor increased during this period

and the petroleum industry enhanced its already dominant position. Mohn (2008) estimates that investments in the oil and gas sector grew by NOK 40 billion from 2002 to 2007, or the equivalent of 3 percent of GDP in 2002, with heavily increasing demand for labor over this period.

Figure 1: Commodity and Consumer Price Index 2001-2007



Source: Statistics Norway

In order to examine the developments in the petroleum industry and in related industries, we rely on linked employer-employee data for all private sector employees in Norway for the period 2001-2007. This provides complete data on employment in Norwegian industries and regions, as well as on labor mobility across industries. The data furthermore provides information concerning salaries and educational attainment, enabling us to examine employees' characteristics. We restrict the analysis to private sector employees (excluding NACE 75-91 and 74.50 recruitment agencies) aged 18-65 who work more than 20 hours per week. This leaves a population of 8.3 million worker-year observations, or around 1.2 million per year. The analysis for Stavanger focuses on the labor-market region around Stavanger, including the official statistical regions of Stavanger/Sandnes and Jæren, with 490.000 observations.

We first identify industries whose core activities are oil and gas exploration and exploitation. This includes industries directly involved in oil and gas extraction, as classified by Statistics Norway (Ekeland 2014; Prestmo et al. 2015): extraction of crude petroleum and natural gas (NACE 11.100), service activities incidental to oil and gas extraction (NACE 11.200), and transport via pipelines (NACE 60.300). In addition, we include industries in which all firms supply goods and services targeted at the petroleum industry, following the broader classification of the Norwegian petroleum industry by Blomgren et al. (2013). This extended definition includes the manufacturing of refined petroleum products (NACE 23.200), the building and repair of oil platforms and rigs (NACE 35.114 and 35.115), providers of tugboats and supply vessels (NACE 61.106) and offshore supply terminals (NACE 63.224)[2]. We classify all these industries as petroleum industries.

Next, we distinguish between tradable and non-tradable industries by following the definition by Mano and Castillo (2015). They classify primary industries, namely mining, manufacturing, wholesale, transport, finance and business services as tradable, while utilities, construction, retail, food and accommodation services, communication services, and real estate are non-tradable.

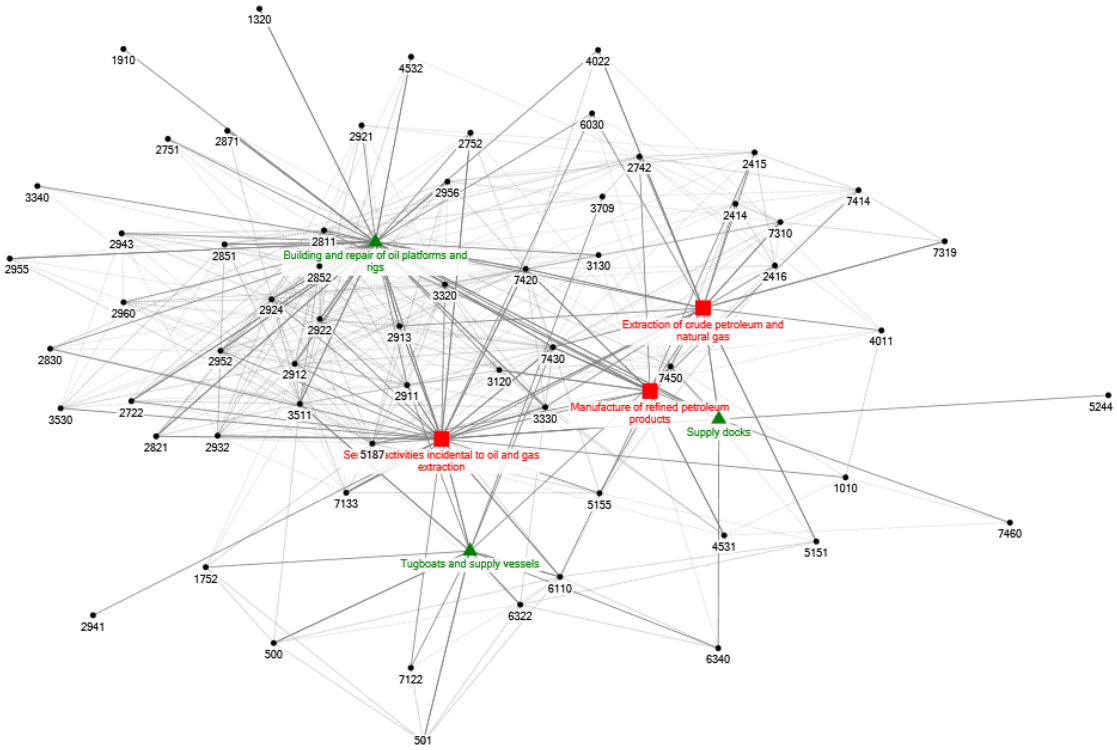
Finally, we identify industries which are related to the petroleum industries. We rely on the method of skill relatedness based on labor mobility flow, as introduced by Neffke and Henning (2013). We apply this to Norwegian data by following the approach in Fitjar and Timmermans (2017), but develop the measure using labor mobility flow during the period 2000-2007. We limit the study to this period as there is a large structural break from 2008 onwards with the introduction of NACE rev. 2. In total, 537 different industries are identified based on 4-digit NACE rev 1.1 codes, giving

[2] Ekeland (2014) uses a similar definition, although omitting manufacturing of refined petroleum products, and tugboats and supply vessels. We follow Blomgren et al. (2013) in including these as petroleum industries.

287,832 potential industry pairs. We observe actual labor mobility between 67,873 industry pairs during the period. We identify industries as related if the standardised skill-relatedness score is higher than or equal to 0.25. In order to counter the impact of temporary fluctuation, we impose the additional criterion that standardised skill-relatedness must be higher than or equal to 0 for at least three of the seven years of measurement. Applying this measure, 6494 of the industry pairs are related.

Figure 2 shows industries which are related to any of the petroleum industries. The petroleum industries included in Statistics Norway's narrower definition are highlighted with red solid squares, while those additionally included in Blomgren et al.'s (2013) broader definition are highlighted with green triangles.

