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Changing Patterns of Manufacturing Growth. A Decomposition Analysis of Location and Growth of Manufacturing Industries in Denmark

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CHANGING PATTERNS OF

MANUFACTURING GROWTH

A Decomposition Analysis of Location and Growth of Manufacturing Industries in Denmark

By

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SPATIAL MODEL AND ANALYSIS

Copenhagen, June 1999

Abstract.

Industrial development in Denmark during the last decades has been characterised by a remarkable change of spatial location of several industries. Among these, perhaps the most significant change has taken place in the manufacturing industries. Where formerly most manufacturing firms were located in the cities and towns of the Eastern and middle part of the country, recent decades have been hard on sunset industries like shipyards and breweries, where employment has declined markedly. In the Western part of the country, however, employment and incomes in manufacturing industries has increased, primarily in industries like textiles and furniture manufacturing.

This paper presents an analysis of these changes and their effects on the distribution of employment and incomes in Denmark. The analysis will be based on the interregional model LINE, developed in the Institute of Local Government Studies. LINE is designed to model economic activity within and between all 275 municipalities of Denmark.

The central part of the analysis will be a decomposition of changes of income. This decomposition will show what parts of changes of income that are attributable to changes of employment, productivity, relative prices, etc., in manufacturing industries. By means of LINE, such decomposition is carried out for all municipalities, and results are presented for diverse regions, and for different types of municipalities, such as rural, peripheral, etc.

Among the finding is a confirmation that manufacturing industries have been instrumental in the relative prosperity that has been found in rural areas. An often heard hypothesis that a weaker performance of the peripheral regions of the country is attributable to a relative decline in manufacturing industries is not confirmed by our findings.

1. Introduction.

Spatial location of industries has changed substantially in many countries during the last decades. In very broad terms, the trends indicated consist in a decline in manufacturing activities and an increase in service activities in urban areas and, correspondingly, an increase in manufacturing activities in rural areas.

In a different set-up, the same tendency may be said to appear when it comes to international location of industries, where manufacturing plants of transnational companies are established in developing countries, and financial and other services gain importance in the metropolitan areas of the rich countries. These tendencies are directly linked to ongoing globalisation. Manufacturing growth in rural areas of rich countries may be linked to globalisation in less obvious ways, or may have preceded it.

In Denmark relocation has been particularly important in manufacturing industries. From the beginning of industrialisation in late nineteenth century, most manufacturing plants have been located around Copenhagen and other cities. As no mineral extraction took place, and no similar activities could compete with the cities for industrial location, manufacturing activities tended to agglomerate in and around the existing cities in Eastern and Central Denmark. In the cities, growing industries found markets and infrastructure such as seaports and railways. As a consequence, urbanisation followed industrial growth, and left Denmark in the middle of this century with a major concentration of manufacturing industries and population in the Copenhagen Metropolitan Region (CMR) and a few other cities (Jensen-Butler 1992).

This has changed markedly since then. Manufacturing growth has, until very recently, primarily taken place in the more peripheral areas of Denmark, first of all in Jutland, where manufacturing employment increased by seventeen per cent from 1980 to 1995, and at the same time, manufacturing employment in the CMR declined with twenty-seven per cent! Where recent decades have been hard on sunset industries like shipbuilding, lighter industries like textiles and furniture manufacturing have grown tremendously in the Western part of the country. It is noteworthy that few companies have actually moved from East to West. What has happened is that old firms in the East have shut down or retrenched, whereas in the West, new firms have appeared, and existing ones have expanded (Maskell 1992).

An important distinction should be made between rural areas in general and peripheral areas. Where the development of rural areas in general has been prosperous, this is not generally the case for peripheral areas. This distinction will be clarified in the following.

The reasons for and incentives behind this change in locational pattern are many and varied (see below). Among the most often heard is that of cost-reduction and defence against labour militancy (Jensen-Butler 1992). This essay, however, is not so much about motives, rather on effects. We will try to trace effects of the changing patterns of manufacturing growth on employment, earned incomes and disposable incomes in various parts of Denmark. We will do so using the method of decomposition. The model applied to this decomposition analysis, the LINE model developed by the Institute of Local Government Studies, will be described in the following, along with a description of the decomposition method itself.

The paper is structured as follows. In Section 2 some theories on rural industrialisation and location are surveyed, and hypotheses on Danish developments are expressed, to be discussed in the following sections. In Section 3, the data sets available for the analysis are described. In Section 4, the LINE model is briefly expounded. In Section 5, theories and methodological problems of decomposition analyses are discussed. Section 6 presents the results of the decomposition analysis of the effects of manufacturing growth on incomes. Section 7 presents a perspective on contemporary manufacturing growth trends, using some very recent data. Section 8 contains an interpretation of the results in the light of theories and hypotheses developed in Section 2. Section 9 contains our concluding remarks.

2. Rural industrialisation. Theories and hypotheses.

Many obstacles confront those who try to develop valid and interesting theories on rural industrialisation and location of manufacturing industries. For one thing, manufacturing industries in local areas are often dominated by a single or a few dominant plants. Closure or establishment of a single of these will often affect average conditions of manufacturing industries in the pertinent area significantly. This is one of the reasons why it is particularly hard to obtain valid theories of regional industrialisation and the development of manufacturing industries, especially in rural areas, where domination of single plants is most likely. This is even more so in Denmark, where the average size of manufacturing plants is small. Nevertheless, a number of theories are worth considering.

A classic on rural industrialisation is Lewis (1954). While economic development of poor countries was Lewis' issue, his theory may be, and has been, applied to aspects of rural development in richer countries[1]. In Lewis' theory, the basic feature of the economy is that of dualism. The economy consists of two sectors, a modern and a traditional one ("capitalist" and "subsistence" in Lewis' words). The modern sector is characterised by high productivity and incomes, with a high proportion of activities in manufacturing and "modern" service industries, while the traditional sector has low productivity and incomes, and is dominated by agriculture. Often the modern sector is seen as urban based; if this is adhered to strictly, Lewis' theory will become one of rural-urban migration (Harris & Todaro 1970). However, Lewis' theory may equally well be seen as one of rural industrialisation; in this case, the modern sector is not geographically confined to the cities, but may proliferate into rural areas.
The dual characteristics of the economy are caused by the nature of the labour market. As the title of Lewis' original contribution indicates, labour is supplied in unlimited quantities to the modern sector. Hence, the elasticity of labour supply is infinite. At the root of this is, as might be expected, a substantial wage gap between the modern and the traditional sectors. The reasons for the existence of this gap are the most critical point of Lewis' theory.

Lewis assumes that a substantial part of the profits made in rural industries will be "ploughed back" through investments in the same industries at the same locations, thereby generating accelerating growth rates (Jorgenson 1967, Lehrmann Rasmussen 1994). This seems fairly much in accordance with the actual changes happening in Denmark, where a large part of new manufacturing firms in rural areas are small family owned companies, probably investing most of their profits in their own firms.

[1] On the use of theories from development economics on regional development, and the problems involved in this, see Atalik & Levent (1998), pp. 341-43. See also Krugman (1995).

