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The high importance of de-industrialization and job polarization for regional diversification

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The high importance of de-industrialization and job polarization for regional diversification

… and the limits to the importance of relatedness

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Abstract

The process of regional diversification has received a growing interest in recent years with a focus on the role of relatedness between economic activities. The main argument is that regions diversify into economic activities closely related to their current activities. However, there are also processes working against this rather path dependent process, such as de-industrialization, job polarization, skill-biased technological change, and urbanization. The purpose of this paper is to analyse the importance of relatedness and these major processes in regional diversification with specific emphasis on the role of job polarization and de-industrialisation. The paper draws on linked employer-employee census data from Denmark 2008-2013. Results show that, while relatedness does matter for regional diversification, job polarization and deindustrialisation entail that the most related industries tend to contract. Hence, the results show that regional diversification is affected by relatedness, but its effect is overshadowed by job polarisation and de-industrialization. This effect is consistent across regions. The results show a role for policy and entrepreneurship in introducing unrelated diversification.

“Empirically, countries move through the product space
by developing goods close to those they currently produce”
(Hidalgo et al. 2007, p. 482)

1. Introduction

The process of regional diversification has received a revival of interest in recent years with a focus on the path-dependence in the evolution of regional economies (Hidalgo et al., 2007; Neffke et al., 2011; Essletzbichler, 2015; Boschma, 2017). These studies find that the process of regional diversification consists of diversification into products, industries or activities, which are related to the current products, industries or activities in the region. The main argument is that new activities draw on and benefit from the existing portfolio of resources in the region. As a result, the evolution of regional economies becomes a rather path-dependent process, where new industries arise from related industries in the region. In addition, Neffke et al. (2011) shows that not only are industries related to the existing structure more likely to enter in a region, but unrelated industries are more likely to exit. Thus, the regional portfolio of related activities affects the possibilities for new activities. Similarly, Boschma (2017) concludes, “studies tend to show that related diversification is the rule, and unrelated diversification the exception” (p. 352)

However, studies focussing on the role of relatedness for regional diversification tend to overlook the major processes that shape these dynamics in most developed countries: de-industrialisation, job polarisation, urbanisation, and skill-biased technological change (Goos et al., 2014; Bernard et al., 2016; Holm et al. 2017; International Monetary Fund, 2018 Ch. 3). That is, the trends for economic activity to shift away from manufacturing and from peripheral areas, for routine middle skill jobs to disappear, and for increasing human capital intensity. The literature on job polarization shows that a significant share of polarization is caused by structural change (Goos et al., 2014; Heyman, 2016), and hence it is interrelated with the regional diversification process analysed in the literature on relatedness, and so are the trends for urbanisation and deindustrialisation. Therefore, the role of relatedness in regional diversification must be analysed considering these processes. For example, a regional economy characterised by a high share of related industries in manufacturing may not benefit from the high relatedness, since it is stemming from manufacturing industries, which are generally in decline. This means that, while the presence of related industries in a region may have a statistically significant effect on relative industry growth, it is likely that the real impact of relatedness is negligible compared to other effects. Thus, the set of diversification possibilities for a regional economy is also affected by a regional exposure to the major processes and not just the set of related activities of the existing industry structure.

The purpose of this paper is to analyse the coevolution of relatedness and the major processes in regional diversification with specific emphasis on the role of de-industrialisation and job polarization.. The paper draws on a detailed matched employer-employee dataset for Denmark, that allows the analysis of the processes affecting regional diversification in great detail.

Results show that, while relatedness does increase the employment growth of regional industries, the processes of job polarization and deindustrialisation together with entrepreneurship entail that the most related industries tend to contract. This result indicate that potential regional development paths is not necessarily those described in the existing literature (e.g., Boschma and Frenken 2011; Neffke et al., 2011; Essletzbichler, 2015; Boschma, 2017). The process of regional diversification is affected by relatedness as expected, but job polarisation and de-industrialisation overshadow this effect. The result is similar and consistent for all Danish regions despite of regional differences in industrial structure, endowments, and development possibilities. This highlights the importance of not neglecting the major processes of de-industrialisation, job polarisation, urbanisation, and skill-biased technological change in analysis of regional diversification. The results also show that relatedness hence reduces job polarization in the sense that the presence of related industries decreases the tendency for regional diversification to remove routine jobs. The paper demonstrate a role for policy and entrepreneurship in introducing unrelated regional diversification.

This paper contributes to the literature on regional diversification in several ways. First, it shows that there are also processes working against the rather path dependent process proposed by the studies of relatedness, such as de-industrialization, job polarization, skill-biased technological change, and urbanization. Second, it analyses the impact of these processes in detail on regional diversification. Third, it demonstrates that policy and entrepreneurship in a region can be used to change the direction of diversification.

The following section gives a brief overview of recent studies of regional diversification, and lays out a general model of regional diversification. Section 3 presents the data and describes the evolution of the Danish regions from 2008-2013. Section 4 describes the details of our methodology, and the evolution of the Danish regions is analysed in section 5. A decomposition is used to expose what causes the observed dynamics. Section 6 sums up and concludes.

2. Theories of regional diversification

In recent contributions in economic geography (Hidalgo et al., 2007; Neffke et al., 2011; Hausmann and Hidalgo, 2011; Boschma et al., 2013; Essletzbichler, 2015, Boschma et al., 2015; Boschma, 2017) models of regional diversification has emphasised how lagging economies catch-up in structural terms, rather than emphasising the creation of new industries, though there are recent exceptions such as Boschma et al. (2017). In contrast, early discussion of structural change focussed on the mechanisms that lead to new economic activities. In the works of Marshall it was increased specialisation that lead to the creation of new separate activities (Marshall 1920), a principle which goes back to Adam Smith's focus on the division of labour and Riccardo's comparative advantages. A complementary perspective is the idea that new activities emerge when old activities are combined in a novel way (Schumpeter 1934, Saviotti and Frenken, 2008, Andersen 2004). Together, these two classical perspectives explain regional diversification as further sub-division of economic activities and as recombination of economics activities. In either case, the new activities stem from the historical activities of the economy.

The recent models of regional diversification have a number of common features. First of all, the set of all current economic activities in the chosen nomenclature (e.g. industry codes) are envisaged as a network. The network is made up of nodes for each activity, and connections between nodes indicating the distance between them. The structure of an economy can then be described as the position of the economy in the network, and regional diversification is described as "moving" through the network. All other things being equal an economy moves in the direction of least resistance; i.e. where the distance between nodes is lowest. This means that regional diversification is highly path dependent: future diversification depends on the current location in the network, thus the current regional capabilities both offers opportunities but also sets limits for diversification (Boschma, 2017). Arguably, focus has been on the dominating role of path dependence and how it confines development, but not on cases where path dependence is interrupted (Zhu et al., 2017). An important element in these models is also that there are many exceptions to this general rule and that these are determined by regional differences. In other word, regional diversification is both path and place dependent (Martin and Sunley, 2006). The survey by Henning et al. (2013) highlights some of the shortcomings of the empirical research based on versions of the network model. Arguably, there is a tendency to focus on describing the path dependence rather than the mechanisms that cause it, and when analysing such mechanisms there is a tendency to focus on the evolution of technology (or knowledge more broadly) and to overlook the roles of institutions and agency (Zhu et al., 2017; Boschma, 2017). In addition, it may be argued that the mechanisms that hinder path dependence in regional diversification are no less important.

Progress on this "network model" has been highly empirically driven with authors using different data and methods to operationalise the network using names such as: the product space (Hidalgo et al., 2007; Boschma et al., 2013), the tree of industrial life (Andersen, 2003), the industry space or R-matrix (Neffke et al., 2011; 2017) or the technology/knowledge space (Kogler et al., 2013, Boschma et al., 2015). The mechanisms identified as driving the path dependence include spinoffs and local labour mobility. To varying degree, recent contributions identify the mechanisms that may cause breaks in the path dependence; i.e. mechanisms that lead to the diversification into parts of the network, which are far from the current location of the economy. The emergence of new, "distant" economic activities in an economy could be a chance event, but there is contested evidence and a debate in the literature whether the "chance event" is a pure chance event or if it is affected by regional conditions (see e.g., Martin and Sunley, 2006; Klepper, 2010). There are several potential factors in a region that can lead to the emergence of new economic activities. Martin and Sunley (2006) argue that the sources of new economic activities in a region could be indigenous creation, where a new activity emerges from within the region without immediate antecedents in the region; as transplantation of new activities from other regions; or as diversification of existing activities into related activities. Isaksen (2015) analyse industrial development in thin regions compared to core regions. He argues that the rise of new industries in a region stems from factors such as the establishment of new firms or spinoff firms, commercialisation of new knowledge stemming from universities or R&D institutions, or as transplantation by the inflow of investments and knowledge from the outside. For core regions, all three sources are likely to be present, but for thin regions, the two first sources are less likely. Core regions have large pools of highly educated labour that increases the absorptive capacity of the region (Cohen and Levinthal, 1990), and there is increasing focus on the importance of access to non local knowledge for regional diversification that is not path-dependent (Zhu et al., 2017; Neffke et al., 2018). Other suggestions for sources of new knowledge that can break the path of development include the presence of knowledge intensive business services, global value chains and research and development facilities in the region (Content et al. 2018). The importance of entrepreneurship for both regional growth and the evolution of the regional industry structure are also established empirically (Klepper, 2010; Noseleit 2015; Stuetzer et al. 2017). Regional institutions and an active regional industrial policy can also be important in introducing new activities in a region and promoting policy-driven unrelated diversification (Boschma, 2017). Thus path dependence, i.e. an economy's location in the network together with the structure of the network, contribute to the explanation of regional diversification but regional diversification also depends on the level of entrepreneurial activity in a region, the presence of different forms of knowledge intensive activities, and the access to knowledge outside the region.