Figure 2: Norwegian Oil & Gas and Related Industries



CROSS-INDUSTRY LABOR MOBILITY PATTERNS

We classify industries into four sectors: petroleum industries, petroleum-related tradables (all industries in black in Figure 2), petroleum-unrelated tradables (all tradable industries not included in Figure 2), and non-tradables. Aggregating employment over these categories, Table 1 shows their employment trends during the period 2001-2007 at the national level and in the Stavanger region

Table 1: Growth of Industries 2001-2007 (2001=100)

	2001*	2002	2003	2004	2005	2006	2007
Norway							
Non-Tradables	100	99	96	99	100	103	105
Unrelated Tradables	100	97	93	92	91	93	93
Petroleum Related Tradables	100	96	96	99	97	101	106
Petroleum	100	101	99	102	111	125	133
Total	100	98	95	96	96	99	101
Stavanger							
Non-Tradables	100	98	94	97	99	105	110
Unrelated Tradables	100	99	98	97	97	101	106
Petroleum Related Tradables	100	95	94	99	102	106	113
Petroleum	100	94	91	92	89	110	119
Total	100	97	94	96	96	105	111

*The values in 2001 for Norway as a whole are 453.248, 531.503, 173.278 and 48.657 for respectively non-tradables, unrelated tradables, petroleum-related tradables, and petroleum firms. For the Stavanger region, the equivalent figures are 21.346, 21.894, 10.700, and 16.106.

Similar to Ekeland (2014), we found an overall increase in petroleum employment. The increase happened almost entirely from 2004 to 2007, which is also when oil prices were rising rapidly in the world market. The petroleum industry grew much faster than other industries, adding a third of

all new jobs over the period, compared to a job growth of only 1 percent in the economy as a whole. As predicted in the resource curse literature, non-tradables grew faster than tradables during the period, expanding by 5 percent, mainly from 2003 to 2007. Among tradables, related industries appeared to benefit overall. While employment in unrelated tradables declined by 7 percent over the period, related tradables grew by 6 percent. Petroleum-related tradables grew mainly from 2005 to 2007, but fared better than unrelated tradables also during the slowdown in the first part of the period.

Stavanger exhibited a stronger employment growth than Norway as a whole, adding 10 percent of all new jobs. Notably, Stavanger had weaker growth in the petroleum industry itself than did the national economy. Indeed, the petroleum industry contracted in Stavanger from 2001 to 2005. Rapid growth between 2005 and 2007 meant the industry still grew by 19 percent over the period as a whole, but this amounted to less than the 33 percent growth in the national economy[3]. Instead, Stavanger's growth was more balanced, with stronger growth in all other categories than the national economy, even if the petroleum industry was still the largest growth sector. Petroleum-related tradables notably grew by 13 percent compared to 6 percent for unrelated tradables, suggesting that processes of regional branching were at play. Stavanger's non-tradable sector also expanded by more than the national level, adding 10 percent more jobs.

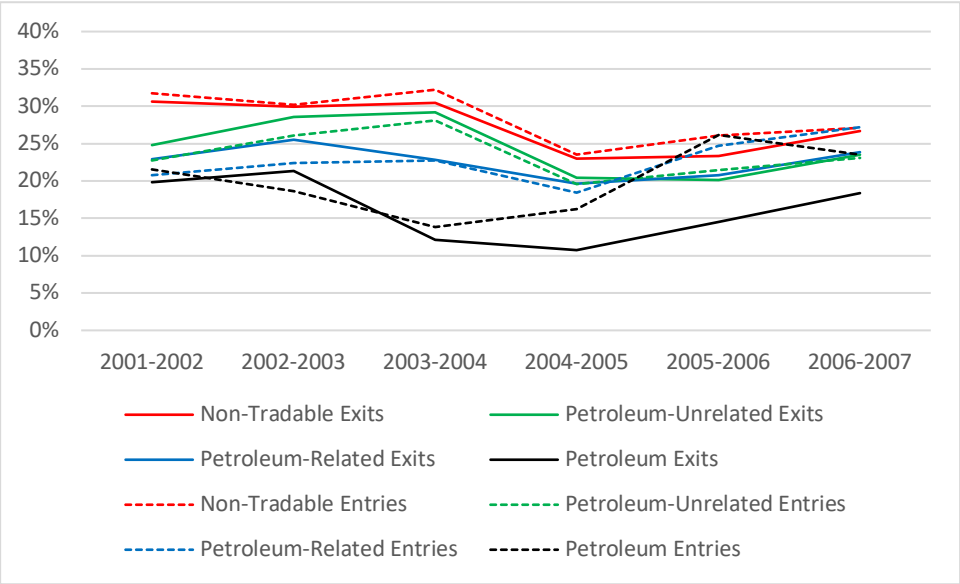
Norwegian oil and gas seems to follow the branching logic of the relatedness literature, growing more strongly in industries which are related to petroleum than in unrelated industries. This is

[3] These overall figures mask considerable within-industry variation in the petroleum industry. Oil and gas extraction grew by 25 percent in Stavanger and oil and gas services by as much as 56 percent, compared to 17 and 26 percent for the national economy. However, the building and repair of oil platforms and vessels dropped by/to 16 percent in Stavanger over the period. This was 20 percent in the country as a whole.

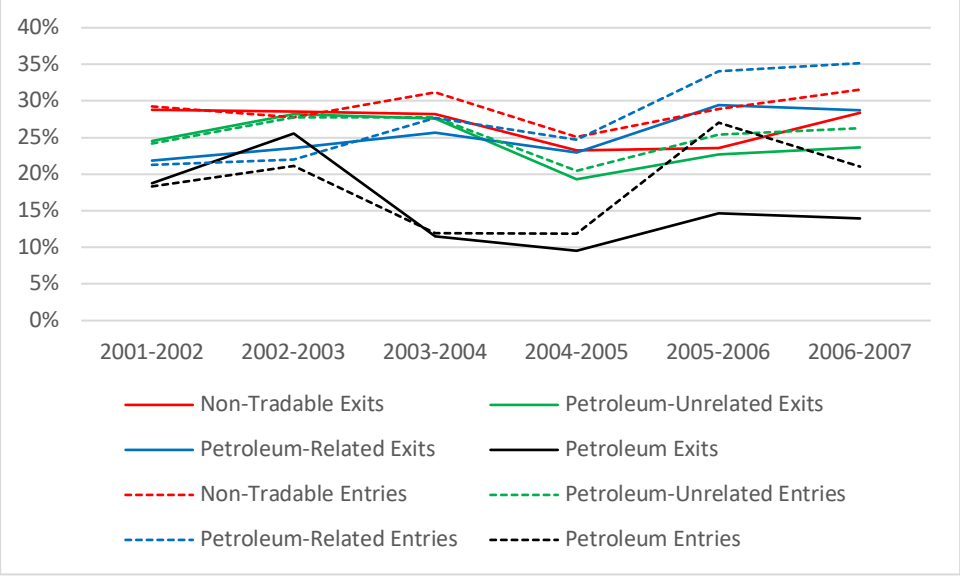
particularly the case at the regional level. Nonetheless, the dominant petroleum industry still grew more strongly than other tradables, even related ones, making the economy even more specialised.