In spite of this, it would probably be widely agreed that the explanatory capability of the Lewis model is limited. This is first of all because of the basic assumption of an unlimited supply of labour, which is what makes the model work. The simply is nowhere to find an "industrial reserve army" in rural Denmark: Unemployment has not been higher than in the rest of the country, and the wage gap is not impressive: in 1995 wages of unskilled workers in CMR and in West-Denmark differed less than eight per cent[2].

Where Lewis and followers were inspired by a classical tradition, theorists of the neo-classical paradigm have given insights into rural industrialisation through, among other things, their contributions to the theories of location[3]. With a given set of production options, input and output prices, transport costs, etc., firms will choose a location that maximises their objective function (e.g., maximises their profits). Assuming that output prices are unaffected by location of individual firms, it may be assumed that firms choose location on the basis of factor availability (F_i), factor prices (p_{Fi}), factor productivity (r_i) and transport costs (T_i) at location i:

(2.1) $$L = f(F_i, p_{Fi}, r_i, T_i)$$

If firms seek to maximise their profits (π), and if profits are seen as a function of location, firms will locate where $\pi(L)$ is maximum. Let L* be the location that solves

[2] To be exact: 7.4 per cent. For skilled workers the difference was 16.3 per cent, for employees with higher education 20.6 per cent. Source: Danish Employers' Federation: Wage Statistics PC Stat 1995. Unfortunately, commensurable data for 1980 do not exist.
[3] For a survey of such theories, see Beckmann & Thisse (1986), especially pp. 49-95.

this maximisation problem. For any given confined set of locations, the problem can be solved[4].

With this as a point of departure, a number of important contributions to the theories of rural industrialisation have emerged. A basic problem involved in this is the fact that the solution L* is basically static. Since industrialisation is by its very nature a dynamic process, the application of location theory to urban industrialisation is likely to make use of comparative statics. If, in the locations considered, the arguments of L=f(.) change, so will the solution to the localisation problem L*. If optimal localisation changes from urban localities in favour of rural location, a theory of rural industrialisation can be generated on the basis of location theory.

Reasons for this may be found in any of the location determination arguments of (2.1). Let us, using Denmark as an example, demonstrate this for the factors one by one.

First, consider factor availability, which in turn may be divided into availability of unskilled labour, skilled and highly educated labour (human capital), financial capital, and land. Locational differences caused by differences in factor availability is what we would relate first of all to the concept of comparative advantages.

First, unskilled labour. During most of the eighties and early nineties unemployment among unskilled workers was comparatively high in most parts of Denmark, including the CMR and other old industrial centres. So, availability of unskilled labour by itself has hardly caused any change of optimal location for manufacturing industries. It could be, of course that unskilled labour has different features in different parts of the country, such as compliance (Jensen-Butler 1992, Illeris 1986). But for this to cause

[4] The solution may not be unique, a problem that we will disregard in the present context.

major changes in optimal location of industries, such differences must have increased during the period under consideration, a much more uncertain statement.

Second, skilled workers and employees with higher education have probably throughout the period been more easily available in the old centres than in rural regions. So this is also a bad candidate for explaining a change in optimal location.

Capital is, if anything, marginally more easily available in the old centres, due to, among other things, higher real estate prices and, therefore, easier availability of collateral. Infrastructure has improved considerably in all of the country during the period and, possibly (although this is hard to quantify), more so in rural regions (but hardly in the periphery). So infrastructure availability may have contributed to relocation.

Land is much more easily available in rural and peripheral areas than in the old centres, and this difference has probably been aggravated during the period. So for new firms, and expanding incumbent ones, availability of appropriate land may have caused location in the peripheral areas rather than in the old centres.

So, for factor availability, we can only explain a marginal part of the relocation that has taken place. Factor prices are probably more important, if not decisive. Not wages, though (see above). Even though this difference may have increased slightly, it seems unlikely to us that it could have generated a massive relocation of manufacturing industries. The rental rate of capital is also, by and large, the same in all of the country, since the interest rate is almost the same. Land prices, on the other hand, have increased much more in the old centres than in the peripheral areas, so here we probably have a partial explanation of the relocation.

Transport costs are higher in the rural and, praticularly, in the peripheral areas than in the old centres, but the difference has become smaller, so that transport costs today is less of an obstacle for location in peripheral areas than it has been.

Differences in productivity and economies of scale can hardly contribute to explaining the relocation either. Labour productivity has increased more in the CMR than in Jutland (see below)[5]. And economies of scale would imply that industries remain in the old centres.

This survey of the explanatory capability of location theories does not seem very convincing. We are left with land availability and land prices as elements that may contribute to industrial relocation, but which seems, from a common sense viewpoint, unable to explain the massive locational change of manufacturing industries that we have observed in the period.

Peter Maskell (1992) offers the following explanation. He suggests that Danish manufacturing firms may be divided into two major groups: The advanced, which use substantial inputs of human capital and managerial know-how; and the backwards, which use little of such inputs. He suggests that relocation has taken place primarily for the backward firms. Advanced firms have remained in the old centres (this is so for most of the chemical industries, for example) or in their “company towns” (of which some in rural and/or peripheral areas; this is true for firms like Lego, Danfoss, Grundfos, Holmegaards Glass Works, and Holeby Diesel).

[5] Ideally, total factor productivity should be compared. However, regional data on capital stock is not available in Denmark.

Maskell continues by asking the question: What happens, when the optimal location of a firm changes over a period, if that firm is already located in a place that was optimal once in the past? If nothing prevents the firm from relocating, it will do so, as soon as accumulated disadvantages of the existing location exceed the transaction costs of moving. If, for some reason, firms perceive barriers against relocation, such firms will stay in the original location. Such barriers may be caused by strong attachment to the original location, or by inappropriate managerial skills.

If the causes of change of optimal location are serious enough, a immobile firm may eventually close down. Instead, new firms will emerge at locations, which are now optimal. If this is the case, small changes in locational determinants will suffice to generate substantial changes of location.

Maskell's explanation seems to accord fairly well with observed facts: that few manufacturing firms have actually moved, while many have closed down in the old centres, while new companies have opened in West Jutland (T. Pilegaard Jensen et al. 1997).

A suggestion made by Krugman (1991, pp. 27-29) deserves mentioning in this context. The interaction of transport cost, economies of scale and population change may cause quite sudden changes of optimal location. If population in a non-industrialised region is very small, economies of scale will prevent any manufacturing production from taking place. If the population in this region grows steadily, sooner or later industrialisation will take place, as the barrier induced by economies of scale will vanish. Once this happens, transport cost in the new location will be smaller, making new firms competitive and capable of rapid growth. This is what Krugman names "the logic of sudden change".

In the case of Denmark, Krugman's simple example is not tenable, since population growth, although disproportionately higher in West-Denmark, is so small that it hardly matters. However, improved infrastructure (in relative terms), increased disposable income (due to increasing transfer incomes, see below), and increased significance of institutional and cultural features of the respective regions (see above) may do the trick between them.

Another important feature of manufacturing location, such as we see it in the real world, is that of specialisation: the fact that in many municipalities and larger regions most of manufacturing production is concentrated on a few types of output. In turn, this may be caused by two things: Agglomeration and economies of scale.