The path dependent diversification of a region reflects changes in technology but there are also effects of technology that are counter to relatedness. In other words, technological change exerts a force on industry structure meaning that activities can grow in a region despite the lack of related activities, or technological change might lead to decline despite lots of regional related. In particular, there are a number of processes that influence the regional evolution of industries regardless of related activities (Goos et al., 2014; Bernard et al., 2016, Holm et al. 2017): Firstly, manufacturing is declining in developed countries through both offshoring and increased automation. Therefore, the presence of regional capabilities in manufacturing might not lead to the growth of related industries since these capabilities have changed from offering opportunities for regional diversification to posing limits. Thus, the process de-industrialisation counterbalance the effects of relatedness by rendering some capabilities less useful. Secondly, a process of polarization in jobs is observed, in the sense that middle skill and middle wage jobs disappear (see e.g., Goos et al. 2014; Holm et al. 2017). Job polarization potentially also work counter to relatedness as a driver for regional diversification, since industries that rely on these middle skills tend to contract regardless of the presence of related industries. Related but distinct processes are skill-biased technological change removing low skill activities and the increased importance of urbanization externalities meaning that economic activity centres near (large) cities.

3. Data

In this paper the regional diversification in seven regional economies are studied. The economies are regions of Denmark the industry codes of workplaces in the region describe the activities undertaken in the region. Regional diversification is studied in a broad sense. Most studies of regional diversification focus only on the emergence of firms with industry codes or product codes that are new to the region, but the argument for the importance of relatedness in regional diversification basically pertains to the emergence and disappearance of economics activities in general. Firm entry and exit within existing industries are also changes in the activities performed in a regional economy affecting diversification, and so are significant changes in the size of incumbent firms (Klepper and Thompson, 2006). Thus, the argument of relatedness also concerns regional diversification in the sense of differential relative expansion of existing industries. Therefore regional diversification in economic activities includes the growth of firms and industries as well as the emergence of new industries, firms and goods.

The data used are linked employer-employee census data with highly detailed information on the employees, the employment relations, the workplaces and the firms. The data are accessed at Statistics Denmark. Regional aggregates are computed from the micro data and in order to comply with confidentiality requirements all industry*region combinations with less than 3 plants or less than 10 full time equivalent (FTE) employees are excluded. Thus an industry becomes “present” in a region only when it has at least 3 plants and 10 FTE employees.

We describe each regional economy by the characteristics of the industries that are present within them, while industries are described by aggregating all employees at workplaces in that industry. This means that each region is analysed independently and that the units of analysis are the regional industries. We use the 4 digit NACE codes to delimit industries and exclude health, education and public sector administration. We use a combination of NUTS2 and NUTS3 codes to delimit regions, as explained in section 3.3 below.

The database goes back to 1980, but there are breaks in both occupation and industry codes around 2007-2008, as well as a change to the administrative boundaries in Denmark in 2007. Hence, we use only data from 2008 until 2013, which is currently the most recent data. The chosen period coincide with the financial crisis, which caused a recession in 2008-2009 followed by a recovery from 2010-2014.

3.1. Operationalising the network

Different terminological tools are needed to describe the network through which regions evolve: a) the distance between two industries, b) the centrality of an industry in the current regional industry structure and c) the centrality of the entire industry structure. We follow Neffke et al. (2011) and Essletzbichler (2015), which entails that the distance between two industries is their *relatedness*. Relatedness depends on technology and may vary both spatially and over time. However, because the current study deals with closely connected regions in a small country over a few years, relatedness is fixed. The centrality of an industry in the regional industry structure is its *standardised closeness*. It is essentially the "average" relatedness of an industry to all other industries in the region. Standardised closeness is specific to a combination of industry and region but it also changes over time as the industry structure of the region changes. Hence, standardised closeness depends on industry, region and time cf. equation 2 below. The centrality of the total industry structure is *technological cohesion*. The more related the industries of a region are to each other, the greater the region's technological cohesion. Technological cohesion is the average standardised closeness of all industries in a region weighted by the industries' regional employment shares, cf. equation 3. Technological cohesion thus has two subscript: region and time.

We apply the method from Neffke et al. (2017) for computing a "skill relatedness index". Alternatives to this approach are discussed in the online appendix. Distance is thus observed in labour flows between industries. If flows exceed expected flows from industry j to industry i then i is relatively related to j. The fact that labour flows more often between the industries than should be expected arguably reflects that the skills acquired in industry j are applicable in industry i and hence i is skill related to j but in principle the opposite need not be true. The skill relatedness index has values from 1 to -1 where 0 means that expected flows and observed flows are equal and positive values mean that observed flows are higher than expected flows. The index used here is computed by pooling all moves between industries in Denmark in 2008-2013, which results in a relatedness matrix. This matrix shows the distance between all possible pairs of industries and can be thought of as our "network". The diagonal of the matrix is not defined by the methodology but we place "1s" along the diagonal, reflecting that the relatedness between an industry and itself is the maximum of the index. In order to emphasise that we do not impose the restrictions of symmetric relatedness we refer to the variable as the skill *inflow* relatedness of i to j, SIR_{ij}.

$$SIR_{ij} = \frac{r_{ij}-1}{r_{ij}+1}, \text{ where}$$

$$r_{ij} = \frac{F_{ij}F_{..}}{F_{i.}F_{.j}} \tag{1}$$

In Equation 1, F_{ij} is the number of people that leave a job an industry i and find a job in industry j, $F_{i.}$ and $F_{.j}$ are the total number of people leaving and entering the two industries respectively, and $F_{..}$ are the total number of people moving between industries in the economy (Neffke et al. 2017).

Since we pool the data, SIR_{ij} is constant across regions and over time but at any point in time for any given region industry i may be more or less *close* to the regional industry structure depending on which other industries are present in the region. This leads to the concept of the standardised closeness, SC_{irt}, which is the share of industries in the regional portfolio of industries in region r at t, which are related to industry i (Neffke et al. 2011; Essletzbichler 2015).

$$SC_{irt} = \sum_{j \in RPF_{rt}} I(SIR_{ij} > p90_t)/N_{rt} \tag{2}$$

More formally RPF_{rt} is the "regional portfolio" – the set of industries that are present in *r* and N_{rt} is the number of elements in RPF_{rt}. $I(\cdot)$ is an indicator function that takes the value 1 if the expression is true and 0 otherwise. $p90_t$ is the threshold distinguishing related industries from other industries. This is defined as the 90th percentile of the cumulative distribution of SIR_{ij}. Cases where $SIR_{ij} = 1$ (i.e. cases where $i = j$) were excluded when determining the 90th percentile.[1]

[1] The robustness of the results to this definition is explored in the online appendix.

Finally, the technological cohesion of a region is the average standardised closeness of industries in the region weighted by employment (defined analogously to the "employment-weighted measure of metropolitan technological cohesion" in Essletzbichler (2015) p. 762).

$$TC_{rt} = \sum_{i \in RPF_{rt}} s_{irt} SC_{irt} \tag{3}$$

where s_{irt} is the employment share of industry i in region r at time t. TC_{rt} can be interpreted as the share of jobs in region r at time t that are skill related to a randomly drawn job in the region.

3.2. Other variables

All other things being equal the theories of regional diversification predicts that industry structure evolves by moving in the direction of least resistance, which will be observed as increasing technological cohesion, because industries with higher standardised closeness are expected to expand in relative terms. At the same time, however, the processes described in section 2 are also observed: jobs move towards cities, jobs in manufacturing disappear, routine jobs disappear and low skill jobs disappear.

Taking the time period into account, is seems obvious that the effect of the financial crisis must be included, as relative expansion of industries in the period 2008-2013 depend on industries' business cycle sensitivity. Finally, the literature has been criticised for neglecting the roles of agency and institutions, which leads us to include a policy variable that measures the amount spend on active industrial policy per job. Table 1 provides an overview of the variables included in the analysis.

Effect	Measure	Variable name	Simple national mean
Technological cohesion	Weighted average standardised closeness,	SC	0.030
Routine jobs	Share of jobs in routine occupations	Routine	0.345
Manufacturing	Share of jobs in manufacturing plants	Manuf	0.235
Periphery	Share of jobs in peripheral municipalities	Periph	0.314
Entrepreneurship	Share of jobs in workplaces founded within the previous five years	Entrep	0.216
Human capital	Share of employees with tertiary education	HC	0.130
Business cycle sensitivity	Standard deviation of yearly plant exit rate 2007-2012	Bus.Cycle	1.343
Relative specialisation (Location Quotient)	Industry share of regional employment relative to industry share of national employment	LQ	1.523
Scale effects	Average plant size	Size	32.614

Regional policy	DKK of active industrial policy per job	Policy	41.682

Table 1: Overview of variables

Jobs in peripheral locations: In Figure 1 the municipalities of Denmark are colour-coded into three groups. City municipalities are municipalities with a city of at least 45.000 inhabitants. Municipalities close to cities are municipalities where there is no city, but where the median commute to a city is less than 30 minutes. The remaining municipalities are then the periphery. This definition follows the Danish Economic Councils (DORS, 2015) and the set of cities with at least 45.000 inhabitants has not changed significantly between 2008 and 2015.

The variable measuring the urbanisation trend ($Periph_{rit}$.) is the share of jobs where the address for the workplace is in a peripheral municipality. Hence, the distinction between municipalities with cities and those close to cities is only indirectly relevant for the variable. Obviously, some regions have more scope than others do for having jobs in peripheral areas but since each region is analysed separately this is inconsequential.