Figure 3: entry and exit of labor 2001-2007

Norway



Stavanger



The growth in all industries also begs the question of where firms recruit the additional labor needed from. To address this, Figure 3 shows the entry and exit rates of workers for each category.

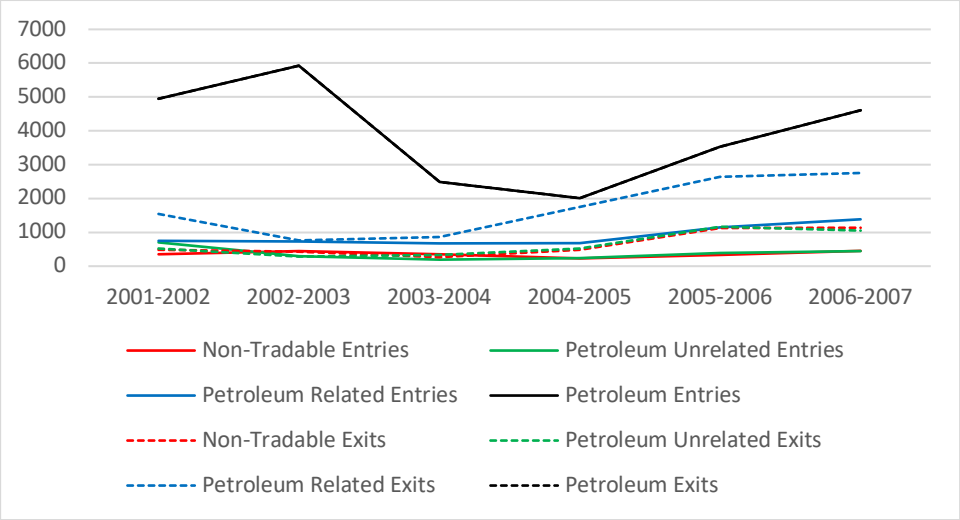
The entry and exit rates are relatively high, varying from 21 to 28 percent for the economy as a whole. In the petroleum industry, exit rates are 20 and 21 percent in the first two years, but subsequently much lower than for other industries – between 11 and 18 percent. This is especially the case in Stavanger, where only 9.5 percent of workers left the petroleum industries in 2005, compared to 19 percent for the regional economy as a whole.

Figure 4 examines entries and exits to and from the petroleum industry only. Non-petroleum industries tend to have more outflow to petroleum than the labor they receive labor from this sector. Over the period as a whole, exits to petroleum outnumber entries from petroleum by a ratio of around 1.9 for petroleum-related tradables, 1.7 for unrelated tradables, and 1.8 for non-tradables. However, during the period of fast growth in petroleum, from 2005 to 2007, unrelated tradables fare worse, even reaching a ratio above 3 from 2005 to 2006. The pattern is similar in Stavanger, as 1918 workers left their related industries for petroleum over the period, while only 1241 moved the other way. However, entries to the oil industry in Stavanger from petroleum firms in other regions also outnumbered exits by more than 500 workers over the period, meeting some of the region's increased labor demand.

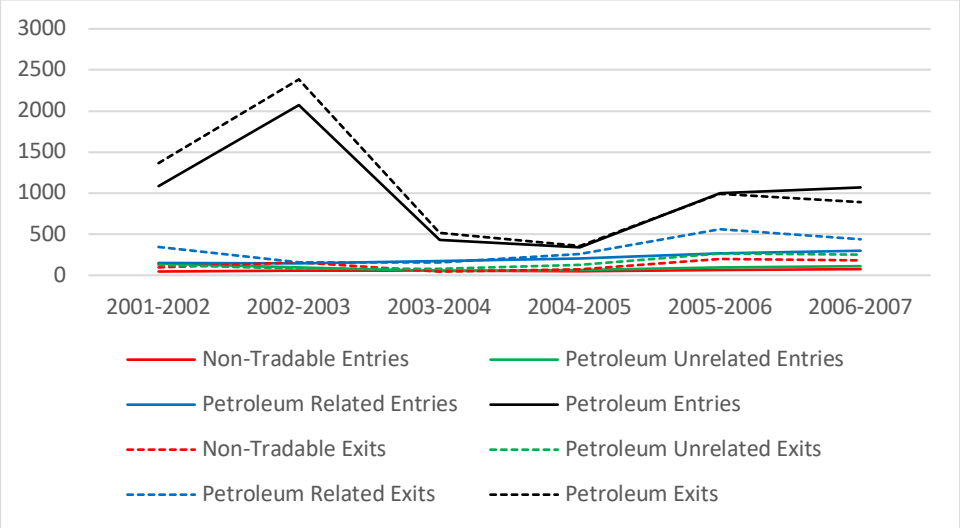
If we only focus on individuals with a high level of education, this difference is even more pronounced. All industries lose more highly educated workers to the petroleum industry than they receive in return. Again, petroleum-related industries lose more than they gain. In the 2006-2007 period, 1077 highly educated employees left their related industries for the petroleum industries, while only 460 workers moved the other way. Petroleum-unrelated firms also lost more than three times as many educated workers to petroleum as they received between 2004 and 2006. However, as a share of total high-skilled labor in unrelated industries, this represents quite a low amount of people in substantial terms.

