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Kapittel 15
Does geographical clustering pay?
Analysis of the Norwegian salted and dried cod industry

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SAMMENDRAG Den norske klippfiskindustrien er mangfoldig både med hensyn til fabrikkstørrelser og organisasjonstyper. Klyngen av klippfiskprodusenter og -eksportører på Nord-Vestlandet bidrar sterkt til samlet eksport, og hovedsete for disse bedriftene er i Ålesunds-regionen. Ålesund er også en av de viktigste byene i Norge når det gjelder eksport av fisk og fiskeprodukt generelt. Det er vel kjent fra litteraturen at geografisk konsentrasjon av bedrifter kan skape selvforsterkende økonomisk vekst. I et marked som blir stadig mer globalt, med sterk konkurranse fra produsenter og eksportører fra land som Island, Canada, Russland, Portugal og Kina, vil det være viktig å opprettholde og styrke denne næringsklyngen. For å kunne utøve den beste næringspolitikken når det gjelder å utvikle næringsklyngen videre, er det viktig å kjenne mekanismene (de eksterne effektene) som skaper innovasjon og verdiskaping. For å synliggjøre mulige positive eksterne effekter i den regionale klippfiskindustrien har vi samlet inn bedriftsspesifikke økonomiske og geografiske data over fire år (paneldata), og estimert produktfunksjoner som inkluderer både bedriftsinterne produksjonsfaktorer (arbeidskraft og kapital) og eksterne klyngevariabler. En viktig kilde til positive klyngeeffekter er knyttet til immateriell kapital i form av tette relasjonelle forbindelser mellom aktørene i klippfiskindustrien. Dette vil kunne fanges opp med en lokaliseringsvariabel som måler geografisk bedriftstetthet. Foreløpige resultat tyder på at det finnes en signifikant ekstern lokaliseringseffekt i den geografisk konsentrerte klippfiskindustrien i Ålesunds-regionen. Klippfiskbedriftene i denne regionen har større verdiskaping enn bedrifter utenfor regionen.

NØKKELORD klippfiskindustri, geografisk konsentrasjon, verdiskapning, næringspolitikk.

ABSTRACT The structure of the Norwegian salted and dried cod industry is manifold, with differences both regarding plant size and type of organisation. The cluster of manufacturers and exporters of this industry in the North-Western region of Norway contributes considerably to total exports, and the main location for these firms is the Ålesund region. Ålesund is also the most important Norwegian town for exports of fish and fish products in general. It is well known from literature that geographical clustering of firms may induce self-reinforced growth effects. In an increasingly more competitive global environment, with stronger competition from producers and exporters in countries like e.g. Iceland, Canada, Russia, Portugal and China, it will be important to preserve and even strengthen such a cluster. In order to recommend adequate policy to support the development of this cluster one must recognize the mechanisms that create innovation and value added. To reveal possible localized external returns to scale in the regional salted and dried cod industry, a panel of firms is analysed by estimating a production function including both internal production factors and external economy variables. One important source of positive cluster-effects can be associated with immaterial capital related to connections between different actors within the industry. Preliminary results show that there is a significant localized external effect in this cluster, implying that geographical clustering in the central Ålesund region will induce more value added than otherwise.

INTRODUCTION

The Norwegian salted and dried cod industry has traditionally had a strong position in international markets. The main market for salted & dried cod is Portugal (Asche and Gordon, 2015), followed by Brazil (Neto *et al.,* 2016). However, other South-American and a few African countries are also important. When it comes to salted cod, Portugal is also the most important market, while Spain here is second largest.

The structure of this industry is manifold, with differences both regarding plant size and type of organisation. The industry is to a large extent geographically concentrated in Møre and Romsdal county, the North-Western part of Norway, and this area is likely to host the only salted & dried fish cluster in the world. Producers and exporters from this part of the country contribute considerably to the value added of the salted and the salted & dried cod industry (Bjørndal, Ekerhovd and Bjørndal, 2015). Within this part of the country the Ålesund region is the most important location, not only for export of salted / dried cod, but also for exports of fish products in general.

