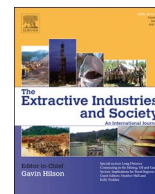




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Original article

Benefitting from co-location? Evidence from the upstream oil and gas industry

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ABSTRACT

Numerous contributions study firms' clustering in space and the nexus between productivity and agglomeration. This paper analyses how different sectors and firms within the Norwegian upstream oil and gas industry benefit from regional agglomeration. Since upstream oil and gas value chains develop and produce sophisticated and highly customized knowledge-intensive goods and business-to-business services, the sector is a particularly interesting candidate for studying localized external economies. Our estimated panel data models on the value added of 1500 firms indicate that firms in the upstream oil and gas industry benefit from being co-located, particularly firms within the same subsector.

1. Introduction

Countries with domestic petroleum resources often have policy ambitions related to generating economic benefits from their upstream oil and gas industry.¹ Frequently, policy makers are not satisfied with creating income from petroleum extraction alone, but want to increase value added and employment through development of domestically located sectors that supply technologies and services to the upstream oil and gas industry. Furthermore, policy makers may even seek to stimulate regional growth and employment opportunities in particular regions by stimulating industrial competence locally. These policy ambitions are often referred to as local content development, where the objective is to build an internationally competitive industry with a domestically oriented knowledge base (Heum, 2008). Furthermore, local content development policies may according to Ablo (2015) be instrumental to create synergies between the extractive industries and the overall national economy.

Across petroleum-producing countries, very different patterns in the development and employment of the domestic supplier sectors have been observed. In some countries the supplier sectors have employment that is considerably higher than in the upstream oil and gas companies alone. Given the potential for economic growth, it is natural to ask what conditions are necessary for the establishment and growth of a domestic supplier sector. We still lack understanding of the mechanisms that create and enhance innovations, productivity growth, and economic

impacts from modern petroleum extraction, particularly the role of spatial proximity or distance between economic agents related to the industry.

The capacity of firms to innovate or increase productivity is not only defined by the firms' boundaries, but also increasingly depends on external resources that agglomerate in different places (Lecocq et al., 2012; Lundvall, 1992). The research in regional development (and others, e.g. economic geography) argues that firms may benefit from geographic clustering through localized knowledge spillovers, territorial learning, and specialization (Marshall, 1920; Krugman 1991b, 1991a; Jaffe et al., 1993; Storper, 1995; Audretsch and Feldman, 1996; Porter, 2000; Rosenthal and Strange, 2003).

Productivity and innovation are endogenous phenomena shaped through interaction between firms and their environments (Fagerberg et al., 2009, 21). There is rich evidence that firms cluster in space and that there is a nexus between productivity and clustering. Regionally specialized industries tend to grow at a faster pace induced by learning that takes place between neighboring firms, which isolated firms miss out on. This paper goes beyond identifying the effects of clustering across a broad set of sectors, but address particular issues related to agglomeration economies or localized external returns to scale, more specifically the nexus between geographic and sectorial dimensions in terms of productivity impacts. It is argued that localized external economies of scale are related to knowledge spillovers and specialized suppliers, and these issues are examined by employing econometric

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¹ The upstream oil and gas industry includes seismic exploration for underwater crude oil and natural gas resources, drilling of exploratory wells, and subsequent drilling and operating wells that bring crude oil or raw natural gas to the surface. In this paper, the upstream oil and gas industry is defined as "oil companies" and "oil and gas sector suppliers", that is, companies that are direct or indirect suppliers of capital equipment, materials, and services to the oil companies.

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models of firm value added on a panel data set of 1.500 firms. We test if localized external economies of scale have statistically significant effects on the productivity of the supplier sector.

In the next section, the nature of agglomeration economies in general (Section 2.1), and agglomeration economies in the petroleum sector in particular (Section 2.2), is discussed. In Section 2.3, a historical overview of the Norwegian upstream oil and gas industry is provided. Furthermore, the subsectors in the industry (2.4) are described, and insights to the geographic distribution of the industry is presented (2.5). In Section 3, the econometric model specifications are provided, followed by the presentation of the empirical results and discussion in Section 4. Finally, in Section 5, concluding remarks are provided.

2. Background and theory

2.1. The nature of agglomeration economies

Past contributions have tried to explain why sectors and firms in some regions thrive whilst others struggle (Porter, 1990; Henderson, 1997). What has been lacking, however, are contributions studying the empirical impact of cluster composition on regional economic performance (Delgado et al., 2012). Firms may receive economic benefits in the form of increased productivity and profits due to localization in a cluster.