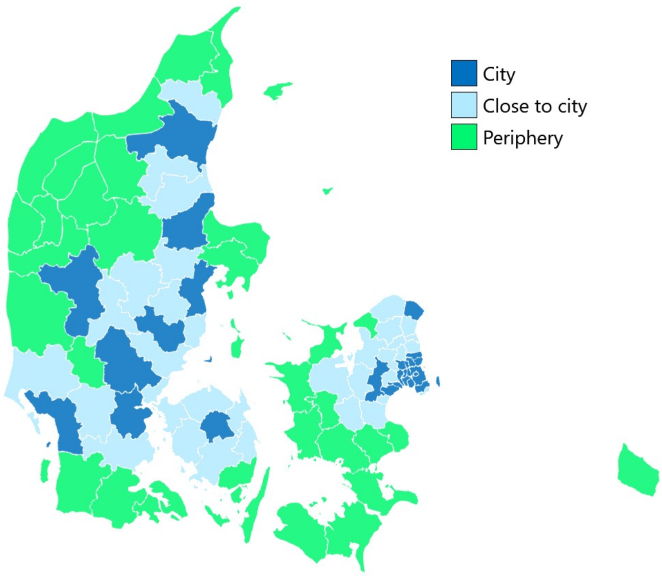

Figure 1: Cities and the periphery

Routine jobs and manufacturing jobs: Following Goos et al. (2014) routine jobs are those with a 1-digit ISCO classification of either: “4: Clerical Support Workers”, “7: Craft and Related Trades Workers” or “8: Plant and Machine Operators and Assemblers”. $Routine_{rit}$ is the share of jobs with a ISCO classification as a routine job, and $Manufacturing_{rit}$ is the share of jobs at plants with a manufacturing classification in NACE2.

Business cycle sensitivity: Our measure of business cycle sensitivity (Bus.Cycle) is based on the rate at which plants are closed down. This is computed as an economy level indicator since our industrial classification is relatively detailed and many regions have only few plants in several industries. Our data only allows us to use 2007-2012 data when computing exit rates at the industry level since there is a break in the industry codes between 2006 and 2007, and 2013 is the last year of available data. It is possible and likely that the average exit rate differs across industries and hence what is a "high" exit rate differs. In addition, it is possible that the timing of the crisis varied over industries. Therefore, business cycle sensitivity is measured as the standard deviation of the exit rate of the six years 2007-2012. This value is invariant at the industry level but the regional average will vary over regions and time as the regional industry structures change.

Policy: Statistics Denmark provides information on the municipalities' yearly expenses on active industrial policy.[2] These are divided into seven categories: Miscellaneous incomes and expenses, growth fora, tourism, human resource development, innovation and new technology, business services and entrepreneurship, and development of peripheral and rural areas. There is some indication that municipalities have some discretion in labelling of expenses and significant variations from one year to the next are observed, so we use the three year average of the sum of all seven categories.[3] This is then transformed into expenditures per private sector job. $Policy_{rit}$ is the average expenditure per job in industry i in region r. As municipalities within the region differ in their expenditures per job, industries will have different average depending on whether they tend to locate in high expenditure municipalities or not.

Location Quotient: The growth of an industry in a region will depend on the same industry's success in other regions. If another region is specialised in the industry, then there will be relatively high agglomeration externalities in the other region, and the industry will be better placed to expand where it is already relatively large. This spatial division of labour emerges from trade and will be included in the variable for regional relative specialisation: LQ_{rit}. It is computed as industry employment share in the region relative to the industry's national employment share. The location quotient is the variable in our analysis, which accounts for spatial effects, as it is the variable, which takes into account each region's industry structure relative to other regions.

Human capital, entrepreneurship and firm size: Finally, we include variables intended to capture the potential for technological development leading to breaks in the path of regional diversification, as identified in earlier studies. These are: 1) entrepreneurship, $entrep_{rit}$, defined as the share of employees in plants founded less than five years ago; 2) human capital intensity, HC_{rit}, defined as the share of employees with tertiary level education; and 3) size, $size_{rit}$, defined as the average employment of plants.

3.3. Regions

The Danish economy consists of highly different regions, each with its own path of development. It is expected that the degree to which observed regional diversification is explained by path dependence varies over regions, and this variation will be very useful when evaluating the explanatory power of the theory. We distinguish between seven regions defined at the NUTS3 level with the exceptions of the NUTS2 regions of Copenhagen and Zealand, since the corresponding NUTS3 regions are highly economically integrated. The resulting seven regions is illustrated in Figure 2.

[2] Found on www.statistikbanken.dk, table REGK31. The functions referred to here as active industrial policy are functions numbered 6.48.xx. Last accessed 23 February 2018.

[3] Miscellaneous is mostly a negative expense indicating that incomes are registered in this account. Some of the remaining account are used be very few municipalities but are used consistently each year by these municipalities.

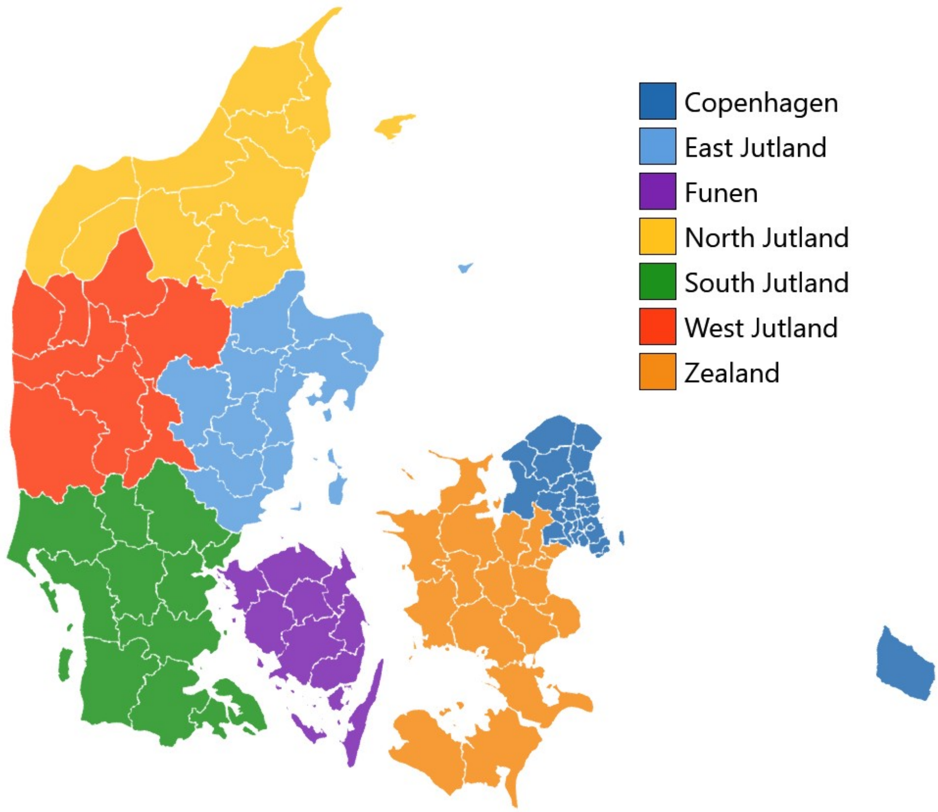

Figure 2: The seven Danish regions

Comparing figures 1 and 2 gives a simple picture of the economic geography of Denmark. The Copenhagen region comprises of the city of Copenhagen, which stretches across several municipalities, but also the cities Roskilde and Elsinore. There are practically no marginal municipalities in this region except for the north-west and the island of Bornholm to the east. The municipalities in the region of Zealand, in contrast, are practically all peripheral except for a few bordering Copenhagen. Funen is centred around a single city (Odense). South Jutland is the peripheral area along the border with Germany but also includes three smaller cities (Esbjerg, Kolding and Vejle). East Jutland contains three cities: the second city of Denmark, Aarhus, and the smaller cities Randers and Horsens. North and West Jutland are both almost completely peripheral except for Herning in West Jutland and Aalborg in North Jutland. Some regions are almost completely peripheral while others are highly urban.

3.4. Change 2008-2013

Figure 3 shows the regional differences in Denmark in 2008 along the ten variables included in the analysis. As the variables each have their own scale they are presented relative to the simple mean across the seven region in Figure 3. The means were reported in Table 1. The national mean of technological cohesion (TC) is 0.03 meaning that a randomly chosen job will be related to 3% of other jobs in the region. Figure 3 shows that all regions have an index close to 100 so TC is quite stable across regions. Human capital intensity varies heavily: the Copenhagen region is almost at index 200 relative to the average (which is 0.13). East Jutland is also above average while all other regions are below average.

The two regions with high HC also have high rates of entrepreneurship but so does Zealand. The national average is 0.22 meaning that 22% of employees are in young plants. Some co-occurrence between routine jobs and manufacturing jobs was expected and it is observed that Copenhagen has the smallest proportion of both, while West Jutland has the highest. But in-between there is some differences in the ranking, which indicates that there are regions with relatively non-routine manufacturing (East Jutland) and regions with relatively routine service jobs (Funen). The share of jobs in peripheral areas follow the expectations from Figure 1. Most regions exhibit similar average location quotients except the particularly specialised West Jutland and the less specialised East Jutland and Copenhagen regions. Business cycle sensitivity is quite stable across the regions while plant size varies. Average plant size is largest in the regions with the largest share of manufacturing jobs, but size is also above average in the Copenhagen region, which potentially reflects the location of head offices. Finally, average policy is 41.68 DKK per private sector job, but the average in Copenhagen is much less. Policy expenditures are particularly high in North Jutland and in Funen.