Figure 4: entry into Petroleum and exits from petroleum

Norway



Stavanger

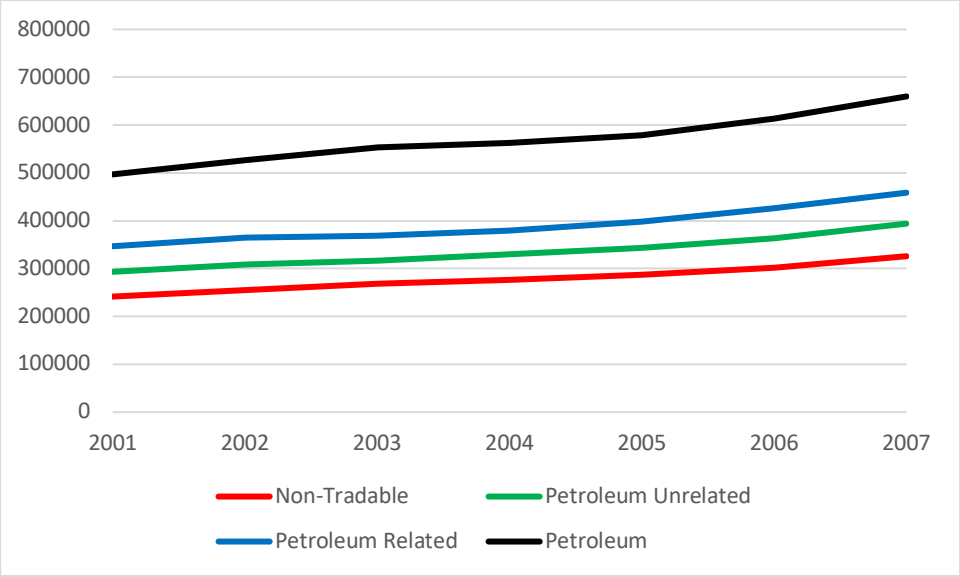


That many workers decide to move to petroleum is not surprising. These industries pay considerably higher wages than other industries. Figure 5 shows the mean wages in each industry category. In 2007, the average wage in the petroleum sector[4] was 44 percent higher than petroleum-related tradables, 67 percent higher than petroleum-unrelated tradables and more than double the average in non-tradables. The petroleum industry in Stavanger paid higher wages still, reaching 2.2 times the average of non-tradable wages. Wages in petroleum-related tradables are notably higher than in unrelated ones. This is especially the case in the Stavanger region, where the difference is NOK 95,000 compared to NOK 60,000 at the national level. Petroleum-related tradables in Stavanger paid wages above the national average for these industries throughout the period, while unrelated tradables only did so towards the end. In 2007, petroleum-related tradables in Stavanger paid 12 percent more than the national average, while unrelated tradables paid 6 percent more and non-tradable 0.6% more.

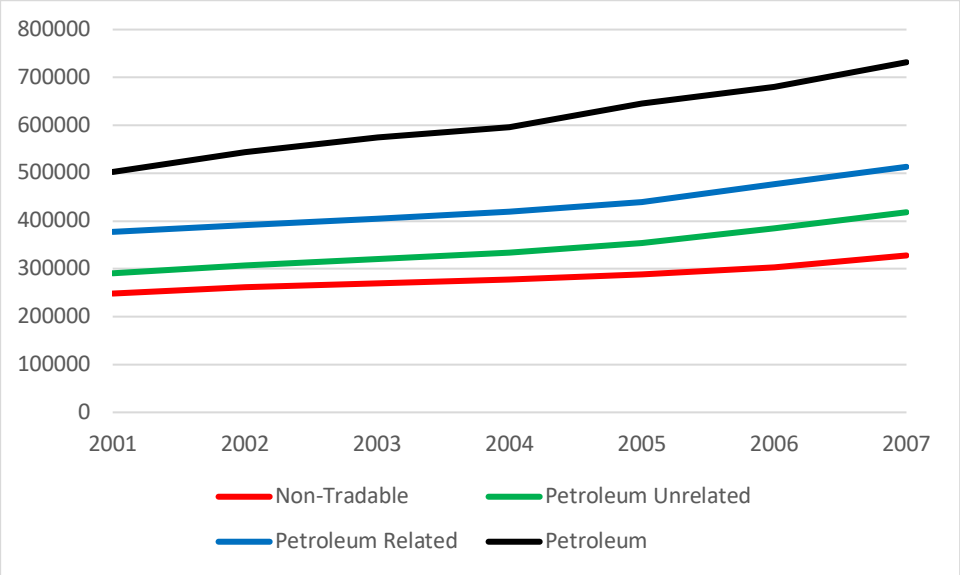
[4] The differences within the petroleum industry are also substantial, in particular between oil and gas extraction firms and other sub-categories. The average wage in oil and gas extraction was NOK 869.628 in 2007, and between NOK 504.643 and NOK 745.612 in the other petroleum industries. In Stavanger, the average wage in oil and gas extraction was NOK 922.394 in 2007.

Figure 5: Mean and median income levels, by industry types. NOK

Norway



Stavanger



In order to examine whether this is related to observable differences in the types of workers employed by these industries, Table 2 shows the results of regressing individual salaries for the four industry categories and for other features of the workers. The analysis reveals that even after controlling for education and demographic characteristics of the workers, petroleum-related tradables still pay around NOK 33,000 higher salaries than unrelated tradables. In Stavanger, the difference is NOK 64.000. These differences are still dwarfed by the petroleum industry, which pays around NOK 150,000 above the average wage in petroleum-related tradables.

Table 2: Regression of wages (in 100,000 NOK) on industries, controlling for demographic characteristics

	Norway			Stavanger		
	Coef.		Std.	Coef.		Std.
Non-tradables (baseline)						
Unrelated tradables	0.332	***	0.002	0.284	***	0.012
Petroleum-related tradables	0.688	***	0.003	0.928	***	0.015
Petroleum	2.104	***	0.005	2.433	***	0.014
Female	-0.818	***	0.002	-1.154	***	0.011
Age	0.015	***	0.000	0.027	***	0.001
Years since graduation	0.011	***	0.000	0.019	***	0.000
College (non-STEM)	1.478	***	0.003	1.874	***	0.015
College (STEM)	1.030	***	0.002	1.334	***	0.015
Constant	1.489	***	0.012	1.205	***	0.025
Year dummies	yes			yes		
Region dummies	yes			yes		
R^2	0.19			0.19		
N	8,172,254			484,287		

Table 3 shows separate regressions for the period with unchanged petroleum prices (2001-2003) and for the period with growing oil prices (2004-2007). The differences in wages between petroleum and other industries grew larger in the latter period. In the first period, wages in the petroleum industry were around NOK 120,000 higher than in related industries in Norway as well

as in Stavanger. In the growth phases, the difference grew to NOK 150,000 nationally and NOK 170,000 in the Stavanger region. Petroleum-related industries in Stavanger notably also had to pay a wage premium compared to the same industries nationally. In the growth period, wages in petroleum-related industries in Stavanger were on average NOK 100,000 higher than in non-tradables when the worker's characteristics were taken into account. In the national economy, the difference was NOK 70,000.

Table 3: Regression of wages (in 100,000 NOK) on industries, two periods

	Norway 2001-2003			Norway 2004-2007			Stavanger 2001-2003			Stavanger 2004-2007		
	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
Non-tradables (baseline)												
Unrelated tradables	0.324	***	0.002	0.336	***	0.003	0.216	***	0.011	0.327	***	0.020
Petroleum-related tradables	0.668	***	0.003	0.701	***	0.004	0.816	***	0.014	1.004	***	0.024
Petroleum	1.889	***	0.006	2.232	***	0.007	2.059	***	0.013	2.686	***	0.022
Controls	yes			yes			yes			yes		
Year dummies	yes			yes			yes			yes		
Region dummies	yes			yes			yes			yes		
R^2	0.22			0.17			0.32			0.16		
N	3,495,113			4,677,141			201,857			282.430		

WHICH WORKERS MOVE?