It is well known from literature that geographical clustering of firms induces self-reinforced growth effects, and one important source is the growth in immaterial capital in the form of tighter relational connections between the actors in the industry. Whereas the maritime cluster in Møre and Romsdal county is seen as a complete industrial cluster (Hervik *et al*., 2011), which is also a worldwide leader in specific areas related to complicated maritime operations, the marine (seafood) sector has been highlighted as one of the most promising future industrial clusters in Norway (Tveterås and Asche, 2011). The marine cluster in general, and the salted & dried cod cluster in particular, have hitherto been devoted relatively little attention. One exception is provided by salmon aquaculture, where a cluster analysis has been undertaken by Tveterås and Battese (2006) (see also Tveterås and Aarset, 2001). Insights regarding the salted & dried cod industry of this region, the competition it faces, its value chains and margins may be decisive for its future profitability. In recent years, Norwegian salted & dried cod has faced much stronger competition from raw fish from Iceland, Canada and Russia, from new species like Pacific cod that is processed in Portugal, and from processors in China (Fjørtoft and Aarseth, 2005; Asche *et al*., 2007). Not only does Norway export the final product, but also salted cod, which is processed (dried) in Portugal, and frozen cod that is processed in China and re-exported (Egeness *et al*., 2012).

The purpose of this paper is to analyse the possibility of localised external economies of scale in the regional salted & dried cod industry. To be able to detect such effects, a panel of firms is analysed by estimating a general specification of a production function which includes both internal production factors (labour and capital) and external economy variables. The data consist of economic and geographic information on all firms in the industry for the period 2009–2012.

The rest of the paper is organised as follows. The next section gives some background information on the industry. This is followed by an outline of the theoretical framework, the methodology and the data. Section four presents the empirical results, and the final section concludes.

INDUSTRIAL BACKGROUND

In 2013 Norwegian exports of salted cod and salted & dried cod reached a value of NOK 3.9 billion or almost 50 % of total cod exports, with salted & dried cod representing NOK 3.1 billion. About 90 % was shipped from the Ålesund region, indicating the possible presence of an industry cluster. The raw material used by this industry includes both fresh and frozen fish of the different types, delivered primarily by Norwegian, Icelandic and Russian fishermen.[1] The domestic value chain of this industry consists of both producers and exporters (Bjørndal, Ekerhovd and Bjørndal, 2015).

The data set is for the years 2009–2012 and includes all firms in the industry. For each year we have data for 10 exporters while the number of producers varies from 32 to 34, giving a total of 42–44 observations per year (table 15.1). The firms are the same throughout the period. Several of the firms produce salted cod in addition to salted & dried cod. Moreover, many of them are exporters as well as producers. Total employment in the 2009–2012 period has varied between 751 and 836 with total value added varying between NOK 412.7 million and NOK 834.4 million. Combined producers and exporters are much more important for value added and employment than pure exporters, as is natural. It is important to bear in mind that this industry is very important for total value added in the fishing industry (Bjørndal, Ekerhovd and Bjørndal, 2015).

TABLE 15.1. INDUSTRY STATISTICS 2009–2012.

Year	No of producers	No of exporters	Total value added mill NOK	Total employment
2009	32	10	574.0	751
2010	34	10	834.4	836
2011	34	10	790.5	786
2012	33	10	412.7	822

Source: Bjørndal, Ekerhovd and Bjørndal (2015).

It is noticeable that total value added varies considerably over time with total valued added in 2010 more than twice that of 2012. The reasons are found both on the input side, in terms of variations in quantities and prices of fish as well as on the output side, in terms of variations in product prices.

The firms in the data set are mainly located in Møre and Romsdal county, but there are some firms located in Troms and Finnmark counties. Table 15.2 shows the geographical locations of the firms.

1. After salting, the fish will undergo a drying process so as to prepare the final product. Salted & dried cod – in Norwegian klippfisk – or bacalhau as it is known in countries like Portugal and Brazil (bacalao in Spain) – is salted and dried fish mainly produced from cod or saithe, but can also be produced from link, tusk and haddock.

TABLE 15.2. GEOGRAPHIC LOCATIONS OF THE FIRMS.

Municipality	Labour market region[a]	County	No of firms
Ålesund	Ålesund	Møre and Romsdal	19
Sula	Ålesund	Møre and Romsdal	8
Giske	Ålesund	Møre and Romsdal	4
Haram	Ålesund	Møre and Romsdal	3
Averøy	Kristiansund	Møre and Romsdal	2
Kristiansund	Kristiansund	Møre and Romsdal	1
Aure	Aure	Møre and Romsdal	1
Smøla	Smøla	Møre and Romsdal	1
Fræna	Molde	Møre and Romsdal	1
Karlsøy	Tromsø	Troms	1
Torsken	Torsken/Berg	Troms	1
Måsøy	Måsøy	Finnmark	1
Nordkapp	Nordkapp	Finnmark	1

Source: Bjørndal, Ekerhovd and Bjørndal, (2015).
[a] Labour market regions according to Statistics Norway, based on commuting distances and actual commuting (Sing Buller, 2009).