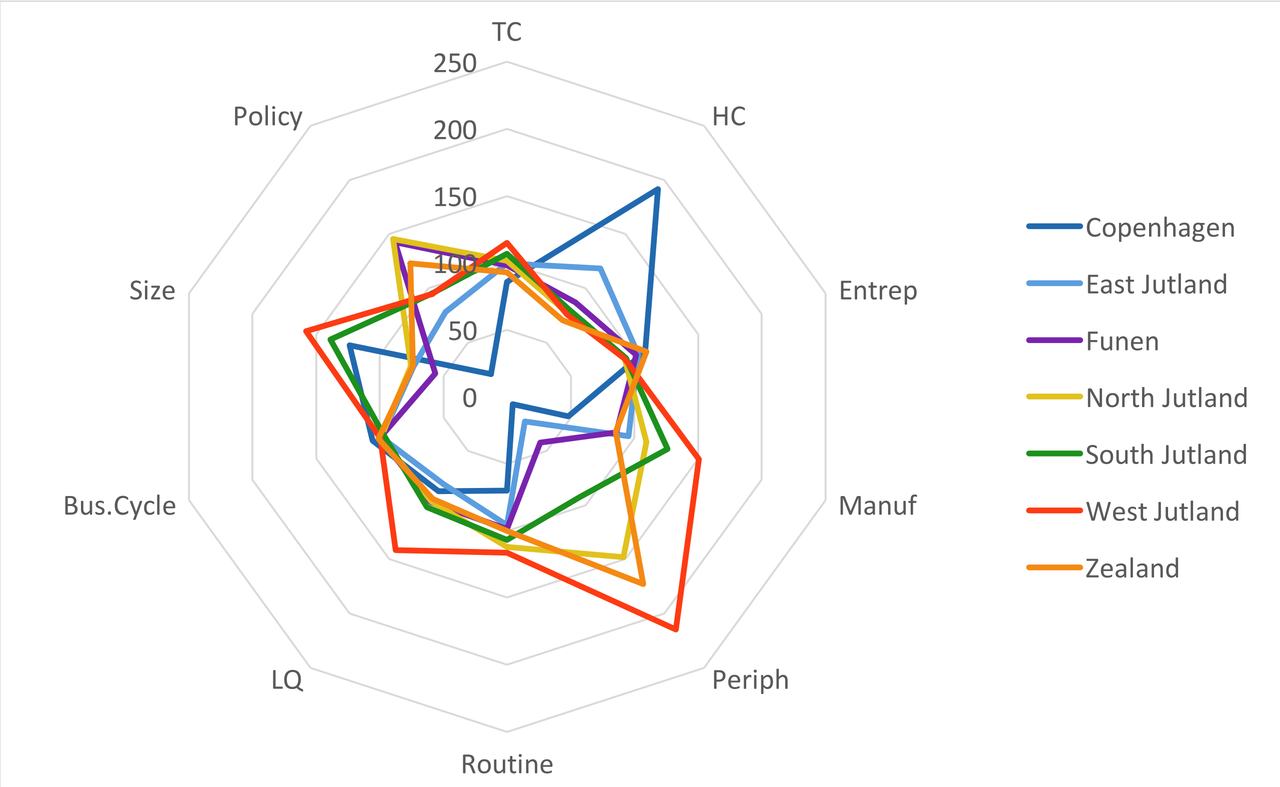

Figure 3: Industry structure 2008

Figure 4 shows the change in index values from 2008 to 2013. Policy expenditures increase heavily: the smallest increase is about 45% in North Jutland and the largest is above 100% in Copenhagen. However, it should be noticed that the starting points also differed.

Except for Copenhagen there were decreases in average technological cohesion. This indicates that regional industry structure did not move in the network towards the direction of least resistance as suggested by the relatedness theory. Interestingly, the location quotient increases in most regions indicating increased specialisation despite the decreased technological cohesion. The processes of job polarization (fewer routine jobs) and de-industrialization are observed in all regions, and so is skill-biased technological change in the sense of increasing human capital intensity. The urbanization process is also observed, except for South

Jutland. Finally, workplaces tend to become smaller (except in West Jutland) but at the same time they become older: the share of jobs in new workplaces (entrepreneurship) decreases.

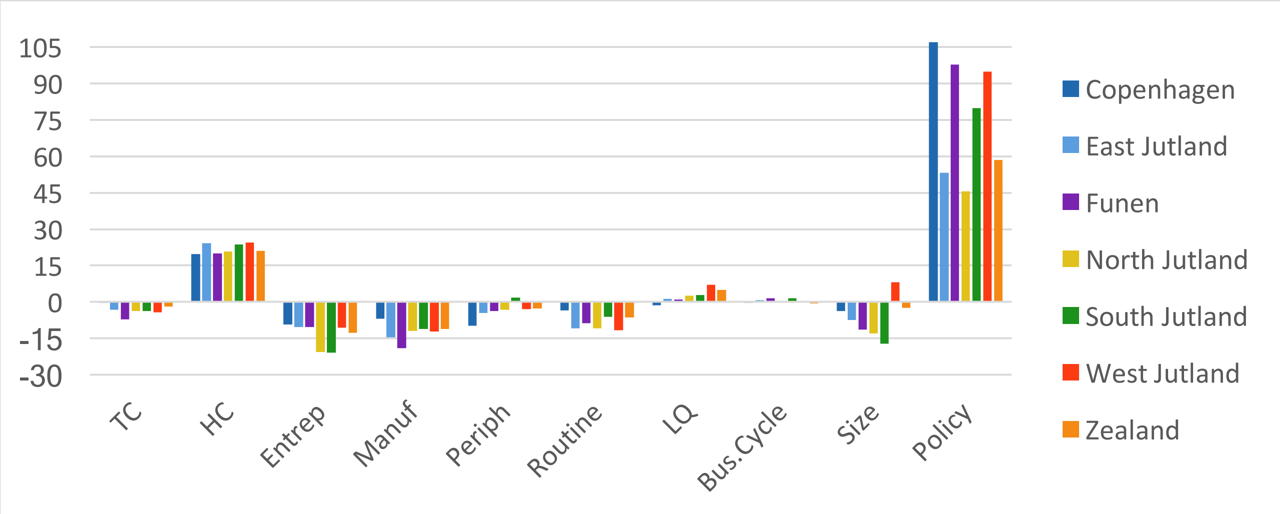

Figure 4: Change 2008-2013

Figure 4 shows that, despite the initial regional disparities in 2008 in figure 3, the regions develop in largely the same direction. There is some convergence in policy expenditures as regions with initially low (high) levels tend to show the highest (lowers) increase. In the remaining variables there is, if anything, a tendency for increased regional diversity. The average location quotient and workplace size in West Jutland increase even further, Copenhagen becomes even more urbanized, and de-industrialization is not strongest in the regions with most manufacturing jobs; North, West and South Jutland.

4. Methodology

Kogler et al. (2017) and Essletzbichler (2015) apply decomposition methods as part of their analyses of change in knowledge space and technological cohesion respectively, and this method is the starting point here. Therefore, the change in technological cohesion is split into four elements:

1. Between effect. If industries with high standardised closeness benefit from the availability of relevant skills in the regional economy, then industries with higher standardised closeness should grow more than others, thereby increasing technological cohesion.
2. Entry effect. The regional economy should diversify into relatively related industries and hence entry should contribute positively to technological cohesion.
3. Exit effect. Industries that are related to few other industries in the region should disappear, which will increase technological cohesion.
4. Within effect. The distance between two industries in the network is fixed, cf. earlier, but mathematically there will still be change within industries: As industries emerge and disappear in a regional economy, the number of industries related to a given, continuously present, industry will change, and hence the standardised closeness of that industry will change.

Using a decomposition method thus means that the term “cause” is used in a mathematically tautological sense rather than with causal meaning. The methodology used to decompose change in technological cohesion into these four effects is a mathematical identity, which has been used in studies of productivity since the 1990s.

$$\Delta TC_r = TC_{rt^*} - TC_{rt}$$
$$= \sum_{i \in C_r} \Delta s_{ir}(SC_{irt} - TC_{rt}) + \sum_{i \in N_r} s_{irt^*}(SC_{irt^*} - TC_{rt}) +$$
$$\sum_{i \in X_r} s_{irt}(SC_{irt} - TC_{rt}) + \sum_{i \in C_r} s_{irt^*} \Delta SC_{ir} \quad (5)$$

The four terms on the right of equation 5 are the four effects in the same order as above: The effect of differential growth, emergence, disappearance and within industry change. $t < t^*$ (here 2008 and 2013 respectively) and Δ indicates the difference between the two point in time. s_{irt} is the employment share of industry i in region r at time t. The sets of industries C_r, N_r and X_r are the intersection and two relative complements of RPF_{rt} and RPF_{rt^*}, i.e. the sets of continuing, entering and exiting industries.[4]

The same decomposition can be used for all variables where we observe a regional change from 2008 to 2013. For example, the change in entrepreneurship rate for a region is also the sum of four effects: relative expansion of industries with high or low entrepreneurship rate, the emergence or disappearance of industries with high or low entrepreneurship rate and changes in entrepreneurship rate within industries.

The method of equation 5 is clearly a bivariate method focussing on the relationship between industries' growth and standardised closeness. In other words, all other effects are not held constant. The second step of our analysis therefore is to apply a second decomposition method that takes into account confounding effects in the effect of differential growth (Holm et al. 2016).

The effect of differential growth can be rewritten as the sum of K products, where K is the number of confounding variables included plus one for the variable in focus. This is shown in equation 6 which extends the identity of equation 5.

$$\sum_{i \in C_r} \Delta s_{ir}(SC_{irt} - TC_{rt}) = \sum_{k=1}^{K} \alpha_k Cov(x_{k,irt}, SC_{irt}) \quad (6)$$

$x_{k,irt}$ is the k'th element of the vector X_{irt}, which include the K variables of the analysis. In our case $K = 9$, cf. table 1. The effect of differential growth from equation 5 is on the left of equation 6. The element arising from $x_{k,irt} = SC_{irt}$ is the direct effect of standardised closeness while the remaining effects $(x_{k,irt} \neq SC_{irt})$ are the indirect effects of other variables, e.g. the effect of entrepreneurship on the change in technological cohesion. The K parameters a_k are the estimated slope coefficients of a WLS regression of relative industry growth on the K variables of the analysis, with s_{irt} as weight. The a_k parameters and the covariances are computed using the set of industries C_r.