The above analyses provide insights into the volume of labor mobility flow across different types of industries and the average salaries within these industries. Besides the number of people that move between industries, we are interested in the characteristics of these workers. Therefore, we ran a multinomial logit regression analysis that estimated the (log) likelihood of a worker moving into a sector, depending on their previous sector of employment and their individual characteristics. The analysis takes on the following form:

$$\text{Logit}\,[\Pr(\text{Industry}_{i,t} = j)] = \alpha_j + \beta_{1j}\,\text{Industry}_{i,t-1} + \beta_{2j}\,\text{Income}_{i,t-1} + \beta_{3j}\,\text{Gender}_i + \beta_{4j}\,\text{Age}_{i,t-1} + \beta_{5j}\,\text{Years since graduation}_{i,t-1} + \beta_{6j}\,\text{STEM education}_{i,t-1} + \beta_{7j}\,\text{Other college education}_{i,t-1} + \beta_{8j}\,\text{County}_{i,t-1} + \beta_{9j}\,t$$

This model predicts the likelihood that individual *i* is employed in the *j*th industry at time *t* depending on the industry in which *i* works at time *t-1* as well as *i*'s income, education (distinguishing between STEM degrees and other university degrees, and also considering the number of years since graduation), age and gender, all measured at time *t-1*. Industry can take one of four values *j*: Non-tradable, petroleum-unrelated tradable, petroleum-related tradable, or petroleum. Income is measured as taxable employment income in 100.000 NOKs. Education is a dummy variable that takes the value 1 if *i* has completed a university degree at any level. We include separate dummy variables for educational background in the STEM subjects (Science, Technology, Engineering and Mathematics) and in other subjects. Those workers educated in STEM are identified by having 5 as the second digit (referring to natural sciences and technical subjects) in the Norwegian standard classification of education (NUS2000). Gender is a dummy variable that takes the value 1 for females and 0 for males. County is a vector of dummy variables for the counties of Norway, reclassified to merge counties forming part of the same labor market[5]. We also include dummy variables for each year *t* of observation.

Table 4 presents the results of the analyses. As relatedness is identified based on labor mobility patterns, it goes without saying that there is a positive coefficient for the likelihood of moving between petroleum and petroleum-related industries. However, the effect is far from symmetric.

[5] The counties merged are Oslo and Akershus, Hedmark and Oppland, Aust-Agder and Vest-Agder, and Sør-Trøndelag and Nord-Trøndelag.

Employees in petroleum-related industries have 5.6 times higher odds[6] of moving into petroleum industries than those working in non-tradables. For employees in petroleum industries, the odds of moving into petroleum-related industries are only 2.3 times higher than for those working in non-tradables. Employees in petroleum industries are also the least likely to move into unrelated tradables or non-tradables among all sectors.

Table 5 presents the results of the same analyses of the data for the 2004-07 period only. The discrepancy between petroleum and related industries became more pronounced when oil prices were growing. The coefficient for moving from petroleum-related industries into petroleum remained the same. However, the coefficient for leaving petroleum for a related industry dropped significantly. The discrepancy was also larger in Stavanger, and even more so during the 2004-07 period. During this period, employees in petroleum-related industries had 5.8 times higher odds of moving into petroleum than non-tradable workers with similar characteristics. However, petroleum workers had only 1.6 times higher odds of moving into petroleum-related industries than non-tradable workers.

There are also differences in the mobility of individuals with different wage levels between these industries. For non-tradables and all non-petroleum tradables, there is a negative relationship between income and the likelihood of moving, meaning that high incomes reduce the likelihood of moving to jobs in these sectors compared to staying within the same job. The effect is stronger for non-tradables and petroleum-unrelated tradables, and somewhat weaker for petroleum-related tradables. For moving into the petroleum industry, the relationship is positive, meaning that individuals with high incomes are more likely to leave their job for the petroleum industry. This

[6] This is calculated by exponentiating the coefficients.

means that lower income workers are more likely to move to all industries outside the petroleum sector, while workers with higher income are more likely to change to jobs in petroleum industries. If we assume that higher wages are linked to individuals with higher levels of human capital, there appears to be a skill-bias in mobility towards petroleum industries.

STEM education also significantly increases the likelihood of moving into the petroleum industry over staying in the same job. It also increases the likelihood of moving into unrelated tradables and – especially – to petroleum-related tradables. Conversely, non-STEM education reduces the likelihood of moving into the petroleum industry. In the growth period from 2004-07, the effect of STEM education on the likelihood of moving into the petroleum industry became stronger, reaching par with its effect on moving into petroleum-related industries. In the Stavanger region during this period, STEM education had a positive effect only for moving into petroleum.

Table 4: Multinomial logit on exit from related industry type (Benchmark: Stayers)

	Move to non-tradable			Move to unrelated tradable			Move to petroleum-related tradable			Move to petroleum		
Norway	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
Non-tradable (baseline)												
Unrelated tradable	-1.65	***	0.00	1.61	***	0.00	0.32	***	0.01	-0.08	***	0.02
Petroleum-related	-1.75	***	0.01	0.20	***	0.01	2.37	***	0.01	1.72	***	0.02
Petroleum	-2.33	***	0.02	-0.80	***	0.02	0.83	***	0.02	3.24	***	0.02
Income	-0.22	***	0.00	-0.20	***	0.00	-0.10	***	0.00	0.02	***	0.00
Female	-0.28	***	0.00	-0.47	***	0.00	-0.53	***	0.01	-0.57	***	0.02
Age	-0.02	***	0.00	-0.02	***	0.00	-0.02	***	0.00	-0.02	***	0.00
Years since graduation	-0.01	***	0.00	0.00	***	0.00	-0.00	***	0.00	-0.01		0.00
College (STEM)	-0.12	***	0.01	0.13	***	0.01	0.37	***	0.01	0.16	***	0.01
College (non-STEM)	0.01		0.01	0.36	***	0.00	0.15	***	0.01	-0.04	*	0.02
Constant	-0.26	***	0.01	-2.39	***	0.01	-3.75	***	0.02	-6.20	***	0.07
Year dummies	yes			yes			yes			yes		
County dummies	yes			yes			yes			yes		
N= 6,215,666												
Pseudo R2= 0.13												
log L=-3292072												
Stavanger	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
Non-tradable (baseline)												
Unrelated tradable	-1.63	***	0.02	1.61	***	0.02	0.03	***	0.04	0.25	***	0.05
Petroleum-related	-1.65	***	0.03	0.30	***	0.03	2.37	***	0.03	1.60	***	0.04
Petroleum	-2.41	***	0.05	-0.68	***	0.04	0.56	***	0.04	2.36	***	0.04
Income	-0.23	***	0.01	-0.20	***	0.00	-0.06	***	0.01	0.00		0.00
Female	-0.34	***	0.02	-0.54	***	0.02	-0.45	***	0.03	-0.43	***	0.03
Age	-0.02	***	0.00	-0.02	***	0.00	-0.01	***	0.00	-0.02	***	0.00
Years since graduation	-0.00		0.00	0.00	***	0.00	-0.01	***	0.00	-0.01		0.00
College (STEM)	-0.28	***	0.04	0.01		0.03	0.12	***	0.03	0.07	**	0.03
College (non-STEM)	-0.03		0.03	0.36	***	0.02	0.01		0.03	-0.08	*	0.03
Constant	-0.34	***	0.04	-2.23	***	0.04	-3.84	***	0.06	-3.59	***	0.076
Year dummies	yes			yes			yes			yes		
N= 369,525												
Pseudo R2= 0.14												
log L=-200561												

Significance levels***< 0.01; **<0.05; *0.10

Table 5: Multinomial logit on exit from related industry type. 2004-2007.