First we review agglomeration: The tendency for industrial plants to locate in the proximity of other plants of the same industry. This tendency seems to be enhanced in recent years (Malmberg & Maskell 1997). In Denmark, we have a number of such agglomerations, four of which are described below. Here, only a few outlines from theory will be given.

Why do firms from the same industries agglomerate? In the literature, three reasons dominate: Labour pooling, technological spillovers and learning, and intermediate inputs. Labour pooling occurs, because employees prefer working at locations, where more than one firm are potential employers. Technological spillovers and learning occurs, when new knowlegde of production or management is disseminated among firms, carried by employees or by direct co-operation among firms. Intermediate inputs

of goods and services can be produced more efficiently by suppliers of manufacturing firms, when they can take advantage of the presence of many firms in one place[6].

Another phenomenon that may cause manufacturing production to be specialised at specific locations is economies of scale. This may or may not coincide with agglomeration. In Denmark, the most important representatives of economies of scale are the “company towns”, where a single industrial plant dominates local manufacturing production. They rarely coincide with agglomerations.

How important are agglomerations and economies of scale to rural industrialisation? Probably not very important, since both tend to take place in urban environments (or to urbanise the pertinent area). But some of the more agglomerated manufacturing industries in Denmark have proliferated into rural areas, notably textiles and furniture manufacturing (see below).

Agglomerations, economies of scale, infrastructural improvements etc. Are unlikely to benefit the peripheral regions very much. Hence, we would expect less favourable developments in the peripheral areas. This is also well-known throughout Europe, for instance in Ireland (Hart & Gudgin 1994, O’Farrell 1986)

To sum up, we will express some hypotheses that stem from theory and from the evidence reviewed so far:

- Manufacturing industries in Denmark are instrumental in rural prosperity as well as the decline in peripheral regions observed in the eighties and nineties.

[6] For a more detailed exposition of theories of agglomeration, see, e.g., Krugman (1991), pp. 36-54.

- The pattern of manufacturing growth, especially the differences observed between Jutland and the CMR, is mainly caused by the exploitation of comparative advantages of the respective regions. However, the Jutland industrialisation represents a postponement of globalisation and is vulnerable for the same reason.
- Successful local concentration of production is caused by economies of scale, technological spillovers and labour pooling.

In the following, these hypotheses will be discussed, using the results of our analyses.

3. Datasets.

There are two datasets available for the analysis: The SAM-K1[7] databank related directly to the LINE model and the municipal "national" accounts named KRNR.

The SAM-K1 databank contains data from 1980, 1987 and 1992-95. In the following, only data from 1980 and 95 will be used. Data for 275 Danish municipalities exist for the following variables of interest to us:

- Population by municipality of residence, five age categories, seven educational categories, whether unemployed, and whether insured against unemployment.
- Employment by municipality of work and municipality of residence for twelve industries including two categories of manufacturing industries (including electricity, water and gas supply). At municipality of residence, employment is available by educational categories and unemployment insurance category.

[7] The number 1 indicating that this is the first of its kind; in time, it is intended that it should also comprise the KRNR-data.

- Primary income (wages, salaries and profits of personally owned businesses) by municipality of work and municipality of residence for the same twelve industries.
- A large number of taxes and transfer payments by municipality of residence and by educational category.

The SAM-K1 databank is the first of its kind comprising data from all Danish municipalities. This makes it extremely useful for our purpose. However, a few limitations of the database must be mentioned.

First, the fact that is only contains data from a few years and only for twelve industries makes it less useful. Only two categories of manufacturing is also a drawback. In the following, in most cases the two manufacturing industries are lumped together. Finally, it is unfortunate that educational categories are only available at municipality of residence. In the Institute of Local Government Studies (AKF) in co-operation with Statistics Denmark, ongoing efforts are paid to improve available data.

The other dataset, the KRNR, is a result of this ongoing work. It is produced by Statistics Denmark at the behest of the AKF. It presents data from the years 1993-97 for many of the categories of the national accounts system. In Denmark, national accounts are now produced according to the new standards of national accounting (ENS95). These standards are also used for KRNR. This implies that comparative analyses involving data from both categories of national accounts should be carried out with caution.

The KRNR contains data from each of the 275 municipalities and for 130 industries, including 54 manufacturing industries. Data include:

- Gross output in fixed and current prices.
- Intermediate consumption in fixed and current prices.
- Gross value added in fixed and current prices.
- Employment.

Needless to say, this is a much better source of information when the purpose is an analysis of manufacturing industries. However, the short span of years for which it is available makes it unsuited for the sort of decomposition analysis that we have in mind. Hence, our choice of data sources is a mix of the two datasets presented, where the SAM-K1 is used for the following decomposition analysis, and the KRNR is used to perspectivise the analysis by including recent trends.

Apart from the SAM-K1 and KRNR, a few other data sources are used, including the wages statistics of the Danish Employers' Federation.

4. The LINE model.

The LINE model is the interregional model of the AKF. It has been presented in detail in a number of contributions (Madsen et al. 1998, Filges et al. 1999).

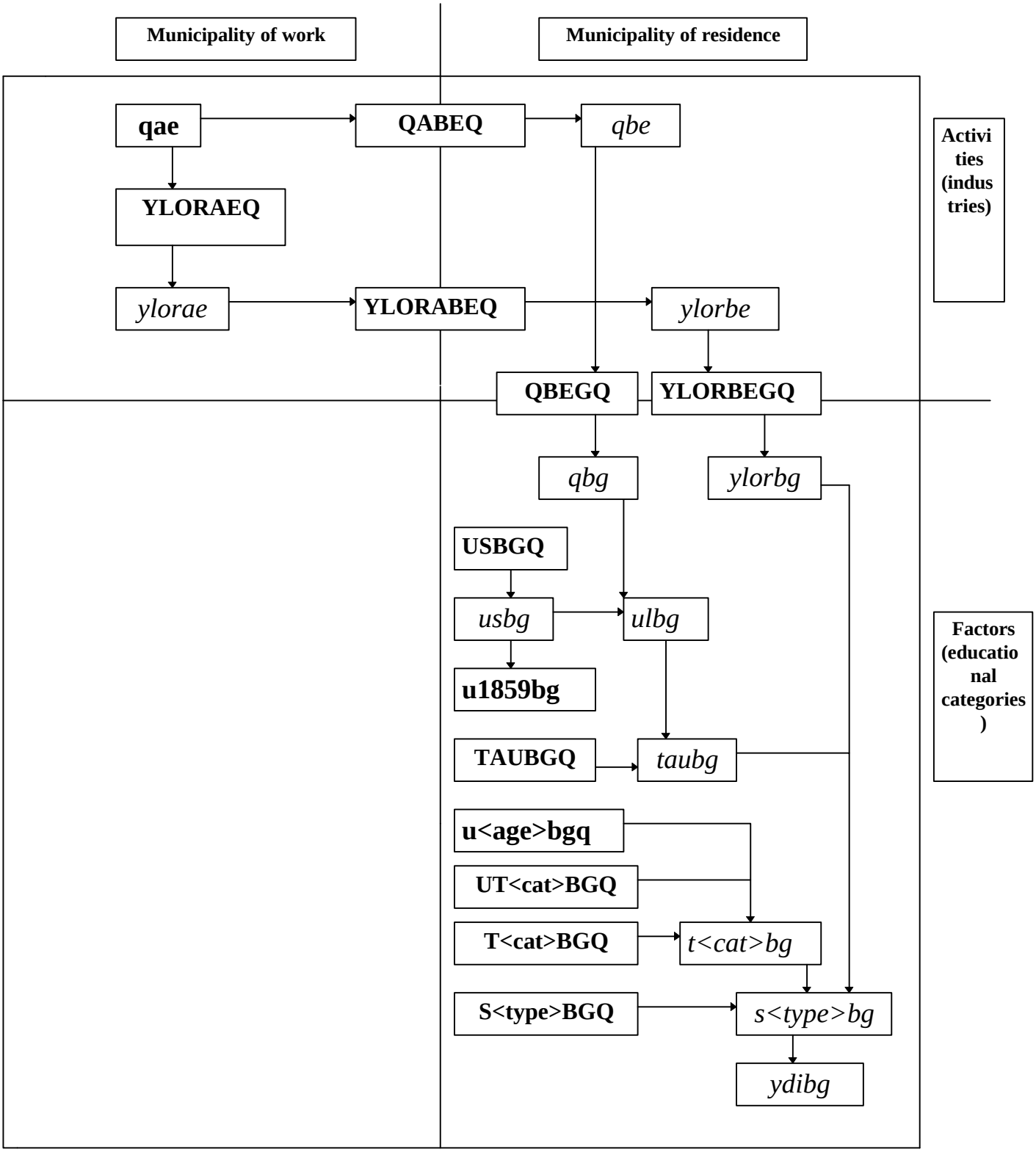
For the purpose of decomposition of manufacturing income, only a small part of the model needs to be exposed. Figure 4.1 shows the relevant parts of the model.