It is in general prudent to apply the equation 5 identity before extending it with equation 6, as the relevance of further decomposing the effect of the between effect (equation 6) depends on the importance of the effect relative to other effects. In particular, some characteristics of regional economies change mostly because of changes within industries, and in such cases there in no reason to further decompose the effect of differential growth.

We also apply a regression analysis to study the relationship between standardised closeness, regional diversification and the remaining variables of Table 1. The regression analyses are reported in the online appendix.

[4] $C = RPF_t \cap RPF_{t^*}$, $N = RPF_{t^*} \cap RPF_t^C$, $E = RPF_t \cap RPF_{t^*}^C$. Superscript C denotes absolute complement.

5. Results

5.1 The decrease in technological cohesion and the relative importance of differential growth

Figure 4 above shows that technological cohesion decreased in 6 of the 7 regions. In Copenhagen it did not change. Figure 5 shows why technological cohesion decreased in the remaining regions. In East Jutland, South Jutland and Zealand the decrease is largely accounted for by the "between effect": Technological cohesion decreased because industries with high standardised closeness contracted in relative terms.[5] This means that the presence of skill related industries did not support growth and questions the idea that regional diversification is in the direction of least resistance. Instead, it implies that when new firms are created or incumbent firms grow, then these new activities are not in industries benefitting from high standardised closeness.

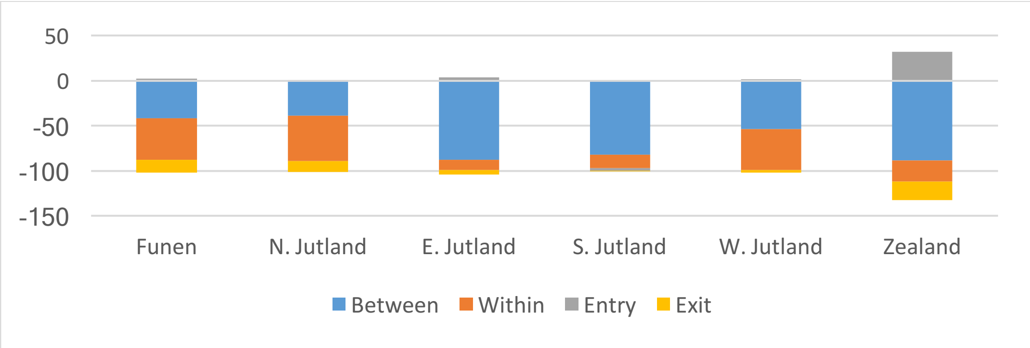

Figure 5: Why technological cohesion decreases

In Funen, North Jutland and W. Jutland the "between effect" only explains roughly half the decrease in technological cohesion while the "within effect" explains the rest: technological cohesion decreased because the standardised closeness of industries decreased. Since skill relatedness is fixed over time (cf. equation 1) standardised closeness of a given industry can only decrease if new industries are unrelated and/or related industries disappear. The effects of entry and exit are generally small and the negative effect of exit fits with the interpretation of the "within effect": contrary to the network model, industries that disappeared often had high standardised closeness. However, the generally positive effect of entry does support the network model (e.g., Neffke et al., 2011): industries that emerge have high standardised closeness.

The primary result in Figure 5 is the negative between effects. It appears contrary to the results in the regression analyses reported in the online appendix, which showed a positive relationship between technological cohesion and growth. All other things being equal such a positive relationship must lead to increased technological cohesion. Figure 5 shows as that all other things are not equal, and below these confounding effects are identified.

5.2 Other effects on decreasing technological cohesion

Figure 6 shows a further elaboration of the negative between effects of Figure 5. Therefore, the contributions sum to -100 for each region. The first thing to notice is the consistently positive effect of standardised closeness, which is also consistent with the regressions: After controlling for confounding effects, industries with high standardised closeness do tend to expand. The reason why the negative 'between effects' were

[5] This and the following conclusion are robust to alternative specifications of the SC variable. These results are reported in the online appendix.

found in Figure 5 is that standardised closeness correlates with a number of other variables that are detrimental to growth. There is also a consistently positive effect of business cycle sensitivity: the effect of business cycle sensitivity on growth combined with its correlation with standardised closeness tends to increased technological cohesion.

The two main effects countering the positive effects are de-routinesation and de-manufacturing. Industries with high standardised closeness tend to be in manufacturing and to have a large share of routine jobs, hence the decline of both also decreases standardised closeness. This means that departure from the network model is largely caused by these two long-term processes. However, there is also support for the network model, as there are consistently negative contributions from human capital intensity, entrepreneurship and from policy. These suggests that -- in as much as human capital intensive industries are also innovative – innovation and entrepreneurship lead to divergence from path-dependence, and that industrial policy tends to focus on industries that diverge from the path. Both results are reassuring to the network model.

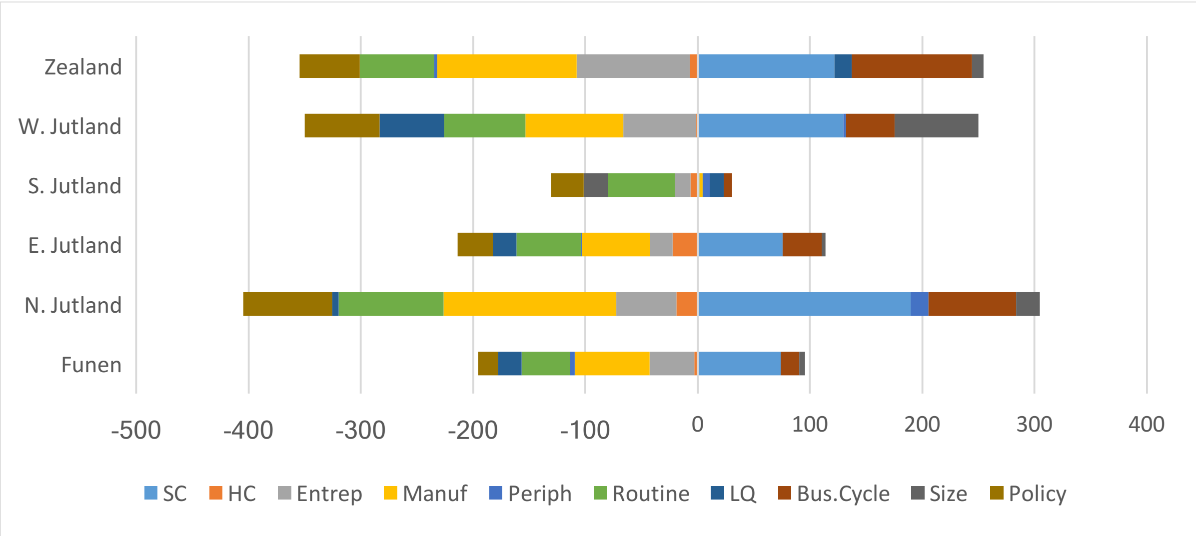

Figure 6: Why industries with high standardised closeness do not expand

Figures 5 and 6 can in principle be repeated for all variables in the analysis, though if the 'between effect' is small in the first figure then there is no interest in decomposing it further. These figures are available in the online appendix. For the decreases in $Routine$ there is generally a large 'between effect', while for the decreases in $Manuf$ there is by definition no 'within effect' as firms do not change industry, and hence the 'between effect' is large. The further decomposition of the 'between effects' shows that standardised closeness works opposite to the effects of $Routine$ and $Manuf$ themselves. This means that higher standardised closeness work as a brake, slowing down the processes of job polarization and de-industrialization.

6. Conclusions

The results suggest that the predominant network model of regional diversification cannot be discarded. An industry in a region benefits from the simultaneous presence of skill related industries, thus leading to path dependent regional diversification of economic activities. Departures from this path are to a large extent caused by innovation and entrepreneurship, and furthered by active industrial policy. However, while the mechanisms pointed to in earlier studies are confirmed they do not explain regional diversification. The main drivers of regional diversification are long-term processes, especially the disappearance of routine activities and manufacturing activities; job polarization and de-industrialization. This also means that technological cohesion in a region will increase the region's resilience to the processes of job-polarization and de-industrialization. In other words, the tendency for routine jobs and manufacturing jobs to disappear is lessened by the presence of skill related activities in the region.

Active industrial policy was found to have a positive effect on the relative growth of regional industries. This is a secondary, but potentially very interesting result and therefore must be qualified. Specifically, it means that an industry will increase its share of regional employment, if it is disproportionately located in the municipalities of the region, which tend to spend more on active industrial policy per private sector job. The result is consistent with active industrial policy creating jobs, but it does not say whether this is a net increase in jobs for the region, or whether the jobs were created in the spending municipality or another municipality in the same region.

The analysis was undertaken separately for seven Danish regions. The regions are quite diverse and cannot obviously be grouped into a taxonomy. The regions cannot only be ranked on one-dimensional scale according to urbanization. Despite the disparities across the regions, the mechanisms causing regional diversification were found to be very similar across the regions. The fact that the result was found consistently over very different regions increases both the validity of the model and the exceptions to it. The path-dependence of regional diversification is statistically significant but in practice it is overshadowed by other processes.