THEORETICAL AND METHODOLOGICAL FRAMEWORK

AGGLOMERATION ECONOMIES

Innovations and growth through firms' interactions with other agents have been addressed from different theoretical angles during the last two-three decades, from the classic innovation system approach (Lundvall, 1992) and various cluster theories (Porter, 1990; Krugman, 1991a and b) in the first decade, to geographic oriented innovation system approaches in the last decade (Frenken *et al.*, 2007; Boschma *et al.*, 2009; Fitjar and Rodriguez-Pose, 2013). Self-reinforced industrial clusters with considerable scale and/or scope advantages are important for regional and national economic growth, employment and income generation. The self-reinforcing mechanisms may originate from positive linkages between different parts (agents) of the cluster (Krugman, 1991; Krugman and Venables, 1996).

The essence of cluster theory is that *cooperation*, *competition* and *complementarities* between the agents within the cluster will increase the total knowledge resource base of the cluster and thus strengthen its innovative capacity. Although clusters have been characterized as innovative and unique phenomenon by many researchers, the cluster literature has not been able to adequately describe the mechanisms and channels involved in the knowledge diffusion process (knowledge spillovers). Innovation abilities are often seen as a result of interactions between industry actors that makes a larger variety of knowledge accessible. It is also critical to differentiate between different kinds of knowledge spillovers (Wolfe and Gertler, 2004). A common distinction in the literature has been that knowledge can either be «codified» (standardized and written down in documents), or it can be «tacit», referring to knowledge that is best mediated through face-to-face interaction and geographical proximity (Audretsch and Feldman, 2004). Tacit knowledge often emerges learning-by-doing-using-and-interacting and experience gained at the workplace (Lundvall and Lorenz, 2008). Codified knowledge is easier to transfer over long distances than tacit knowledge (Gertler, 2003). Thus knowledge may rest on geographic boundaries, where the cost of transmitting information presumably rises with distance. Increasing the knowledge base and the innovative capacity will also strengthen the firms' value added and their global competitiveness, making the region even more attractive for new business set ups.

In the more recent geographically oriented innovation literature the focus is more directed towards effects of physical proximity between agents, «related variety», and localised socio-institutional interactions on innovation and economic growth (e.g. Baptista, 2001; Frenken et al., 2007; Boschma et al., 2009). However, there have been disagreements regarding the impact of global versus local interactions within and outside the value chain (Fitjar and Rodriguez-Pose, 2011; 2013). Based on a recent empirical analysis of firm innovation in the maritime supply industry in Møre and Romsdal, Frøystad and Nesset (2014) found that interaction with a diversity of international partners within the global value chain was more important for product innovation than interaction with local partners. These findings are probably of less relevance for the salted & dried cod industry in the same region. All the firms in this industry interact primarily with international customers and other international agents, and the main difference between the firms' interaction patterns is probably the degree of interaction inside and outside the national and, in particular, the regional value chain.

In any industry that is dependent on specialised products and services, as is the case for the salted & dried cod industry, knowledge transmission and thus diffusion of innovations will depend on market size. A large market is necessary in order to support the existence of a large diversity of human and physical capital. In addition, physical proximity or spatial density will increase the immaterial capital base and thus further accelerate the knowledge diffusion process, and in particular when knowledge is tacit. In particular, spatial concentration of the industry is important for the fishing industry as this industry is also spread over a large coastline, implying high transportation costs between some of the agents (Tveterås and Battese, 2006).

THE BASIC MODEL AND ESTIMATION TECHNIQUES

According to Caballero and Lyons (1990), a general production function extended to include effects of external economies can be written as:

$$(1)\ Y = f(K, L, E, V),$$

where Y is total value-added measured as total production value minus the value of intermediate inputs, K is capital inputs, L is labour inputs, E is an external economy index, and V is a productivity index. The function f is homogeneous of degree γ in K and L, and of degree one[2] in E and V. A panel data version of a common specification of this production function is the translog specification[3]:

$$(2)\ \ln Yit = \alpha_i + \beta_L \ln Lit + 0.5\beta_{L2}(\ln L)^2_{it} + \beta_K \ln Kit + 0.5\beta_{K2}(\ln K)^2_{it} + \beta_{LK}\ln Lit \ln Kit + \beta_E \ln TLt + \beta_C\, SDr + \beta_D\, Dt + u_{it},$$

where subscript i refers to firm, subscript t refers to year, and subscript r refers to region. TLt is total number of employees in the industry representing market size. SDr is a region specific spatial density function which can be measured by the relative number of firms producing/exporting salted & dried cod per km^2 land area in the different regions. TLt and SDr are the variables that account for possible external economy (cluster) effects and reflect the E variable in equation (1). The productivity index V is represented by year dummies for each year, Dt, which proxy a trend variable taking account of changes both on the input and output side that have an impact on value added.