The two dimensions of the figure denote the dimensions of the model. The horizontal dimension is spatial: In this case, only municipality of work (or production) and

municipality of residence are mentioned. In the full model, another category is added: Municipality of demand.

The other dimension follows the category of the social accounting matrix (SAM) approach (Madsen et al. 1999). In the full model, the SAM matrix consists of five categories of social accounting: Activities, factors, institutions, wants and commodities. In our case, we can make do with two: Activities or industries and factors, in our case equivalent to educational groups.

Figure 4.1. The LINE Model.



The interrelations of the model can be described following the arrows of figure 4.1: *qae* denotes employment by municipality of work *a* and industry *e*. *YLORAEQ* is a coefficient matrix of primary income per employed person in municipality *A* and industry *E*. Hence:

(4.1) $ylorae = YLORAEQ * qae$

where *ylorae* is primary income in municipality *A* and industry *E*. Following the arrows to the right in figure 4.1, we arrive at *QABEQ*, a coefficient matrix of employment in municipality of work *A* and municipality of residence *B* for each industry *E*. In other words *QABEQ* describes commuting. So does the coefficient matrix *YLORABEQ*, which denotes primary income earned in municipality of work *A* by residents of municipality of residence *B* for each industry *E*. By the same token:

(4.2) $qbe = QABEQ*qae$

(4.3) $ylorbe = YLORABEQ*ylorae$

where *qbe* and *ylorbe* is employment and primary income, respectively, in municipality of work *B* for each industry *E*.

Next step is to transform employment and primary income from industries to factors (in this case: educational categories). This means following the arrows downwards to the bottom right cell. It is done in the following way:

(4.4) *qbg* = *QBEGQ*qbe*

(4.5) *ylorbg* = *YLORBEGQ*ylorbe*

where

- *qbg* is employment by municipality of residence and by educational category;
- *QBEGQ* is a coefficient matrix of the shares of employment in municipaly of residence *B* and industry *E* that is made up by educational category *G*.
- *y1orbg* is primary income by municipality of residence and by educational category;
- *YLORBEGQ* is a coefficient matrix of the shares of ,primary income in municipaly of residence *B* and industry *E* that is made up by educational category *G*.

Next step is transforming primary income to disposable income by adding tranfers and subtracting taxes. First, unemployment is calculated.

The supply of labour by municipality of residence, age group and educational category, *usbg*, is derived from population of age 18 to 59, *u1859bg* in the following way:

(4.6) *usbg* = *USBGQ*u1859bg*

where USBGQ is a coefficient matrix of shares of labour supply in each age group by municipality of residence and educational category. Unemployment is then calculated as *ulbg=usbg-qbg*. Unemployment benefit is then calculated[8]:

(4.7) *taubg* = *TAUBGQ*ulbg*

Other transfer incomes are derived thus:

(4.8) *t<cat>bg* = *T<CAT>BGQ*UT<CAT>BGQ*u<age>bgq*

where:

- *t<cat>bg* is transfer income of category *cat* by municipality of residence and educational category;
- *T<CAT>BGQ* is a coefficient matrix of income transfer of category *cat* per person, who receives that transfer by municipality of residence and educational category.
- *UT<CAT>BGQ* is a coefficient matrix of shares in the population of persons in the relevant age group who receive income transfer of category *cat*, by municipality of residence and educational category.
- *u<age>bg* is the population in age group *age*, by municipality of residence and educational category.

The sum of all transfer incomes accruing to persons in municipality of residence *b* and belonging to educational category *g* is named *tbg*.

[8] In the model used, a correction is imposed to allow for unemployed persons not insured. This is disregarded in the exposition above. The same is true for a few other complicating elements that has little relevance in the present context, such as interest payments, etc.

Taxes are calculated in a similar way:

(4.9) $s<type>bg = S<TYPE>BGQ*y(ti)<type>bg$

where

- *s<type>bg* is tax of category *type*, paid by persons in municipality of residence *b* and educational category *g*.
- *S<TYPE>BGQ* is a coefficient matrix of tax rates for tax category *type*, by municipality of residence and educational category.
- *y(ti)<type>bg* is taxable income of category *type*. This can be *ylorbg*, taxable transfer incomes (or other incomes, omitted in this exposition).

The sum of all taxes paid by persons in municipality of residence *b* and belonging to educational category *g* is named *sbg*.

Finally, disposable income is calculated as:

(4.10) $ydibg = ylorbg + tbg - sbg$

This ends the segment of the LINE model that is going to be used in this analysis.