Acknowledgements

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The high importance of de-industrialization and job polarization for regional diversification

… and the limits to the importance of relatedness

Online Appendix

Version: 9 May 2018

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Contents of the online appendix

Regression analysis

The value added of performing a decomposition compared to regression analysis is that the effect of differential growth can be decomposed into the direct effect of the variable in question and the indirect effects arising from other variables being studied, and that the method allows us to completely account for the causes of the change in technological cohesion. This means that we get directly comparable values for the role of path dependence (the share of the change in technological cohesion attributed to standardised closeness) and the confounding effects of covariance between standardised closeness and other variables, not least the variables capturing the trends towards fewer routine jobs, fewer manufacturing jobs and increased urbanization. However the similarity with regression analysis and the fact that WLS estimates are part of the decomposition suggests that it may be informative to report the result of a regression of relative industry growth on the set of variables in X_{rit}. This regression will show the effects of the 10 variables described above measured in 2008 on relative industry growth 2008-2013 with all the standard caveats regarding regression and causation.

Tables A.1 and A.2 show the results of regression analyses. The regression is undertaken for each region and for a pooled dataset where errors are clustered at the regional level.

Table A.1: regression results

	Funen			Copenhagen			N. Jutland			E. Jutland		
	Est		Robust SE	Est		Robust SE	Est		Robust SE	Est		Robust SE
Intercept	1.149	***	0.200	1.205	***	0.301	0.828	***	0.200	1.072	***	0.156
Periph	-0.031		0.231	0.057		0.282	0.013		0.152	0.199		0.215
HC	-0.069		0.306	1.853	*	0.977	0.596		0.362	1.217	***	0.387
Routine	-0.435	**	0.184	0.045		0.299	-0.072		0.198	-0.073		0.201
SC	0.189		2.679	1.868		3.581	3.212		2.538	1.315		2.277
Manuf	0.113		0.154	-0.484	***	0.179	-0.064		0.112	-0.187	**	0.092
Entrep	0.296	***	0.224	0.460		0.467	0.491	*	0.279	0.260		0.238
LQ	-0.109		0.041	-0.447	*	0.248	-0.013		0.022	-0.051		0.043
Bus.Cycle	0.039	***	0.156	0.026	***	0.123	-0.031		0.118	-0.129	*	0.069
Size	0.001		0.002	0.000		0.001	0.000		0.001	0.000		0.001
Policy	0.001		0.001	-0.002		0.001	0.001	**	0.000	0.002		0.001
N	309			385			322			370		
R2	0.0812			0.0878			0.0720			0.1133		

Dependent variable: Relative employment growth of regional industry. Significance: *: 10%, **: 5%, ***: 1%

Table A.2: regression results

	S. Jutland			W. Jutland			Zealand			Pooled		
	Est		Robust SE	Est		Robust SE	Est		Robust SE	Est		Robust SE
Intercept	0.762	***	0.276	1.168	***	0.182	1.511	***	0.249	1.018	***	0.076
Periph	-0.095		0.151	-0.143		0.185	-0.261	*	0.143	0.009		0.035
HC	0.529		0.363	0.417		0.409	0.558		0.712	0.737	**	0.201
Routine	-0.124		0.254	-0.348	**	0.158	-0.364	*	0.205	-0.190	**	0.073
SC	2.407		2.324	4.931	***	1.686	1.395		3.354	2.334	**	0.664
Manuf	-0.067		0.088	-0.075		0.091	-0.233		0.147	-0.133	*	0.056

Entrep	0.375		0.344	0.286		0.254	0.438		0.341	0.373	***	0.042
LQ	0.006		0.029	-0.048	**	0.019	0.001		0.034	-0.032	**	0.013
Bus.Cycle	-0.025		0.082	-0.069		0.079	-0.281		0.224	-0.064		0.037
Size	0.001		0.001	0.000		0.001	0.000		0.001	0.000		0.000
Policy	0.004		0.003	0.001	**	0.001	0.002	**	0.001	0.001	**	0.000
N		353			297			330			2366	
R2		0.1280			0.1107			0.0340			0.0498	

Dependent variable: Relative employment growth of regional industry. Significance: *: 10%, **: 5%, ***: 1%

The results for the pooled data (final results in table A.2) conform more or less with expectation. Regional industries are predicted to grow if they have high human capital intensity, a low share of routine jobs, high standardised closeness, high rate of entrepreneurship and if they are not manufacturing. More surprisingly, there are no effects of locating in the periphery, of business cycle sensitivity and of workplace size. And there is a negative effect of the location quotient and the effect of policy expenditures is positive and significant. The positive policy effect means that industries, which in 2008 were located in municipalities with higher policy expenditures, grew more than other industries in the wider region over the ensuing five years.

However the remaining results in tables A.1 and A.2 document large regional disparities in growth factors. Standardised closeness is only significant in one region, West Jutland, which was also the region with the highest technological cohesion.

Robustness of main results

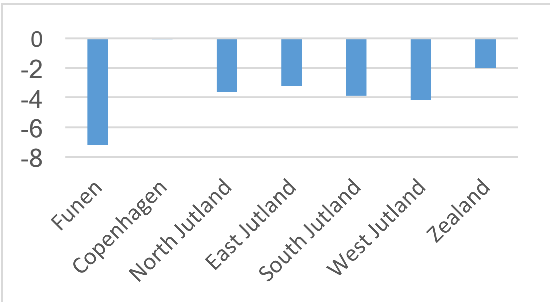


Figure A.1: Change in Technological Cohesion 2008-2013

Figure A.1 shows the change in Technological Cohesion (TC) as studied in the main paper. I.e. the figure replicates the first set of bars in figure 4 of the main paper. This is based on a measure of TC, where the underlying Standardized Closeness (SC) is defined as the share of industries in the region with a Skill Inflow Relatedness (SIR) above the 90th percentile. If the cut-off had instead been the 95th percentile the result is the left panel in figure A.2, and a cut-off at the 75th percentile results in the right panel of figure A.2. The main difference in both cases is that TC is now increasing in Copenhagen.

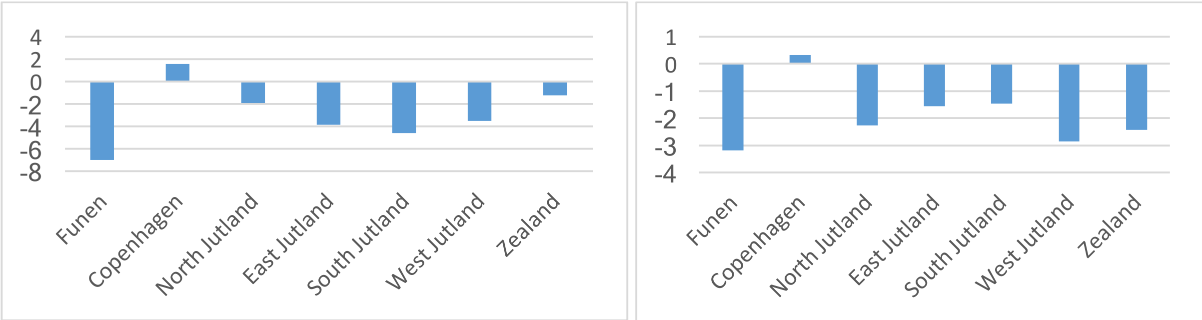


Figure A.2: Change in Technological Cohesion 2008-2013; cut-off at 95th (left) and cut-off at 75th (right)

Figure A.3 reports the decompositions of the changes reported in figure A.2 (compare to figure 5 of the main paper). When only 5 percent of industries are allowed to be related, i.e. when the cut-off is the 95th percentile, then the within effect is dominating in all six cases where TC decreases. In the seventh case it accounts for about half of the change. In the broader definition, when 25 percent of industries are allowed to be related, some of the variation also seen in the main results re-appear: though the effect is never tiny, the between effect varies from absolutely dominating in some cases to less than half in one case. Compared to the main paper, the qualitative difference is that, here, TC increases in Copenhagen and this is mainly explained by industries with higher standardized closeness expanding.

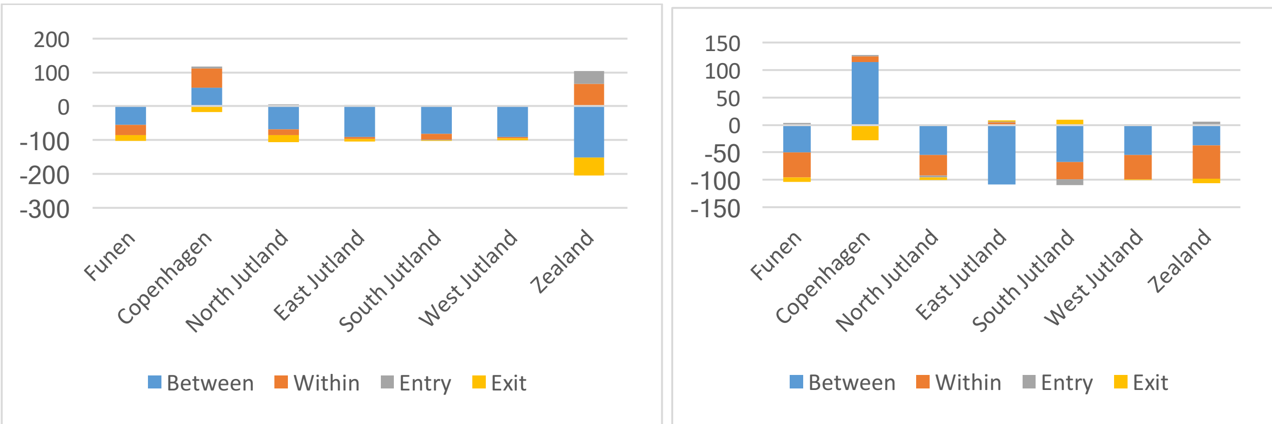


Figure A.3: Why TC decreases; cut-off at 95th (left) and cut-off at 75th (right)

In figure A.4 the between effects of figure A.3 are further decomposed into the direct effect of the SC variable and the indirect effects of other variables. This can be compared to figure 5 in the main paper. The results are qualitatively the same: Policy, job polarization (routine), de-industrialization (Manuf) and entrepreneurship all lead to regional diversification away from the path of increased TC. At the same time, SC does lead to increased TC. There are two exceptions: when the cut-off is the 95th percentile there is a negative effect of SC in S. Jutland and no effect in Funen.