2. This can be viewed as normalisations, since E and V are indices.
3. See e.g. Solheim and Tveterås (2014) for a variant of this specification with only one input factor (labour).

There are two main techniques used to estimate a panel data model; the fixed-effect model and the random-effect model. A fixed-effect model controls for time-invariant differences between firms by modelling firm specific constant terms or dummies. In the fixed-effect model impacts of time-invariant variables like e.g. the spatial density variable (*SDr*) will be included and thus hidden in the constant term. Technically, a time-invariant characteristic of a firm is perfectly collinear with the firm dummies, and can therefore not cause changes of a firm. In a random-effect model, the variation across firms is assumed to be random and uncorrelated with the predictor or independent variables in the equation. An advantage of the random-effect model is that one can include time-invariant variables (e.g. *SDr*). In the following, both types of models will be estimated. The Hausman test, where the null hypothesis is that the preferred model has random effects and the alternative hypothesis says that the effects are fixed, will be run to decide between the two techniques.

THE DATA

Firm level data have been taken from SNF's data base on the accounts of Norwegian companies (Berner, Mjøs and Olving, 2014). The variables are the following:

1. Firm identification number.
2. Value added per firm.
3. Number of employees per firm.
4. Total tangible fixed assets per firm.
5. Total fixed assets per firm.
6. Labour market region.
7. Municipality

With firm identification number, it is possible to track firms over time. There are two measures of capital, namely, total tangible fixed assets (*K1*) and total fixed assets (*K2*). Total tangible fixed assets (*K1*) include land, buildings and other property, machinery and plant, fixtures and fittings, furniture, office machinery etc. Total fixed assets (*K2*) include intangible fixed assets and financial fixed assets in addition to tangible fixed assets. Based on commuting distances and actual commuting, Statistics Norway has defined different labour market regions (Sing Buller, 2009). Firms are classified according to the municipality (region) where their head office is located. The data set contains 173 observations, and table 15.3 gives some summary statistics for value added (*V*), labour (*L*), and the two measures of capital (*K1* and *K2*). In addition to mean values, minimum and maximum observations are given as well as standard deviation.

Mean value added per firm per year varies between NOK 10.7 million in 2012 and NOK 21.5 million in 2010. When considering minima, maxima and standard deviations, it is obvious that there are substantial differences both across firms and over years. Indeed, for 2010–12 negative value added can be observed for some years. When it comes to labour, there is much less variation over time although there is substantial variation across firms, with minimum of zero in all years and a maximum of 96 employees observed in 2012. For the two measures of capital it can again be observed that there is limited variability when comparing mean values over time while there is considerable variation across firms.

TABLE 15.3. SUMMARY STATISTICS.

Year	**No of firms**	**Mean value added per firm. mill NOK** (min, max, *std*)	**Mean no of employees** (min, max, *std*)	**Mean total tangible fixed assets per firm. mill NOK** (min, max, *std*)	**Mean total fixed assets per firm mill NOK** (min, max, *std*)
2009	42	15.5 (0.0, 111.4, *20.9*)	19.5 (0, 83, *20.9*)	18.0 (0.0, 256.0, *42.3*)	33.3 (0.0, 504.5, *86.2*)
2010	44	21.5 (–15.5, 162.3, *36.4*)	20.0 (0, 78, *21.5*)	18.7 (0.0, 243.6, *41.8*)	31.7 (0.0, 529.9, *85.1*)
2011	44	19.4 (–3.3, 162.5, *32.6*)	18.8 (0, 87, *21.9*)	16.1 (0.0, 132.6, *26.6*)	27.9 (0.0, 336.1, *58.7*)
2012	43	10.7 (–31.5, 72.0, *–31.5*)	20.6 (0, 96, *23.8*)	16.8 (0.0, 140.3, *28.6*)	29.7 (0.0, 301.5, *58.5*)
Total	173	16.8 (–31.5, 162.5, *28.1*)	19.7 (0, 96, *21.9*)	17.4 (0.0, 256.0, *35.2*)	30.7 (0.0, 529.9, *72.7*)

There are some missing observations for *V*, *L* and *K*. In addition, there are some zero values, in particular for *L*. The zero *L* observations are in the main for exporters that are owned by producers and where the mother company is responsible for administration also of the export company.

The size of the industry is measured by two alternative variables. One is measuring employment in the salted & dried cod industry as shown in table 1 (*TL1*), and the other measure an aggregate of related industries (*TL2*). The latter variable is included in both because of potential cooperation, competition and complementarity effects between firms in the salted & dried cod industry and those in related industries. Having studied what may be considered related industries, we have selected the following:

- Wholesale of fish, crustaceans and molluscs (NACE-code[4] 46381),
- Drying and salting of fish (NACE-code 10201),
- Freezing of fish, fish filets, shellfish and molluscs (NACE code 10202)
- Slaughtering and other processing and preserving of fish and fish products (NACE code 10209).