5. Decomposition analysis.

Whenever a phenomenon can be seen as a mathematical function of more than one variable, a decomposition analysis can be relevant, if you wish to separate the influence of each variable. Assume that our dependent variable *y* can be written:

(5.1) $$y = f(x_1, x_2, \ldots, x_n)$$

Decomposing a dependent variable is often most interesting when we consider changes in that variable. Assume that we consider changes taking place between time 0 and time 1. Then:

(5.2) $$Dy = y^1 - y^0 = f(x^1_1, x^1_2, \ldots, x^1_n) - f(x^0_1, x^0_2, \ldots, x^0_n)$$

A decomposition analysis can be said to consist of ways of reformulating (5.2), so that each independent variable $x^1_1, x^1_2, \ldots, x^1_n$ is assigned an expression of its own. An example might be:

(5.3) $$Dy = f(x^1_1, x^1_2, \ldots, x^1_n) - f(x^1_1, x^0_2, \ldots, x^0_n) + f(x^1_1, x^0_2, \ldots, x^0_n) - f(x^0_1, x^0_2, \ldots, x^0_n)$$

In this case, x_1 is assigned its own expression $f(x^1_1, x^0_2, \ldots, x^0_n)$. Decomposition can be applied in a number of ways. Two important methods are often named *isolated* and *cumulative* decomposition. When applying the isolated decomposition method, each variable is taken in turn, leaving the others unaffected. An isolated decomposition of (5.2) may look like this:

(5.4) $$Dy = f(x^1_1, x^1_2, \ldots, x^1_n) - f(x^1_1, x^0_2, \ldots, x^0_n) -$$

$$f(x^0_1, x^1_2, \ldots, x^0_n) - \ldots - f(x^0_1, x^0_2, \ldots, x^1_n) +$$
$$f(x^1_1, x^0_2, \ldots, x^0_n) + f(x^0_1, x^1_2, \ldots, x^0_n) +$$
$$\ldots + f(x^0_1, x^0_2, \ldots, x^1_n) - f(x^0_1, x^0_2, \ldots, x^0_n)$$

In (5.4) each argument of *f* is taken in turn, and the other arguments are left unchanged. It this way one can get an impression of the importance of each independent variable in the total change of *y*. The problem involved in the isolated decomposition is that the sum of the decomposition steps $f(x^1_1, x^0_2, \ldots, x^0_n)$, $f(x^0_1, x^1_2, \ldots, x^0_n), \ldots, f(x^0_1, x^0_2, \ldots, x^1_n)$ may not be – and is usually not – identical to $D y$, the change in the dependent variable.

Another approach is the cumulative method. Following this approach, (5.2) may be decomposed like this:

(5.5) $$Dy = f(x^1_1, x^1_2, \ldots, x^1_n) - f(x^1_1, x^0_2, \ldots, x^0_n) - f(x^1_1, x^1_2, \ldots, x^0_n) - \ldots - f(x^1_1, x^1_2, \ldots, x^1_n) + f(x^1_1, x^0_2, \ldots, x^0_n) + f(x^1_1, x^1_2, \ldots, x^0_n) + \ldots + f(x^1_1, x^1_2, \ldots, x^1_n) - f(x^0_1, x^0_2, \ldots, x^0_n)$$

In this way, obviously, the sum of the decomposition steps equals the change in the dependent variable. But the problem with this method is that the importance of each step depends on the sequencing of the individual steps. This means that (5.5) and

(5.6) $$Dy = f(x^1_1, x^1_2, \ldots, x^1_n) - f(x^0_1, x^1_2, \ldots, x^0_n) -$$

$$f(x^1_1, x^1_2, \ldots, x^0_n) - \ldots - f(x^1_1, x^1_2, \ldots, x^1_n) +$$
$$f(x^1_1, x^0_2, \ldots, x^0_n) + f(x^1_1, x^1_2, \ldots, x^0_n) +$$
$$\ldots + f(x^1_1, x^1_2, \ldots, x^1_n) - f(x^0_1, x^0_2, \ldots, x^0_n)$$

may well assign different importance to the independent variables x_1 and x_2, even though in the final end the sum of the decomposition steps in (5.5) as well as in (5.6) equal the change in the dependent variable *Dy*.

Yet another approach is the "mirror image" of the isolated decomposition, where the independent variables in turn are changed from new to old values:

(5.7) $$Dy = f(x^1_1, x^1_2, \ldots, x^1_n) - f(x^0_1, x^1_2, \ldots, x^1_n) - f(x^1_1, x^0_2, \ldots, x^1_n) - \ldots - f(x^1_1, x^1_2, \ldots, x^0_n) + f(x^0_1, x^1_2, \ldots, x^1_n) + f(x^1_1, x^0_2, \ldots, x^1_n) + \ldots + f(x^1_1, x^1_2, \ldots, x^0_n) - f(x^0_1, x^0_2, \ldots, x^0_n)$$

This method suffers from the same problem as the isolated decomposition: There is no guarantee that the sum of the decomposition steps will equal the total change.

As implied by the considerations above, there is no perfect way of decomposing changes in a dependent variable. Various suggestions have been made to remedy this schism. One is the approach suggested by Fugimagari and Sawyer, using the arithmetic average of the results of the isolated decomposition (5.4) and (5.7). In this case, each decomposition step is weighted with an average of old and new values of the other independent variables (Wier 1998, pp.105-06, Andersen 1998, pp. 10-14).

In this paper, a hybrid of the isolated and the cumulative decomposition methods is used. Cumulative decomposition is used whenever it is favoured by the logic of interrelations between the variables. For example, the total change in primary income in all industries can be cumulatively decomposed into change of primary income in manufacturing industries and other industries. In all other cases, isolated decomposition is chosen. By using such a hybrid, it is our contention that possible ambiguities due to choice of method will be small[9]. This has been shown to be the case in similar studies (Jensen-Butler et al. 1999).

Table 5.1 demonstrates the specific way that changes in primary income at municipality of work has been decomposed. Table 5.2 shows the same for disposable income at municipality of residence.

[9] An appendix demonstrating decomposition results using alternative methods is available from the authors.

Table 5.1. Decomposition steps of primary income at municipality of work.

Variables → Decomposition Step ↓		Employment *qae*	Income per employed person/ productivity *YLORAEQ*	Primary income *ylorae*
1	Number of jobs changed, employment composition retained.	*qa*. Changed to 1995 values, ..*e* retained	Constant	Endogenous
2	Employment changed, including composition	*qae* changed to 1995 values	Constant	Endogenous
3	Relative prices changed.	Constant	*YLORAEQ* multiplied with vector of deflators in industries.	Endogenous
4	National productivity changed	Constant	*YLORAEQ* multiplied with change in national productivity in each industry	Endogenous
5	Local productivity changed.	Constant	*YLORAEQ* changed to 1995 values.	Endogenous

Note: Each of the decomposition steps are carried out for a. manufacturing industries in isolation and b. all industries. Changes in disposable income are also calculated (see section 6). Names of variables, see section 4 in the text.

Table 5.2. Decomposition steps of disposable income at municipality of residence.

Variables→ Decomposition steps ↓		Population size and composition: *u<age>bg*	Labour force activity rate: *USBGQ*	Commuting: *QABEQ YLORABEQ*	Educational composition: *QBEGQ YLORBEGQ*	Transfers: *T<cat>BGQ UT<cat>BGQ*	Taxes: *S<type>BGQ y(ti)<type>bgq*
6	Change in population size and composition	*u<age>bg* changed to 1995 values	Constant	Constant	Constant	Constant	Constant
7	Change in labour force activity rate	Constant	*USBGQ* changed to 1995 values	Constant	Constant	Constant	Constant
8	Change in commuting pattern	Constant	Constant	*QABEQ YLORABEQ* changed to 1995 values	Constant	Constant	Constant
9	Change in educational composition of population	Constant	Constant	Constant	*QBEGQ YLORBEGQ* changed to 1995 values	Constant	Constant
10	Change in transfer rates	Constant	Constant	Constant	Constant	*T<cat>BGQ* changed to 1995 values	Constant
11	Change in transfer structure	Constant	Constant	Constant	Constant	*UT<cat>BGQ* changed to 1995 values	Constant
12	Change in tax rate	Constant	Constant	Constant	Constant	Constant	*S<type>BGQ* changed to 1995 values
13	Change in tax structure	Constant	Constant	Constant	Constant	Constant	*y(ti)<type>bgq* changed to 1995 values

Note: Disposable income, *ydibg*, is endogenous in each of these calculations. Names of variables, see section 4 in the text.