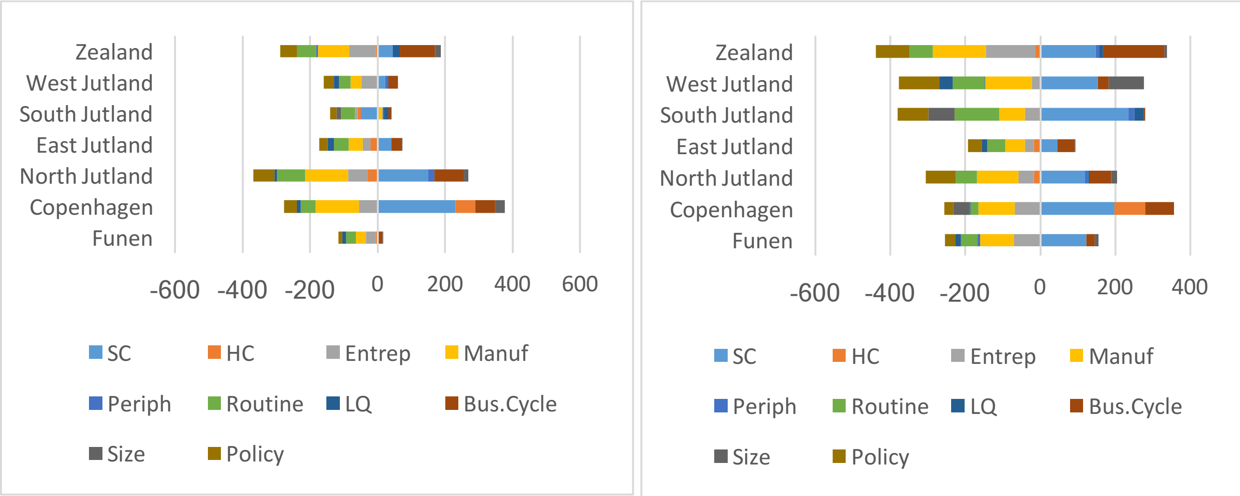


Figure A.4: Why industries with high SC do not expand; cut-off at 95th (left) and cut-off at 75th (right)

Figures A.2-A.4 demonstrate that the results presented in the main text are robust to variations in the threshold that distinguishes related and unrelated industries. An additional potential concern is the fact that the SC variable is the share of related industries with no consideration of the size of these industries. Therefore the next set of results are based on computing SC as the share of related jobs, not industries, in the region. In other words, equation 2 of the main paper becomes equation A.1.

$$SC_{irt} = \sum_{j \in RPF_{rt}} I(SIR_{ij} > p90_t)\, x_{jrt} / \sum_{j \in RPF_{rt}} x_{jrt} \qquad \text{(A.1)}$$

Equation A.1 is identical to equation 2 of the main paper except for the addition of x_{jrt}, which is the number of jobs in industry j in region r in year t. With this measure of SC the percentage changes in TC across the seven regions are reported in table A.5. Again, there is an increase in Copenhagen and a decrease in all other regions. There is a slight tendency for the changes to be greater compared to other results.

Figure A.5: Change in TC by jobs 2008-2013

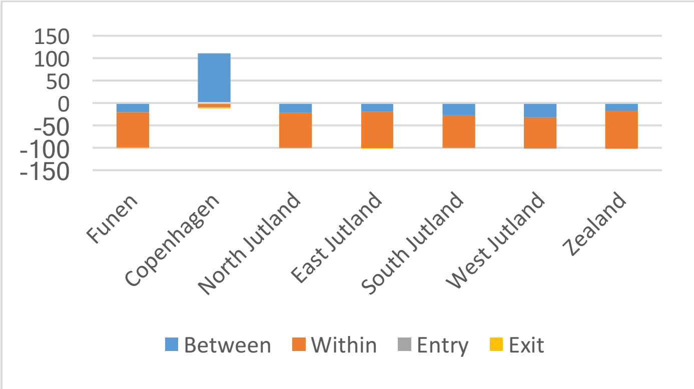


Figure A.6: Why TC by jobs decreases

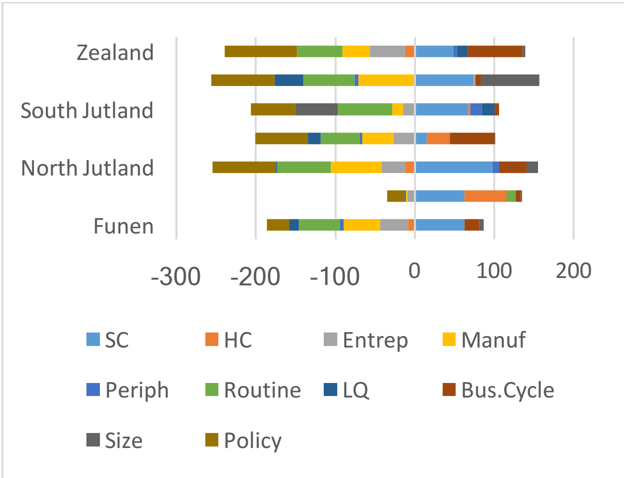


Figure A.7: Why industries with high SC by jobs do not expand

When decomposing the change in TC by jobs the result is quite different from earlier results, cf. figure A.6. In these results, the dominating effect is the within effect in all six cases of decreasing TC. That is, the main reason why TC is decreasing is that the values of SC for the industries of the region are decreasing. This happens because jobs in related industries are disappearing. In other words, because of the alternative definition of SC in equation A.1., the between and within effects are now closely linked: industries with higher SC contract (the negative between effect) which means that the specific value of SC for the industries that are related to the declining industries, falls too (the negative within effect). Copenhagen presents are more peculiar case: despite exhibiting a large positive between effect in figure A.6 there within effect is still negative. In other words, despite the region's increasing TC there is decreasing SC for the average industry. This negative within effect must then be explained by the negative entry and exit effects, which are barely visible in figure A.6. As related industries vanish and unrelated industries enter the sum in the numerator of equation A.1 decreases. Despite these differences in the first step of the decomposition it is reassuring to see in figure A.7 that the final result is not qualitatively affected. There is a positive direct effect from SC while regional divergence is mostly accounted for by entrepreneurship, policy, job polarization and de-industrialization.

Summing up it must be noted that the observation of constant technological cohesion in the Copenhagen region reported in the main paper is unique. In all three alternatives attempted above technological cohesion increases in Copenhagen. A second difference compared to the results in the main paper is that the between effect is only dominating when standardized closeness is computed as a share of industries. When instead computed as a share of jobs, i.e. when weighted, the within effect dominates. However, this is a direct consequence of the methodology and is caused by the negative between effects, as argued above. Despite these differences the above analysis shows that the results are robust to alternative specifications of standardized closeness. Regardless of the specification, the final stage returns to same results: there is a positive direct path-dependence created from industries with high standardized closeness expanding, but this effect is counteracted by job polarization, de-industrialization, entrepreneurship and active industrial policy.

Additional methodological considerations

In order to compute relatedness, standardised closeness and technological cohesion a process for measuring the distance between two nodes in the network must be chosen. Co-occurrence is widely used to indicate that two nodes are close (Hidalgo et al., 2007; Hausmann and Hidalgo, 2011; Neffke et al., 2011). Co-occurrence suffers from the drawback that it only captures revealed relatedness. It does not contain information on in what sense the activities are related. Co-occurrence can for example not distinguish between activities that are similar and activities that are related. An alternative approach is to focus explicitly on similarity in the inputs used (Andersen, 2003; Essletzbichler, 2015; Neffke et al., 2017). An extension of measuring relatedness from similarity of inputs is to see the use of common collaboration partners as an indicator of relatedness (Isaksen, 2015). Relying on the similarity of inputs suffers from the drawback that industries to varying degree rely on special and generic inputs and hence the choice of input will determine which industries are found to be close. Despite this drawback, similarity in inputs must be preferred to co-occurrence measures, since the former offers a consistent measure of distance between nodes, while the latter captures distance in any form.

Most studies use either input-output tables (Andersen, 2003; Essletzbichler, 2015) or labour flows (Neffke and Henning, 2013; Neffke et al., 2017) when determining the distance between two nodes by the similarity of inputs. In the current study, we want to study industries at a highly disaggregate level and therefore cannot use input-output tables. When relying on labour flows the links between the most closely linked nodes will be revealed first. Even with relatively little data it will soon become apparent which pairs of industries have large flows of labour between them. It is, however, very difficult to distinguish slight differences in distance among pairs of nodes, which are far apart. This suggests pooling data over longer timespan to observe more labour flows, and it suggest to use a categorization of distance. For example to collapse the distance measure into a binary variable indicating whether pairs are close or not.

Decompositions of changes in remaining variables

The decomposition methodology employed in the main paper results in a decomposition of the change of all variables, not just technological cohesion. These additional results are presented below. The additional decomposition of the between effect is only included when the between effect is a large share of the total change.

Figure A.8: Why Entrepreneurship decreases (left) and human capital intensity increases (right)

In all regions, industries with many new plants do have high growth (positive between effect) but the within effect outweighs it, and drives the decrease in entrepreneurship. New plants are not created fast enough and young plants are not expanded fast enough to keep the average plant age from increasing.