For salted & dried cod, producers will be included in 10201 while exporters belong to 46381. According to SNF's data base on the accounts of Norwegian companies (Berner, Mjøs and Olving, 2014), in 2012 these four groups included a total of 573 firms with positive employment. Table 15.4 gives annual employment for these firms. It can be seen that the salted & dried cod industry (table 15.1) represents only a small fraction of total employment. It can also be noted that total employment shows little variation over time.

TABLE 15.4. TOTAL EMPLOYMENT FOR FIRMS IN NACE-CODES 46381, 10201, 10202 AND 10209 (*TL2*) FOR 2009-12.

Year	Total employment
2009	9,807
2010	10,075
2011	10,540
2012	10,945

As mentioned above, spatial density (*SDr*) may be measured by the relative number of industry related firms per km^2 land area in the different regions. A major problem with this measure is, however, that most of the firms (77 %) are located in one of the labour market regions, namely Ålesund, and the rest of the firms are thinly spread out on the other regions (table 15.2). This gives a very high density for the Ålesund region and very low density for all the other regions. An almost identical alternative is to use a dummy variable (*SD1r*) with value 1 for firms located in the Ålesund region and value 0 for firms located outside the Ålesund region. A stricter location dummy (*SD2r*), with value 1 for firms located in Ålesund *municipality* and value 0 otherwise, will also be tested in some of the regressions.

4. NACE is Nomenclature statistique des activités économiques dans la Communauté européenne, representing a statistical classification of economic activity in the EU.

EMPIRICAL RESULTS

The basic model from equation 2 is first run with capital measured as total fixed tangible assets (*K1*). Both a fixed-effect (FE) and a random-effect (RE) model are estimated, and a Hausman test is conducted in order to choose the appropriate model (see appendix 1). The two models show quite different overall variance explanations with R-squares of only 0.08 in the fixed-effect model and 0.639 in the random-effect model. The Rho-statistic shows that the main part of the explained variances is due to differences across the firms (90 % in the fixed-effect model and 73 % in the random-effect model). The first order labour coefficient is negative but far from being significant in the fixed-effect model, and this is a quite counter-intuitive result. It may, however, be due to the inclusion of the cross-product of labour and capital as an explanatory variable (based on the standard translog production function). The coefficients of this cross-product are far from significant in both models. By excluding the cross-product of capital and labour, the two models become more equal and much easier to interpret. This is shown in table 15.5.

The two models show quite similar overall variance explanations, with R-squares around 0.6. The significant coefficients are mainly the same and with fairly stable point estimates. The only exception is that the first order effect of capital is significant (at the 10 % level) only in the random-effect model RE1.

The Hausman test clearly indicates that the covariance between α_i and the explanatory variables is close to zero, implying that the coefficients from both the fixed-effect and the random-effect models are consistently estimated. However, in this case the standard errors of the random-effect estimators will be less than the standard error of the fixed-effect estimators, favouring the former model. In addition, the random-effect model enables a unique estimate of the value added effect of the time-invariant location dummy variable.

TABLE 15.5. FIXED-EFFECT AND RANDOM-EFFECT ESTIMATORS WITH β_{LK}= 0. BASED ON THE STRICT CAPITAL MEASURE (*K1*) AND LABOUR MARKET LOCATION DUMMY (*SD1*). FULL SAMPLE.[a,b]

	Fixed-effect Model FE1	Random-effect Model RE1
lnL	0.252** (0.111)	0.330*** (0.081)
$(\ln L)^2$	0.092*** (0.035)	0.087*** (0.023)
lnK1	0.152 (0.415)	0.208 (0.075)
$(\ln K1)^2$	–0.002 (0.027)	–0.005 (0.008)
D(2009)	0.582*** (0.144)	0.558*** (0.134)
D(2010)	0.594*** (0.142)	0.564*** (0.132)
D(2011)	0.443*** (0.136)	0.441*** (0.130)
lnTL1	0.783 (0.925)	0.181 (0.493)
SD1	*(omitted)*	0.983*** (0.365)
Const	0.166 (7.094)	3.863 (3.575)
R-squared overall	0.559	0.632
No obs/firms	165/44	165/44
Wald Chi2(9)		107.31
Sigma_u	1.060	0.952
Sigma_e	0.578	0.578
Rho	0.771	0.731
Hausman test FE1 vrs RE1: Chi2(8) = 3.14 (P=0.925)		

[a] Standard deviations in parentheses.
[b] *** indicates sign. at the 1 % level, ** indicates sign. at the 5 % level, and * indicates sign. at the 10 % level.