As can be seen from table 5.1, steps 1-2 and 3-5 are cumulative. Also, for each of the steps in table 5.1, a cumulative decomposition is made regarding changes caused by manufacturing industries and all industries. All other decomposition steps are isolated.

In the following section, results of the decomposition of primary income at municipality of work for manufacturing industries and for all industries are exposed in some detail. Further, in a more summary way, results concerning disposable income are presented.

6. Results of the decomposition analysis.

To facilitate the exposition of the decomposition analysis, eleven groups of municipalities have been generated. To illustrate effects in rural and peripheral areas, categories of rural and peripheral municipalities have been set up. Further, the rural part of the country is illustrated by agricultural municipalities, where agriculture is a dominating industry in income earning (location factor 4)[10].

As for geographically comprehensive areas, Jutland and the CMR are chosen as contrasts. Also, West Lolland is cut out, being the region with the most significant development problems (see below).

To elucidate developments in manufacturing industries, five groups of municipalities with special interest for these industries have been generated. First, *general manufacturing* municipalities are those where primary income in manufacturing

[10]For precise definitions of the municipality groups, see notes to table A1. A complete listing of the municipalities in each group is available from the authors.

industries in 1980 was more than twice the national average (21.5 per cent). Most of the twelve municipalities in this group turn out to be “company towns”, minor town communities dominated by a single manufacturing plant. They are scattered all over the country. As will be clear from the following, most of these have performed somewhere between not too good and disastrous.

Further, four groups of municipalities have been formed according to dominance of a single manufacturing industry. These are

- Municipalities dominated by manufacturing of textiles, wearing apparel, and leather (industrial group no. 15009 in Statistics Denmark’s 53-grouping), named textiles manufacturing municipalities;
- Municipalities dominated by manufacturing of chemicals (industrial group no. 24000 in Statistics Denmark’s 53-grouping), named chemicals manufacturing municipalities;
- Municipalities dominated by manufacturing of wood and furniture (the sum of industrial groups nos. 200000 and 361000 in Statistics Denmark’s 130-grouping), named wood & furniture manufacturing municipalities;
- Municipalities dominated by manufacturing of electrical and optical equipment (industrial group no. 30009 in Statistics Denmark’s 53-grouping), named electronics manufacturing municipalities.

In the following, these four groups are named “specialised municipalities”. The groups are generated on the basis of gross value added in 1995[11], applying location factor 4. It seems that, apart from specialisation on the level of municipalities, agglomeration

[11] The choice of this dataset for the purpose of forming these groups of municipalities is the lack of sufficient data from 1980 for this purpose, see above.

plays a role (see above). There seems to be substantial tendencies to agglomeration in all four cases.

It is clearly seen from table A1 that changes in the location of manufacturing industries has been massive. It is also clear that the development has been relatively beneficial for rural and even most of the peripheral areas.

Further, the less fortunate regions are the old industrial centres of the East, most clearly exemplified by West-Lolland, clearly a case of sunset industry decay (the closure of the shipyard of Nakskov in 1987). This phenomenon is well-known throughout Europe in such places as the British Midlands (Keeble & Wever 1986, Keeble & Kelly 1986).

Even the CMR has clearly been unfavourably affected by the development. In manufacturing industries, employment has plummeted, and primary income has declined. Even though much of this is recovered by progress in other industries, the fact remains that the CMR has performed below country average and certainly below the performance of Jutland. Some decaying sunset industries have been located in the CMR, but this case is less clear than that of West-Lolland. Many contradictory trends are blended in this area of 1.8 mill. inhabitants, including recent trends of growth in some human-capital-intensive industries, see below.

When it comes to municipalities with a large part of primary income earned in manufacturing industries, a number of interesting trends can be observed. First, in the general manufacturing municipalities growth of primary income is about the same as the national average, whereas the growth of employment is higher, indicating that productivity growth is below the national average (see below).

Further, most of the municipalities where specific manufacturing industries hold a significant part of primary income have experienced higher growth in employment and primary income than the national average (the exception is chemicals – but only for manufacturing employment).

The results of the decomposition analysis throw more light on the regional patterns of change in primary income. As noted above, changes in primary income in each region will be decomposed into changes caused by changes in:

a) Number of jobs
b) Employment, including changes in composition
c) Changes in relative prices at the national level
d) Changes in national productivity of each employed person
e) Changes in local productivity of each employed person deviating from the national trend.

For each of these elements, the share of the total effect that originates from manufacturing industries is calculated.

The calculation results from the first decomposition step, the effect of changing the number of jobs without specialisation (that is, number of employed persons, with no changes of employment composition) is shown in table A2. For most categories of municipalities, clearly changes in number of jobs have limited effect on primary income. This is true for total income as well as manufacturing income. The only exception is West Lolland, where the collapse of large industrial plants has been crucial in the negative development of that region.

It might be noted, though, that the municipalities with specialised manufacturing industries have done better than other categories, and that growth of manufacturing employment has contributed markedly (26 to 35 per cent) to growth caused by change in number of jobs.

When incorporating employment composition in the equation (table A3), paradoxically, effects on primary income are reduced in most categories. It might have been expected that people moved from lower paid jobs to higher paid jobs, thereby raising primary income whenever employment composition changes. It turns out that the opposite is true. Part of the explanation may be the decline in sunset industries like shipyards, since jobs in such places have generally been well paid. Persons laid off in such industries may often have been unable to obtain equally well paid jobs. It might be said that the loss of primary income seen in table A3 (when compared with A2) is the price of the loss of competitiveness of such industries. In particular, the loss of jobs in the manufacturing industries of the CMR more than accounts for the total loss of primary income in the region, reflecting retrenchments in shipbuilding, newspaper printing, breweries, and more.

Changes in primary income due to changes in terms of trade among industries are shown in table A4. A small or negative figure here indicates that a large part of incomes have been earned in industries with little increase in prices, such as agriculture. Conversely, for municipalities dominated by industries with rapidly increasing prices we would expect a high figure. This is exactly what table A4 shows. In particular, note that the changes caused by manufacturing industries' terms of trade are fairly equal in all of the groups. Differences in the change in total primary income, thus, are primarily due to different intensities of agriculture.

Changes in primary income related to changes in national labour productivity are displayed in table A5. Due to data unavailability (see above), national productivity in manufacturing industries varies very little among the groups. As labour productivity in all industries and in manufacturing industries happen to have changed identically (30.5 per cent), the effect on total primary income in various groups depends very much on the shares of manufacturing and agriculture (where productivity has grown more than in manufacturing industries).