A distinction between two types of external agglomeration economies – localization and urbanization economies – is often made in the literature. The former increase returns within a single or more narrowly defined industry (industry clusters) and draws on seminal insights from Marshall (1920), and argue that firms that co-locate could enjoy external economies because of exchange of inputs, expertise, and division of labor (Paci and Usai, 1999). The latter increase returns to a diversity of industries in a regional or urban economy (Rosenthal and Strange, 2004) and emphasizes the positive externalities associated with new ideas across different sectors, as suggested by Jacobs (1969). These agglomeration economies have also been referred to as intra (localization) and inter (urbanization) clustering (Melo et al., 2009). The results from past contributions on agglomeration effects have demonstrated mixed results, often depending on the focus of the study as well as the unit of observation, e.g. firm level or regional level (Delgado, 2012). Some contributions have demonstrated the effects of localization economies (Cingano and Schivardi, 2004; Henderson, 2003) as well as some contributions demonstrating the effects of urbanization economies (Jacobs 1969; Combes 2000; Glaeser et al., 1992; Caragliu et al., 2016).

Agglomeration effects or localized external returns to scale have received attention in a large number of studies,² as documented in several literature surveys (e.g., Rosenthal and Strange, 2004; Melo et al., 2009; Cohen and Paul, 2009; de Groot et al., 2016). Several of the studies investigating agglomeration effects have been based on a production function approach following Hall (1990). These studies have generally demonstrated that clustering of economic activities increases productivity because of external economies of scale.³ The external scale economies in turn increase the competitiveness of a geographic location, as the firms located in the location presumably have higher productivity than firms located outside the location. The literature has shifted from focusing on external economies of scale that lower transportation and transaction costs to highlighting knowledge spillovers, innovation, and learning (Malmberg et al., 2000). This view is supported by Capello and Nijkamp (2009) who underline reflections that

might be useful for industrial economists such as collective learning and relational proximity, where “endogenous spatial development patterns of knowledge are not left to simple probabilistic contacts, but explained through territorial processes” (Capello and Nijkamp, 2009, 8).

Kaldor (1970, 340) argued that agglomeration economies are the result of “the development of skills and know-how, the opportunity for easy communication of ideas and experience, the opportunity of ever-increasing differentiation of processes and specialization on human activities”. Both strong ties between regional actors (Scott, 1993; Storper, 1995) and knowledge spillovers from science-based activities (Romer, 1986, 1990; Lucas, 1993; Krugman, 1991b, 1991a) can contribute to higher rates of innovation, increased entrepreneurial activity, and increased productivity within geographically bounded areas. Location and geographical proximity can influence innovation rates and technological progress (Lundvall, 1988; Glaeser et al., 1992; Jaffe et al., 1993; Audretsch and Feldman, 1996; Glaeser, 1999; Baptista, 2000, 2001). This is particularly true for circumstances where there is high degree of knowledge uncertainty, hence not easily conveyed using a standardized medium. One example is “tacit knowledge” and it is based on the fact that “we know more than we can tell” (Polanyi, 1966, 4). Face-to-face interaction (Storper and Venables, 2004), and geographical proximity (Boschma, 2005), becomes central as it facilitates the diffusion of tacit knowledge (Maskell, 1998; Von Hippel, 1998). Bathelt et al. (2004) argue that buzz is communication shared through face-to-face contacts and through the co-location of firms and people within the same region or industry. This motivates studying whether firms in a specific sector or technological domain, such as the upstream oil and gas industry, benefits from co-location.

2.2. Agglomeration economies in the upstream oil and gas industry?

Conditions for agglomeration economies may not be present in all industries, and much of the cluster research has focused on manufacturing and information technology sectors, which often are characterized by a high level of technological sophistication and innovation rates. These characteristics are certainly present in the upstream oil and gas industry (Silvestre Dos Santos and Dalcol, 2009) that develops highly customized knowledge-intensive goods and services. Offshore field development, which involves design, engineering and construction of production facilities and infrastructure, is a highly complex process where many types of knowledge and technologies are combined. Consequently, many supplier firms have specialized in different knowledge and technological domains, where there are often significant tacit knowledge elements. Thus, the industry is characterized by knowledge-intensive firms with demanding customers in several stages of the value chain. Each offshore field has unique technological solutions partly reflecting the heterogeneity of petroleum reservoirs (e.g. petroleum well pressure and temperature) and other physical field characteristics (e.g. water depth, current and wave conditions, distance from onshore facilities). Since offshore fields have entered into development at different points in time, the almost continuous technological changes in the industry have influenced the organization and technological concepts of the development phase. During its production life cycle, a petroleum field will typically be subject to several small and large investment projects related to maintenance, technological upgrading and capacity expansion. These life cycle investment projects will often be complex and unique in several respects due to the uniqueness of each field in terms of technological concepts, reservoir and other physical characteristics. This leads to the need for involvement of many supplier firms and extensive interaction between firms in various stages of the project. It is not uncommon that cumulative investment costs during the production phase are similar or above the initial field development investment costs, which typically are in the range of one to ten billion US dollars. Another important aspect in relation to studying agglomeration effects in one particular industry, from a theoretical standpoint, is the beneficial role of relatedness highlighted as important for firms

² “External economies”, “localized external returns to scale” and “agglomeration effects” are used interchangeably throughout this paper.

³ Among the early studies following Hall (1990) using aggregated (sector) data were Caballero and Lyons (1992), Caballero and Lyons (1990) and Bartelsman et al. (1994). Examples of later studies using disaggregated (firm, worker) data are Graham et al. (2010) and Martin et al. (2011).

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