Regarding the year dummies, the dummy for 2012 is excluded. The dummies for 2009, 2010 and 2011 show significant positive effects compared to 2012. Year 2012 is the exceptional year, and regressions including the 2012 year dummy and excluding one of the other show a significant negative effect of year 2012. This is also reflected in the observed measures of value added in table 15.1. There was a large drop in total value added from 2011 to 2012.

Localised external effects will be picked up by the coefficients of the total employment variable (*TL1*) and the location dummy (*SD1*). The coefficient for *TL1* is not significant. We have also substituted *TL1* with the broader measure *TL2*, but the coefficient of this broader measure also turns out to be insignificant. This may, however, be due to very low variability for these two variables. Increasing the time series could change this picture. The location dummy *SD1* is however significant in the RE1 model, indicating a localised external effect of spatial density on value added for firms located in the Ålesund region.

To test the robustness of this result, three different models with different measures of capital and location dummies are also estimated. The results of these estimations are given in appendix 2. Model RE2 differ from model RE1 only with respect to the location dummy variable. In RE1, the location dummy variable has value 1 for firms located in the greater Ålesund region (34 firms and 136 observations) and 0 otherwise (10 firms and 40 observations). In RE2 the location dummy variable has value 1 for firms located in Ålesund municipality (19 firms and 76 observations) and 0 otherwise (25 firms and 100 observations). The results of the two models are quite similar. This is what one would expect: municipalities other than Ålesund that belong to the Ålesund labour market region are very close to Ålesund municipality, and this calls for competition, cooperation and complementariness to be reflected in both dummies. Results for the models RE3 and RE4, where the broader capital measure is included, show no significant effects of this capital measure.

Figure 15.1 shows the firm and period specific relationships between estimated value added using model RE1, and actual value added. Dots on the 45 % line show perfect match.

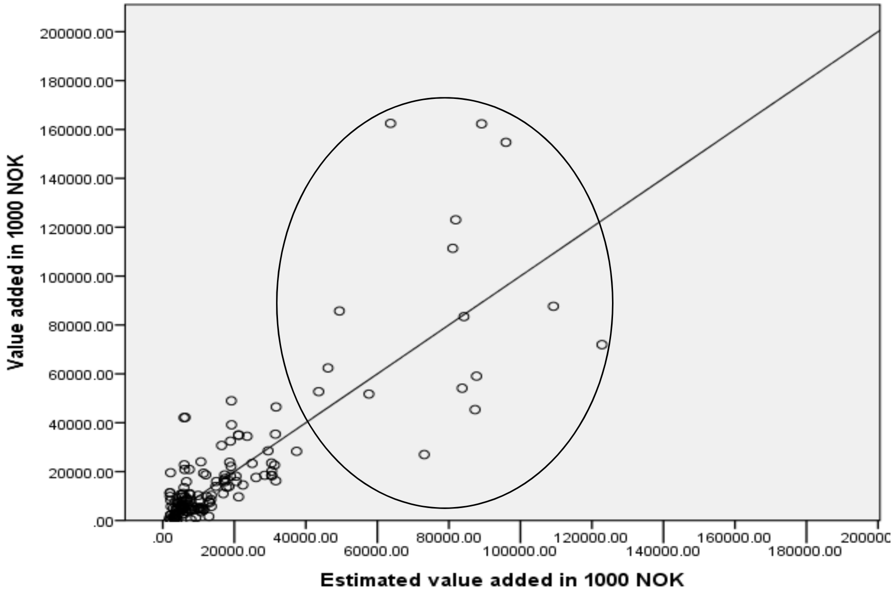

Figure 15.1. Correspondence between actual value added and estimated value added (model RE1) for each firm-period observation.

The mismatch between estimated and actual value added in absolute values is naturally increasing with the level of value added, and thus the four largest firms show the largest deviations. These firms are all located in Ålesund municipality. By removing the 16 observations (within the circle) for these four largest firms, one can test for the robustness of the effect of location on value added. RE5 and RE6 are the same models as RE1 and RE2, respectively, but estimated with the smaller sample where observations for the four largest companies are excluded. The two models give quite similar results (table 15.6), supporting the robustness of the results of model RE1.