Local labour productivity is measured simply as primary income in municipalities per person employed. Deviations from the national level indicate a strong or weak productivity performance compared with the national level. Results are displayed in table A6. Note that there is a difference for Denmark in total between change caused by a change in national and local productivity in manufacturing industries. This is not too surprising, since productivity in 1995 is calculated using employment in 1995, whereas income change caused by this productivity increase is weighted using employment in 1980. When all industries are aggregated, differences tend to even out, but for individual industries and municipalities differences can be substantial.

This section will be concluded with a summary exposition of the results concerning disposable incomes. We do not have data on disposable income in municipalities of work (nor, arguably, is such a concept meaningful). Only municipalities of residence are relevant for this category. In table A7 the results of the decomposition analysis for each of the thirteen decomposition steps (see tables 5.1 and 5.2) are given for all industries and for manufacturing industries (where relevant) and for rural and peripheral municipalities.

It is seen, in general, that most of the tendencies exposed in the analysis of primary income are found again in this material, but often reduced to some extent. This is because changes in primary income, when transformed to disposable income at municipality of residence, are mitigated in a number of ways.

First, commuting between municipalities help spread increases and decreases of income among municipalities. Second, transfer incomes such as unemployment benefits help soften the effects of increasing unemployment and, conversely, dampens the effect of increasing employment (because unemployment, and related benefits, may decrease as a result). Third, the so-called fiscal federalism is at work in this context: Rising primary income will increase taxes, and vice versa.

7. Recent Trends in Manufacturing Industries.

As noted earlier, recent data from the KRNR database seem to change some of the findings of the last sections. To obtain a perspective for the future, some of the data are presented in the following. The data invokes the possibility that at least part of the industrialisation of Jutland in the eighties has in fact represented a postponement of the inevitable effects of globalisation: That Denmark and most other rich countries are bound to lose market shares to low wage countries in Asia and elsewhere[12]. However, recent data also display some surprises.

[12] Note that the recent ”Asian Crisis” does not change this perspective. On the contrary: The crisis has brought along substantial adjustments of currency exchange rates in most of the affected countries, making these even more competitive.

Table A8 shows some patterns of this set of recent data. Data on gross value added (GVA) as well as employment are given. We see some new trends, but also a continuation of some of the tendencies that was pointed out by the decomposition analysis. In this period, the Danish economy has grown fairly well with 15.9 per cent increase in GVA. Manufacturing industries account for almost one quarter of this.

Employment grew by 4.6 per cent, but here, manufacturing industries has almost no importance. However, these changes have been very unevenly distributed among regions and municipality groups. In the following, the most important of the emerging patterns will be expounded.

Starting with the rural and agricultural municipalities, we see that for all industries, GVA has grown almost as much as the national average, whereas employment has stagnated or fallen[13]. However, this is not due to the performance of manufacturing industries. On the contrary, GVA and employment in manufacturing industries have grown more than the country's average. So the weak development in the general economy of these municipalities must be ascribed to other industries. Hence, the hypothesis on above-average growth of manufacturing industries in rural areas is once again confirmed.

Almost the same pattern is found for peripheral municipalities, only here growth of GVA in manufacturing is slightly less than the national average. All in all, we find it fair to say that this evidence does not support the hypothesis that the less favourable development in peripheral areas is caused by a weak performance of the manufacturing

[13] The reduction of employment is noteworthy, since this period is known as one of economic recovery.

industries. Again, the unfavourable development in these regions must be due to other industries[14].

In West-Lolland, even after 1993 (six years after the closure of Nakskov shipyard) the development is still gloomy. The lowest GVA growth and the largest fall in employment among the municipality groups shown in figure A8 is found here. Employment in manufacturing industries has fallen more than ten per cent, accounting for almost three fourths of the total decline in employment. However,
GVA in manufacturing has grown almost as much as the national average, implying a substantial increase in productivity (just as in the period 1980-95, see below).

The trends exposed this far have been fairly similar to those observed in the period 1980-95 for the same regions. So the tendencies observed previously are, by and large, confirmed by the new data. However, not so when comparing the CMR and Jutland. From 1993 to 97 GVA growth is higher in the CMR than in Jutland, in particular so for manufacturing industries. Also, employment has grown faster in the CMR than in Jutland. However, employment in manufacturing industries has grown slightly in Jutland, whereas it has fallen a bit in the CMR (although this fall is amply mitigated by other industries). Such a re-invigoration of manufacturing industries in metropolitan regions is found in other places in Europe as well (Keeble & Wever 1986).

The developments of manufacturing industries in the CMR and in Jutland represent a confirmation that some of the industrialisation of Jutland constitutes a postponement of globalisation. Note, however, that this is not true for rural industrialisation in general (see above).

[14] The ”island periphery” consisting of Bornholm and some other islands is performing much worse than the periphery in general. But even here, manufacturing industries are doing better than the general economy.

With so many winners (rural municipalities, the CMR etc.), who are the losers? Obviously, West-Lolland is one. But also the general manufacturing municipalities, the "company towns", have lost out. In these municipalities GVA in manufacturing industries has not grown at all. And since manufacturing industries are so important in these places, general GVA growth is far below the national average. Note, however, that employment in these municipalities has grown a little more than the national average (also indicating a weak development of labour productivity).

Perhaps the most remarkable fact of the data of table A8 is the substantial difference between the general manufacturing municipalities and the specialised municipalities. Where manufacturing GVA has not grown at all in the "company towns", in the specialised municipalities it has grown at rates from just below the average (textiles) to well above it (chemicals, wood and furniture).

Not surprisingly, of the specialised municipalities the textiles manufacturing municipalities are doing worst. Obviously, this branch of manufacturing is extremely exposed to international competition from Asian and other low cost countries. Hence, it is no surprise that employment has fallen ten per cent in manufacturing industries in these municipalities. One the plus side, however, note that GVA has grown almost as much as the national average.

For the textiles industries in general, the whole period has been hard times. In the four years from 1993-97, employment in the textiles industries in the whole country has declined with more than six thousand jobs or 27 per cent. In their "own" municipalities, the decline is slightly less, 25.8 per cent, approximately 2800 jobs, more than four times the net number of job losses in these municipalities (meaning that

other industries have compensated most of the loss). In the case of the textiles manufacturing municipalities, it is fair to say that the advance of the period of 1980-95 has constituted a postponement of the effects of globalisation.

In the other specialised municipalities, the development has been much more benevolent. The most successful group is the chemicals manufacturing municipalities, where GVA growth in manufacturing industries is almost twice the national average, and accounts for almost half of the total GVA growth in these municipalities. In the chemicals manufacturing itself, employment has increased by 1711 jobs, almost as much as in manufacturing in total (1922 jobs). Even so, the contribution to the total increase in number of jobs in all industries is modest: More than ten thousand jobs were generated in these municipalities. Part of the reason is probably that many of these municipalities are large and have versatile economies.

8. Theories and Evidence. Lessons from the Analyses.

The time has come to review the theories and hypotheses put forth in section 2 in the light of the evidence given. In so doing, we will condense the data and calculation results displayed to focus on the essentials.