	Move to non-tradable			Move to unrelated tradable			Move to petroleum-related tradable			Move to petroleum		
Norway	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
Non-tradable (baseline)												
Unrelated tradable	-1.27	***	0.01	1.25	***	0.01	0.35	***	0.01	0.00		0.03
Petroleum-related	-1.44	***	0.01	0.12	***	0.01	2.12	***	0.01	1.73	***	0.02
Petroleum	-2.46	***	0.03	-1.31	***	0.03	0.61	***	0.02	2.70	***	0.02
Income	-0.02	***	0.00	0.01	***	0.00	0.01	***	0.00	0.03	***	0.00
Female	-0.07	***	0.01	-0.16	***	0.01	-0.31	***	0.01	-0.56	***	0.02
Age	-0.04	***	0.00	-0.03	***	0.00	-0.03	***	0.00	-0.02	***	0.00
Years since graduation	-0.01	***	0.00	-0.00	***	0.00	-0.01	***	0.00	-0.02		0.00
College (STEM)	-0.26	***	0.01	0.03	***	0.01	0.19	***	0.01	0.19	***	0.02
College (non-STEM)	-0.10		0.01	0.21	***	0.01	-0.01	***	0.01	-0.01		0.02
Constant	-0.69	***	0.01	-2.29	***	0.02	-3.74	***	0.03	-6.45	***	0.09
Year dummies	yes			yes			yes			yes		
County dummies	yes			yes			yes			Yes		
N= 3,106,457												
Pseudo R2= 0.10												
log L=-1491859												
Stavanger	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
Non-tradable (baseline)												
Unrelated tradable	-1.30	***	0.03	1.23	***	0.03	0.34	***	0.05	0.44	***	0.06
Petroleum-related	-1.54	***	0.05	0.14	**	0.05	2.31	***	0.04	1.75	***	0.06
Petroleum	-2.69	***	0.07	-1.40	***	0.07	0.46	***	0.06	1.81	***	0.05
Income	-0.04	***	0.01	-0.01		0.00	-0.01		0.01	0.02	***	0.04
Female	-0.14	***	0.03	-0.21	***	0.03	-0.29	***	0.04	-0.42	***	0.03
Age	-0.04	***	0.00	-0.03	***	0.00	-0.02	***	0.00	-0.03	***	0.00
Years since graduation	-0.01	***	0.00	-0.00		0.00	-0.01	***	0.00	-0.02	***	0.04
College (STEM)	-0.34	***	0.06	-0.03		0.05	-0.03		0.04	0.15	***	0.05
College (non-STEM)	-0.18	***	0.04	0.21	***	0.03	-0.11	*	0.05	0.08		0.05
Constant	-0.69	***	0.06	-2.38	***	0.06	-3.61	***	0.07	-3.81	***	0.09
Year dummies	yes			yes			yes			yes		
N= 187,209												
Pseudo R2= 0.11												
log L=-96652												

Significance levels***< 0.01; **<0.05; *0.10

While the analyses in Table 4 gives an impression of the types of workers moving into different industries, they do not provide details on the types of workers moving out of different sectors. For this reason, we reran the analysis on the sub-samples of individuals working in each of the four industry types in year t-1. This allowed us to examine the characteristics of workers moving between particular types of industries. We are particularly interested in the characteristics of workers who move between petroleum and related industries. The hypothesis is that more productive workers tend to leave related industries for the petroleum industry, while less productive workers move the other way.

In this case, we fit the following regression model:

$$\text{Logit}\ [\Pr(\text{Industry}_{i,\,t} = j)] = \alpha_j + \beta_{1j}\ \text{Income}_{i,\,t-1} + \beta_{2j}\ \text{Gender}_i + \beta_{3j}\ \text{Age}_{i,\,t-1} + \beta_{4j}\ \text{Years since graduation}_{i,\,t-1} + \beta_{5j}\ \text{STEM education}_{i,\,t-1} + \beta_{6j}\ \text{Other college education}_{i,\,t-1} + \beta_{7j}\ \text{County}_{i,\,t-1} + \beta_{8j}\ t$$

The full results of these analyses are shown in Appendix Tables A.1 and A.2. We want to focus on the relationship between income, as a proxy for productivity, and mobility between different types of industries. Table 6 shows a matrix of the coefficients for income in these analyses, while Table 7 shows the same analyses for mobility during the 2004-07 period only.

Table 6: Multinomial logit on exit from related industry type, by prior industry. Coefficients for income

	Move to non-tradable			Move to unrelated tradable			Move to petroleum-related tradable			Move to petroleum		
Norway	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
From non-tradable	-0.24	***	0.00	-0.05	***	0.00	0.00		0.00	0.04	***	0.00
From unrelated tradable	-0.13	***	0.00	-0.22	***	0.00	0.01	***	0.00	0.02	***	0.00
From petroleum-related	-0.11	***	0.01	-0.03	***	0.00	-0.17	***	0.00	0.05	***	0.00
From petroleum	-0.34	***	0.01	-0.20	***	0.01	-0.12	***	0.01	-0.01	***	0.00
Stavanger	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
From non-tradable	-0.24	***	0.01	-0.07	***	0.01	0.03		0.02	0.12	***	0.02
From unrelated tradable	-0.14	***	0.01	-0.23	***	0.01	0.01		0.01	0.02	***	0.00
From petroleum-related	-0.21	***	0.02	-0.05	***	0.01	-0.08	***	0.01	0.03	***	0.01
From petroleum	-0.30	***	0.03	-0.09	***	0.02	-0.06	***	0.01	-0.03	***	0.01

Significance levels***< 0.01; **<0.05; *0.10

Table 7: Multinomial logit on exit from related industry type, by prior industry. 2004-2007 only.