TABLE 15.6. RANDOM-EFFECT ESTIMATORS, BASED ON THE STRICT CAPITAL MEASURE (*K1*) AND DIFFERENT LOCATION DUMMIES. SAMPLE WITHOUT THE FOUR LARGEST FIRMS.[a,b,c]

	Model RE5 (SD=Ålesund region)	Model RE6 (SD=Ålesund municipality)
lnL	0.322*** (0.090)	0.292*** (0.086)
$(\ln L)^2$	0.087*** (0.027)	0.090*** (0.027)
lnK1	0.213** (0.081)	0.200** (0.081)
$(\ln K1)^2$	–0.006 (0.009)	–0.006 (0.009)
D(2009)	0.568*** (0.146)	0.582*** (0.144)
D(2010)	0.515*** (0.144)	0.532*** (0.143)
D(2011)	0.388*** (0.140)	0.393*** (0.138)
lnTL1	0.078 (0.594)	0.409 (0.586)
SD1	0.734* (0.414)	0.876** (0.370)
Const	4.710 (4.287)	2.521 (4.318)
R-squared overall	0.539	0.574
No of obs/firms	149/40	149/40
Wald chi2(9)	73.09	75.86

[a] Standard deviations in parentheses. [b] The location dummy is *Ålesund region* in model RE5, and *Ålesund municipality* in model RE6. [c]*** indicates sign. at the 1 % level, ** indicates sign. at the 5 % level, and * indicates sign. at the 10 % level.

Figure 15.2 shows the estimated relationship between value added and labour input for a typical firm located in the Ålesund region and a typical firm located outside the Ålesund region, respectively. The calculations of the relationships are based on the results (the coefficients) from model RE1, and conditioned on the mean value of total tangible fixed assets (*K1*) for all firms.[5] The calculations are also conditioned on the mean coefficient value of the three year dummy variables,

5. The mean value of total tangible fixed assets for all firms in all years is 17.4 mill. NOK (see table 15.3). Mean capital for firms in the Ålesund region is, however, larger than for firms outside Ålesund region (18.9 versus 12.8 mill. NOK).

which will add to the constant term (3.863). As variables *TL1* and $(\ln K1)^2$ were not significant, they were not included in the calculations.

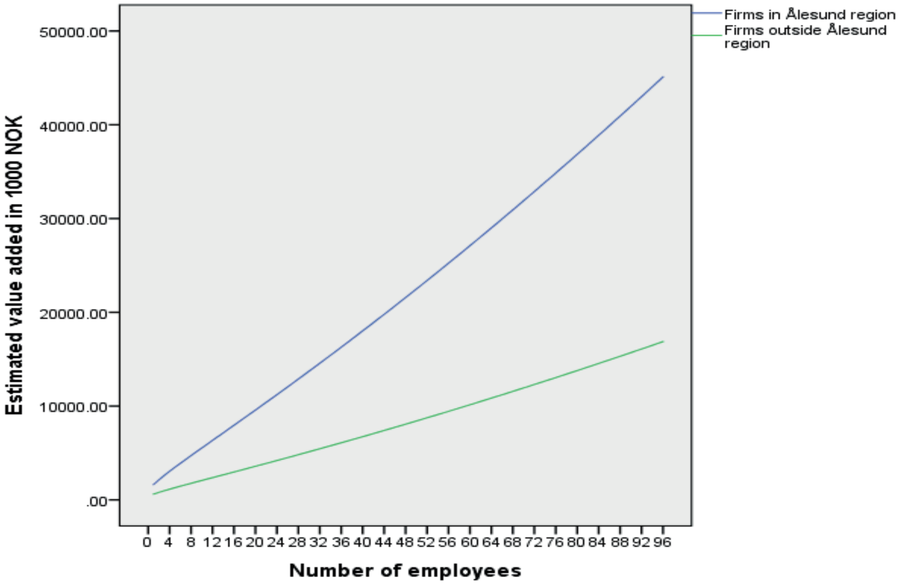

Figure 15.2. Estimated relationship (based on model RE1) between number of employees and value added for firms within the Ålesund region and firms outside the Ålesund region.

Value added is an increasing function of number of employees for firms both within and outside the Ålesund region. There is a positive gap between value added for firms in the Ålesund region and outside the region, and this gap increases with labour input. This gap is an illustration of the localised external effect due to spatial density.

An interesting finding is that labour inputs have significant positive first and second order effects. *A priori,* one might expect a negative second order effect, so that firms would enter a region with decreasing returns. This is not observed here but might be observed if data for more years become available.[6] Capital, on the other hand only has a significant first order effect while the second order effect is not significant. Again, one would expect this to change if more data became available.