The share of workers with tertiary education is growing because of changing educational composition in industries' workforces. Secondarily, HC is increasing because industries that are human capital intensive tend to expand. In East Jutland it is even 40% of the change.

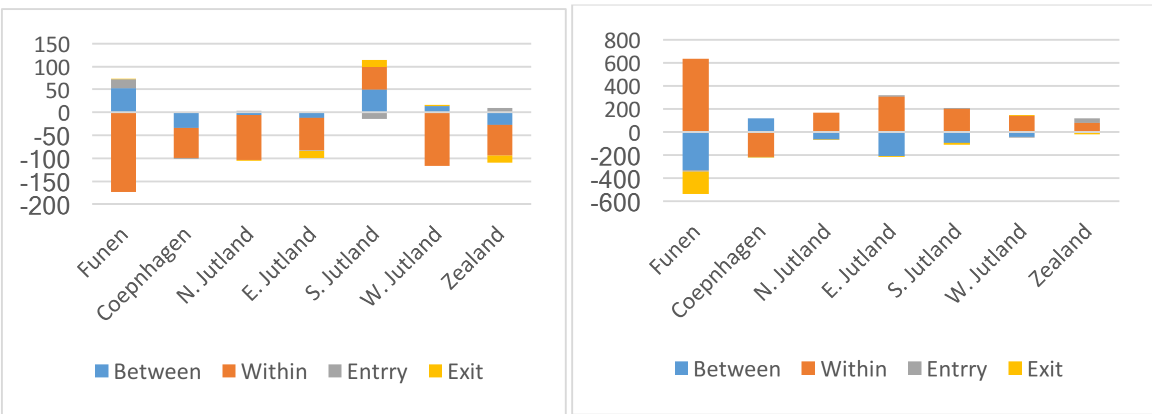
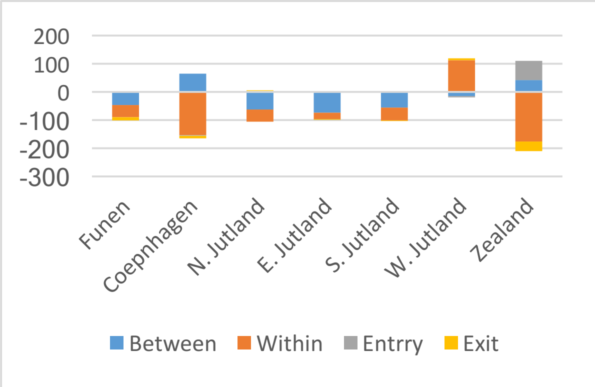


Figure A.9: Why activities disappear from the spatial periphery (left) and specialization increases (right)

The negative within effect shows that industries tend to move jobs towards cities. The negative between effect shows that industries with disproportionally large share of jobs in peripheral areas contract. In Funen, South Jutland and West Jutland industries with many jobs in peripheral areas expand, and in South Jutland jobs are even being moved to peripheral areas.

Regional specialization is increasing because the location coefficient of industries is increasing (the within effect). Industries with high location coefficients tend to have low growth (the between effect). Hence regional specialization is generally increasing because industries contract *least* in regions where they have the highest location coefficient. The effects are opposite in Copenhagen but notice also that LQ is decreasing in Copenhagen. Industries with high location coefficient in Copenhagen grow but regional specialization still decreases because location coefficients tend to fall. This is consistent with new industries emerging in Copenhagen and then diffusing to the rest of the regions over time.



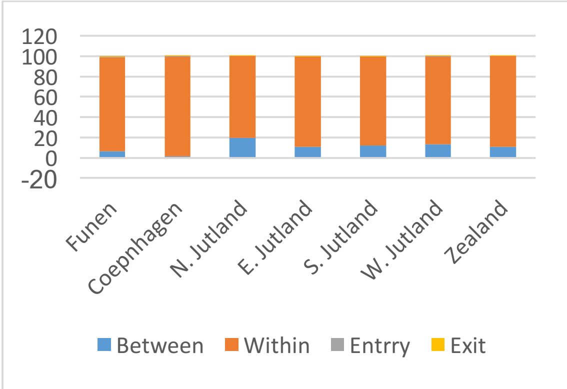


Figure A.10: Why workplace size is decreasing (left) and policy expenditures are increasing (right)

The average firm tends to become smaller (negative within effect) and industries made up of large firms tend to contract (negative between effect). Entry and exit are important in Zealand: exit decreases average size while entry actually increases average size. I.e. new industries consist of relatively large workplaces.

West Jutland is the only region where the average plant size increases and this is caused by growing plants within industries.

Policy expenditures increase because municipalities spend more per private sector job. There is only a small, though consistently positive, between effect: Industries located in municipalities with high expenditures tend to grow; and expenditure growth is strong enough so that the growth does not lead to lower expenditures per job.

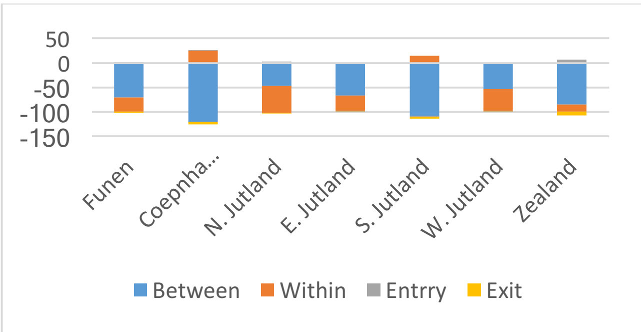


Figure A.11: Why routine jobs are disappearing

Routine jobs decrease because industries with many routine jobs decline. In Copenhagen and South Jutland there is also an opposing tendency for firms to create routine jobs (positive within effect). Entry mostly creates routine jobs too while exit removes them again.

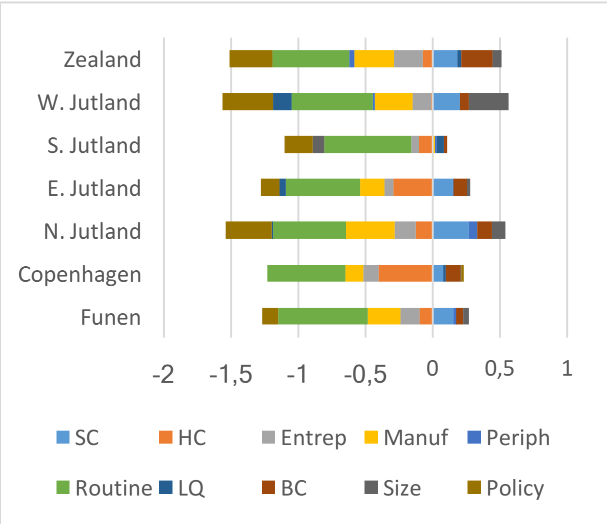
Over the period studied a decrease in the share of manufacturing jobs is also observed, and only very small changes are observed in the variable for business cycle sensitivity. The decompositions for these two variables are not reported as by definition there is no within effect; firms do not get new industry codes and the index for business cycle sensitivity is time invariant.

Further decomposition for de-industrialization and job polarization

Further decomposition only pertains to the between effect and therefore is only interesting when this effect is dominating. Hence it is only interesting for routine jobs, cf. figure A.11. By definition there is no within effect for the manufacturing variable and hence the further decomposition of the between effect for the decrease in manufacturing is also interesting. The same argument pertains to the variable for business cycle sensitivity but since there is almost no change in this variable, there is no change to decompose.

The negative between effect for routine jobs is caused by a negative effect of routine jobs on industry growth. It is exasperated by policy, human capital intensity, entrepreneurship and de-manufacturing. That is, in addition to routine jobs disappearing because they have a direct negative impact on industry growth, routine jobs also disappear because policy favors industries without routine jobs. In addition, human capital intensity and entrepreneurship both create new jobs but often not routine jobs. Finally, manufacturing is decreasing and manufacturing tends to have relatively many routine jobs.

There are also effects counteracting the disappearance. First, Standardized closeness and regional specialization. All other things being equal an industry with higher standardized closeness or with a higher location quotient will retain more routine jobs. Finally, size and business cycle sensitivity: industries made up of large plants or industries that are sensitive to the business cycle tend to maintain routine jobs, all other things being equal. These results are more or less general across all regions.



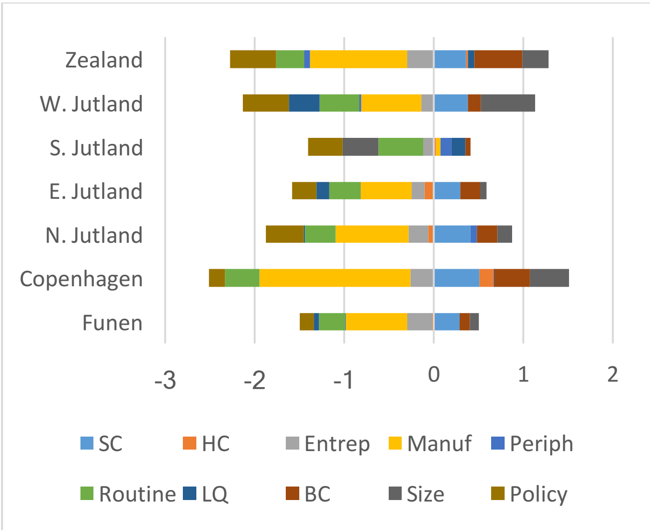


Figure A.12: Why industries with routine jobs contract (left) and why manufacturing industries contract (right)

The decline in manufacturing follows an identical pattern to the decline in routine jobs with the exception that manufacturing, all other things equal, should grow slightly in South Jutland. The observed decline in manufacturing in South Jutland follow from the “ceteris paribus” assumption not being met: job polarization, policy and the fact that industries of large plants contract (and such industries tend to be manufacturing) leads to the decrease in manufacturing.