	Move to non-tradable			Move to unrelated tradable			Move to petroleum-related tradable			Move to petroleum		
Norway	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
From non-tradable	0.02	***	0.00	-0.04	***	0.00	0.02	***	0.00	0.03	***	0.01
From unrelated tradable	-0.09	***	0.00	0.02	***	0.00	0.02	***	0.00	0.03	***	0.00
From petroleum-related	-0.10	***	0.01	-0.04	***	0.00	0.01	*	0.00	0.04	***	0.00
From petroleum	-0.28	***	0.02	-0.14	***	0.02	-0.10	***	0.01	0.02	***	0.00
Stavanger	Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
From non-tradable	0.03	***	0.01	-0.05	**	0.02	0.05	**	0.02	0.10	***	0.02
From unrelated tradable	-0.11	***	0.02	0.00		0.00	0.01		0.01	0.02	***	0.01
From petroleum-related	-0.23	***	0.03	-0.01		0.02	-0.00		0.01	0.01		0.01
From petroleum	-0.24	***	0.04	-0.08	**	0.03	-0.04	**	0.02	0.02	***	0.00

Significance levels***< 0.01; **<0.05; *0.10

Starting with the petroleum industry, there was a positive relationship between income and moving into the petroleum industry from all other sectors. Meanwhile, there was a negative relationship between income and leaving the petroleum industry for all other sectors. This means that the petroleum industry is systematically attracting the highest paid workers from other sectors, while its own lowest paid workers are leaving. For mobility within the petroleum industry, there was a slight negative effect of income on the likelihood of moving. However, during the 2004-07 period, the best-paid workers were more likely to move jobs within the petroleum industry.

Secondly, we note that the effect of income on moving into the petroleum industry is stronger for petroleum-related industries than for unrelated tradables, meaning that related industries are somewhat more susceptible than unrelated industries to losing their best-paid workers to the petroleum industry. However, the negative effect of income on moving in the opposite direction is weaker, meaning that related industries get somewhat better paid workers in return. The only exception to this pattern is the 2004-07 period for Stavanger, when income had no significant effect on the likelihood of petroleum-related workers leaving for petroleum. During this period, mobility from petroleum-related industries into petroleum was very high in Stavanger, for all types of workers in these industries.

Finally, the negative effects of income on leaving the petroleum industry are weaker for all categories in Stavanger than at the national level, while the positive effects on entering it are similar – with the exception of workers leaving non-tradables, where the effect is much stronger. Overall, this implies that mobility is somewhat less skill-biased in the most petroleum-specialised region than for the national economy as a whole.

DISCUSSION AND CONCLUSION

This paper has examined the relationship between the petroleum industry and other industries, focusing in particular on labor-market competition. Departing from the literature on relatedness and on the resource curse, we examined labor mobility between the petroleum industry and other related and unrelated industries at the national and regional level during a period of rising oil prices. Overall, we found patterns in support of the relatedness literature: As the petroleum industry grew over this period, its related industries also grew, and at a higher rate than the growth of unrelated industries. This was particularly the case in Stavanger, which is the main hub of the Norwegian

petroleum industry. Overall, this was indicative of a process of regional branching, with expansion in related industries. However, the strongest growth remained in the petroleum industry itself, indicating increasing specialization of the regional economy in response to rising oil prices. In line with the resource curse literature, we also found stronger growth in non-tradables than in other tradables. Overall, this makes the economy more vulnerable to downturns in the global petroleum market. Indeed, the fall in oil prices from 2014 resulted in rapidly increased unemployment and a contraction of the non-tradable sector, in particular in the Stavanger region.

A more diversified industrial structure would certainly have reduced the impact of these global trends on the national and regional economies. However, the analysis of labor mobility between petroleum and other industries showed how difficult it is to escape path dependent development processes when resource industries are growing. The petroleum industry paid wages which were far higher than any other industry during this period. Even allowing for income, education and other worker characteristics, average wages in the petroleum industry were around NOK 150,000 higher than in petroleum-related industries. As a result, the best-paid (and presumably most productive) workers in petroleum-related industries were more likely to leave these industries and move to the petroleum industry. Meanwhile, the lowest-paid workers in the petroleum industry moved the other way. Overall, this suggests a pattern where the best human capital consistently tends to enter the petroleum industry, while related industries get second dibs on workers.

The literature on relatedness has largely overlooked resource competition of this sort. The analyses provided here shows that relatedness is not an equal playing field. Relatedness dynamics tend to play out much more in favour of the petroleum industry than its related industries. Related industries provide the petroleum industry with workers possessing relevant skills, and it is able to recruit the best among these due to its ability to pay well above market wages. For related

industries, labor-market relatedness is mainly a drawback. Petroleum-related industries pay higher wages than other tradables for comparable human capital, and nonetheless lose a much higher share of their workers to the petroleum industry. The silver lining is that many of these related industries are also linked to the petroleum industry through supplier relations, resulting in overall growth. However, for the regional and national economy, it remains a concern that the most productive human capital tends to accumulate in the petroleum industry.

Overall, this analysis shows that the literature on relatedness could benefit from interacting with other branches of literature, for example, the resource curse literature. The latter provides insights on resource competition and potential negative aspects of relatedness that have hitherto been overlooked in evolutionary economic geography. Meanwhile, perspectives from the relatedness literature may also contribute to developing other bodies of literature, for example, by showing that the resource curse may have different effects on industries which are related to resource industries than on those which are not.

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Errors and omissions are the authors'.

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Appendix Table A.1: multinominal logit on exit from related industry type (Benchmark are those that stay)