6. If a third order term for *L* was included, one would expect a negative coefficient. This has not been pursued here.

CONCLUSIONS

This article presents results from an analysis of the Norwegian salted & dried cod industry using economic and geographic information at the firm level. Based on recent theoretical theories of industrial clustering, different versions of a translog production function explicitly incorporating localized external effects have been estimated. Two different variables accounting for the external effects have been included: a size effect variable (total employment in the industry) and a spatial density function. The data are yearly panel data over a relatively short period of time (2008–2012) but cover all the firms in the industry. The analysis shows that there is a significant external clustering effect in this industry induced by spatial density or physical proximity between firms. We are not able to find any significant external effect from industry size. The spatial external effect seems to be qualitatively good and fairly robust against different specifications. The existence of immaterial capital related to connections/relationships between different klippfish actors within the Ålesund regional industry thus seems to add more value.

There are, however, some peculiarities and shortcomings of this analysis. The results show that the second order effect of labour is significant and positive, though very small. A priori one would expect this effect to be negative. The insignificant second order effect of capital also seem to be in conflict with a priori assumptions. These problems can be due to data limitations, both in terms of how to measure capital and the short time-series at hand. An alternative avenue for measuring capital could be to use assurance values of equipment and buildings. These data are, however, not easily available at the present moment. The lack of significant industry size effects can also be linked to the short time-series and the small variability of these measures. Extending the data-series and/or collecting quarterly or monthly data would probably improve the analysis in this respect. It is difficult to get enough relevant data on a monthly or quarterly basis, but extending the time-series by adding more years is possible. Further analyses with longer time-series and various alternative industry size variables will be conducted in the near future.

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APPENDIX 1

TABLE A1. FIXED-EFFECT AND RANDOM-EFFECT ESTIMATORS, BASED ON THE STRICT CAPITAL MEASURE (*K1*) AND LABOUR MARKET LOCATION DUMMY (*SD1*). FULL SAMPLE.[a,b]

	Fixed-effect Model FE	**Random-effect Model RE**
lnL	–0.419 (1.272)	0.461*** (0.164)
$(\ln L)^2$	0.098** (0.037)	0.095*** (0.025)
lnK1	0.163 (0.417)	0.144 (0.102)
$(\ln K1)^2$	–0.015 (0.037)	0.001 (0.010)
lnLlnK1	0.075 (0.142)	–0.018 (0.019)
D(2009)	0.584*** (0.144)	0.556*** (0.134)
D(2010)	0.596*** (0.142)	0.563*** (0.133)
D(2011)	0.443*** (0.136)	0.434*** (0.130)
lnTL1	0.821 (0.930)	0.162 (0.493)
SD1	*(omitted)*	0.810** (0.366)
Const	0.460 (7.139)	4.088 (3.579)
R-squared overall	0.084	0.639
No obs/firms	165/44	165/44
Wald Chi2(10)		108.40
Sigma_u	1.785	0.951
Sigma_e	0.580	0.580
Rho	0.905	0.729
Hausman test FE vrs RE: Chi2(9) = 2.46 (P=0.982)		

[a] Standard deviations in parentheses.
[b] *** indicates sign. at the 1 % level, ** indicates sign. at the 5 % level, and * indicates sign. at the 10 % level

APPENDIX 2

TABLE A2. RANDOM-EFFECT ESTIMATORS, BASED ON DIFFERENT CAPITAL MEASURES (*K1* AND *K2*), AND LOCATION DUMMIES (*SD1*, *SD2*). FULL SAMPLE.[a,b]

	Model RE2	Model RE3	Model RE4
lnL	0.288*** (0.080)	0.436*** (0.085)	0.411*** (0.082)
$(\ln L)^2$	0.085*** (0.023)	0.079*** (0.024)	0.082*** (0.024)
lnK1	0.198** (0.074)		
lnK2		0.031 (0.047)	0.034 (0.046)
$(\ln K1)^2$	–0.006 (0.007)		
$(\ln K2)^2$		0.004 (0.006)	0.001 (0.006)
D(2009)	0.564*** (0.132)	0.515*** (0.139)	0.521*** (0.137)
D(2010)	0.573*** (0.131)	0.546*** (0.138)	0.552*** (0.136)
D(2011)	0.440*** (0.129)	0.447*** (0.135)	0.447*** (0.133)
lnTL1	0.430 (0.484)	0.274 (0.497)	0.494 (0.488)
SD1		0.612 (0.367)	
SD2	0.856*** (0.307)		0.800** (0.316)
Const	2.394 (3.564)	3.702 (3.615)	2.441 (3.560)
R-squared overall	0.661	0.600	0.619
No obs/firms	165/44	165/44	165/44
Wald Chi2(9)	111.67	94.10	99.18
Sigma_u	0.961	0.922	0.930
Sigma_e	0.578	0.579	0.579
Rho	0.735	0.718	0.721

[a] Standard deviations in parentheses.
[b] *** indicates sign. at the 1 % level, ** indicates sign. at the 5 % level, and * indicates sign. at the 10 % level