		Move to non-tradable			Move to unrelated tradable			Move to petroleum-related tradable			Move to petroleum		
		Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
From non-tradable	Income	-0.24	***	0.00	-0.05	***	0.00	0.00		0.00	0.04	***	0.00
	Gender	-0.31	***	0.00	-0.35	***	0.01	-0.76	***	0.02	-1.30	***	0.05
	Age	-0.01	***	0.00	-0.04	***	0.00	-0.04	***	0.00	-0.02	***	0.00
	Years since graduation	0.00		0.00	0.01	***	0.00	-0.01	***	0.00	-0.04	***	0.00
N= 2,332,949	College (STEM)	0.03	***	0.01	0.22	***	0.02	0.91	***	0.03	0.84	***	0.05
Pseudo R2= 0.04	College (non-STEM)	0.00	***	0.01	0.43	***	0.01	0.13	***	0.02	-0.16	**	0.06
LL=-1243276.6	Constant	-0.39	***	0.01	-1.71	***	0.03	-3.11	***	0.05	-6.89	***	0.19
From unrelated tradable	Income	-0.13	***	0.00	-0.22	***	0.00	0.01	***	0.00	0.02	***	0.002
	Gender	-0.22	***	0.01	-0.50	***	0.00	-0.59	***	0.02	-0.72	***	0.04
	Age	-0.05	***	0.00	-0.01	***	0.00	-0.04	***	0.00	-0.05	***	0.00
	Years since graduation	-0.01		0.00	0.00	***	0.00	-0.01	***	0.00	-0.03	***	0.00
N= 2,670,390	College (STEM)	-0.40	***	0.02	0.22	***	0.01	0.75	***	0.02	1.12	***	0.04
Pseudo R2= 0.05	College (non-STEM)	-0.07	***	0.01	0.36	***	0.01	0.09	***	0.02	0.36	***	0.04
LL=--1372577.1	Constant	-1.10	***	0.03	-1.00	***	0.01	-2.68	***	0.04	-6.19	***	0.18
From petroleum-related tradable	Income	-0.11	***	0.01	-0.03		0.00	-0.17	***	0.00	0.05	***	0.00
	Gender	-0.22	***	0.02	-0.23	***	0.02	-0.33	***	0.01	-0.39	***	0.03
	Age	-0.04	***	0.00	-0.05	***	0.00	0.00	***	0.00	-0.02	***	0.00
	Years since graduation	-0.01	***	0.00	0.01	***	0.00	0.00		0.00	-0.03		0.00
N= 920,489	College (STEM)	-0.50	***	0.03	-0.26	***	0.02	0.22	**	0.01	0.31	***	0.02
Pseudo R2= 0.04	College (non-STEM)	-0.04	***	0.03	0.47	***	0.02	0.15	***	0.01	-0.07	*	0.04
LL=--509654.7	Constant	-1.48	***	0.06	-1.36	***	0.05	-1.80	***	0.03	-5.08	***	0.13
From petroleum	Income	-0.34	***	0.01	-0.20	***	0.01	-0.12	***	0.01	-0.01	***	0.00
	Gender	-0.65	***	0.07	0.26	***	0.05	-0.75	***	0.05	-0.39	***	0.02
	Age	-0.03	***	0.00	-0.03	***	0.00	-0.03	***	0.00	-0.01	***	0.00
	Years since graduation	-0.02		0.00	0.01		0.00	0.00		0.00	0.00		0.00
N= 291838	College (STEM)	-1.00	***	0.09	-0.27	***	0.07	0.38	***	0.04	-0.12	***	0.02
Pseudo R2= 0.04	College (non-STEM)	-0.34	***	0.09	0.56	***	0.06	0.22	***	0.05	-0.14	***	0.03
LL=--127553.4	Constant	-0.90	***	0.28	-2.08	***	0.37	-1.66	***	0.19	-1.41	***	0.10
	Year and country dummies	yes			yes			yes			yes		

Significance levels***< 0.01; **<0.05; *0.10

Appendix Table A.2: multinominal logit on exit from related industry type in Stavanger (Benchmark are those that stay)

		Move to non-tradable			Move to unrelated tradable			Move to petroleum-related tradable			Move to petroleum		
		Coef.		Std.	Coef.		Std.	Coef.		Std.	Coef.		Std.
From non-tradable	Income	-0.24	***	0.01	-0.07	***	0.01	0.03		0.02	0.12	***	0.02
	Gender	-0.34	***	0.02	-0.44	***	0.04	-0.77	***	0.08	-1.04	***	0.11
	Age	-0.02	***	0.00	-0.04	***	0.00	-0.04	***	0.01	-0.02	***	0.01
	Years since graduation	0.00		0.00	0.01	**	0.00	0.00		0.01	-0.03	***	0.01
N= 109,833	College (STEM)	0.13	*	0.05	0.22	*	0.10	0.85	***	0.11	0.71	***	0.13
Pseudo R2= 0.03	College (non-STEM)	0.05		0.03	0.46	***	0.06	0.22	*	0.10	-0.20		0.13
LL=-61331.095	Constant	-0.52	***	0.05	-1.99	***	0.10	-2.70	***	0.16	-4.11	***	0.19
From unrelated tradable	Income	-0.14	***	0.01	-0.23	***	0.01	0.01		0.01	0.02	***	0.00
	Gender	-0.27	***	0.05	-0.61	***	0.02	-0.66	***	0.07	-0.33	***	0.08
	Age	-0.05	***	0.00	-0.01	***	0.00	-0.04	***	0.00	-0.04	***	0.01
	Years since graduation	-0.01		0.00	0.00		0.00	-0.01	*	0.00	-0.02	***	0.01
N= 115,853	College (STEM)	-0.64	***	0.11	0.22	***	0.04	0.45	***	0.08	1.38	***	0.09
Pseudo R2= 0.05	College (non-STEM)	-0.24	***	0.06	0.34	***	0.03	0.07		0.07	0.88	***	0.08
LL=--62953.874	Constant	-1.05	***	0.11	-0.80	***	0.05	-2.58	***	0.13	-3.38	***	0.18
From petroleum-related tradable	Income	-0.21	***	0.02	-0.05		0.01	-0.08	***	0.01	0.03	***	0.01
	Gender	-0.34	***	0.09	-0.15	*	0.07	-0.14	***	0.04	-0.27	***	0.07
	Age	-0.03	***	0.01	-0.03	***	0.00	0.00		0.00	-0.02	***	0.00
	Years since graduation	-0.02	***	0.01	0.01		0.00	-0.01	***	0.00	-0.03	***	0.00
N= 57,533	College (STEM)	-0.77	***	0.12	-0.39	***	0.08	0.05		0.04	0.37	***	0.06
Pseudo R2= 0.03	College (non-STEM)	-0.22		0.12	0.39	***	0.08	0.04		0.05	0.20	**	0.08
LL=-38215.123	Constant	-1.82	***	0.16	-1.90	***	0.13	-2.33	***	0.08	-2.30	***	0.12
From petroleum	Income	-0.30	***	0.03	-0.09	***	0.02	-0.06	***	0.01	-0.03	***	0.01
	Gender	-0.84	***	0.07	0.16		0.09	-0.88	***	0.08	-0.37	***	0.04
	Age	-0.03	***	0.00	-0.04	***	0.01	-0.04	***	0.00	-0.02	***	0.00
	Years since graduation	-0.02	***	0.00	0.00		0.01	-0.01	**	0.00	0.00		0.00
N= 86,306	College (STEM)	-1.36	***	0.09	-0.68	***	0.11	-0.06		0.06	-0.13	***	0.03
Pseudo R2= 0.07	College (non-STEM)	-0.68	***	0.09	0.45	***	0.10	-0.36	***	0.09	-0.37	***	0.04
LL=-35227.58	Constant	-1.62	***	0.28	-1.74	***	0.19	-1.99	***	0.14	-1.13	***	0.07
	Year dummies	yes			yes			yes			yes		

Significance levels***< 0.01; **<0.05; *0.10