To sum up, the decomposition analysis of primary incomes show us that a very substantial relocation of Danish manufacturing industries has taken place from 1980 to 1995. Manufacturing in the rural and peripheral areas has grown more than in the urban areas. Also, manufacturing in Jutland has grown much more than in the CMR, where incomes earned in manufacturing industries has actually declined. However, productivity has increased more than average in some of the unsuccessful regions,

including West Lolland and the CMR. Further, the developments of general manufacturing and specialised municipalities suggest that technological spillovers and labour pooling is important for success of manufacturing industries as a whole, whereas economies of scale seems less important in the Danish case.

Now we venture to examine productivity growth in the various municipality groups. More specifically, we will compare effects of national productivity increases and effects of local deviations from this. This is done by comparing tables A5 and A6, and including additional evidence from recent data. Results of the comparison of the two tables are given in table 8.1.

The difference between national average productivity increase and the average of local productivity increase (see above) poses a question in relation to this: When comparing results from individual groups of municipalities, should the reference point be average national productivity (bottom line of table A5), or should it be national average of local productivity (bottom line of table A6)? As there is no unique answer to this, both comparisons are given below.

Table 6.1. Differences in effects on primary income in manufacturing industries of labour productivity changes 1980-95.

Difference (percentage points) between local productivity in…	…and…	
	National average of labour productivity for municipality group	Average of local productivity for all municipalities
Rural municipalities[a]	4.8	2.5
Agricultural municipalities[d]	1.2	-1.0
Peripheral municipalities[a]	2.5	0.3
West Lolland[a]	12.5	9.3
CMR[a]	6.3	3.9
Jutland[c]	0.8	-2.7
General manufacturing municipalities[e]	-8.5	-11.7
Textiles manufacturing municipalities[b]	9.1	7.0
Chemical manufacturing municipalities[b]	7.7	5.3
Wood & furniture manufacturing municipalities[b]	5.0	2.8
Electronics manufacturing municipalities[b]	3.3	0.4

Notes: See table A1.

Table 6.1 contains a lot of noteworthy information. First we note that rural, agricultural and peripheral municipalities are coping quite nicely when it comes to productivity. West Lolland has the best productivity record of all the groups.

Comparing the performances of the CMR and Jutland is particularly interesting. As we suspected, the CMR has had a higher productivity increase than Jutland. This could be a confirmation of the hypothesis that the development in the respective parts of the country follows a pattern of exploitation of comparative advantages: In the CMR, manufacturing industries have increasingly made use of employees with higher education, and higher salaries, in branches like medicine and electronics. In Jutland manufacturing firms have taken advantage of the presence of a labour force that has high work ethics and loyalty towards their firm (Jensen-Butler 1992, see also above, and Maskell 1992), and who will also accept lower pay (although the difference is not so large, see above).

The worst performer of the groups when it comes to productivity is the general manufacturing municipalities. Since these municipalities represent the “dinosaurs” of Danish manufacturing industries, this is perhaps not too surprising to a Danish newspaper reader: One large manufacturing firm after the other has been in crisis and has gone through retrenchments, and worse. The most spectacular case is the closure of the shipyard in Nakskov in 1987[15]; but note that Nakskov is also part of West Lolland, which has the highest productivity growth of all groups. So the case of Nakskov does not explain much. Rather, the period has been bad times for most large manufacturing plants and for “company towns”.

[15] Up till the seventies, Denmark was known as a shipbuilding nation. After closures of shipyards in Elsinore, Aalborg, Nakskov, Copenhagen, Ringkøbing, Svendborg…. this is hardly the case any more. The shipyard in Munkebo (one of the general manufacturing municipalities) seems to be doing well, though.

By contrast, the specialised manufacturing municipalities do much better. In textiles and wood and furniture there are no individual firms large enough to dominate income generation in any municipality. In chemicals and electronics there is a number of large companies, but few of them dominate local income generation, and only one coincides with the general manufacturing municipalities (namely Bang & Olufsen, located in Struer in West Jutland). The lesson seems to be that successful agglomeration is caused by technological spillovers and labour pooling rather than economies of scale, at least in the period considered here. In Danish manufacturing industries, Small is Beautiful, and Large is Lousy.

The relatively low productivity performance of the Jutland manufacturing industries in this period may constitute a warning: Is the success of manufacturing in this part of the country only a postponement of the inevitable consequences of globalisation? Are the Jutland manufacturing firms bound to lose competitiveness to low wage countries in Asia and elsewhere? Recent evidence, as we have seen, reveal some of the answers. Notably, this was foreseen by Jensen-Butler (1992, pp. 900-02).

When comparing the evidence from 1993-97 on different groups of manufacturing municipalities, once again the lesson is that specialisation pays, but size does not. With the exception of the extremely vulnerable textiles manufacturing municipalities, the specialised municipality groups fare better than almost any of the other groups. This is true for GVA and for employment, for manufacturing industries and for all industries. However, the figures do not confirm the hypothesis that manufacturing industries in Denmark benefit from economies of scale. This is seen from the fact that the group of general manufacturing municipalities is among the worst performers of all. As a consequence, it seems that labour pooling and technological spillovers among firms in the same industry are responsible for this pattern.

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10. Concluding remarks.

This essay has aimed to contribute to the knowledge on the consequences of the changes in the location of manufacturing industries that has been going on in the eighties and nineties. We have shown to what extent the very substantial relocation of manufacturing industries have contributed to the growth of primary incomes and disposable incomes in rural, peripheral and many other regions and types of municipalities.

Early in the essay we expressed some hypotheses for discussion. We have found evidence on each of them:

- The hypothesis on the role of manufacturing industries in income growth in rural areas is confirmed by the evidence, but it cannot be confirmed that manufacturing industries are instrumental in the decline of peripheral regions.
- To some extent the hypothesis on comparative advantages is supported: Growth of manufacturing industries in Jutland is, among other things, caused by the presence of a loyal and compliant work force (Jensen-Butler 1992, Illeris 1986), while in the CMR, manufacturing industries have taken advantage of the presence of a large labour force with higher education. Also to some extent, our suspicions on part of the Jutland industrialisation are confirmed: In the textiles industries, above all, employment has recently declined substantially.
- Successful local concentration of manufacturing production has taken place in the specialised municipalities, indicating that technological spillovers and labour pooling are important in this context. However, it is not confirmed that economies of scale is important for manufacturing growth.

- **Appendix 1. Tables.**

Table A1. Major trends in the development of manufacturing industries in various parts of the country:

Region/type of municipality	Real change 1980-95 (per cent) at location of work in			
	Total employment	Total primary income	Employment in manufacturing ind.	Primary income in manufacturing ind.
Rural municipalities[a]	2.9	46.4	32.0	79.8
Agricultural municipalities[d]	-1.4	38.6	25.7	65.9
Peripheral municipalities[a]	-4.6	31.6	10.2	49.1
West-Lolland[a]	-27.0	-8.1	-60.5	-47.0
CMR[a]	-2.5	26.3	-27.0	-1.3
Jutland[c]	9.8	44.0	16.7	52.6
General manufacturing municipalities[e]	7.0	34.9	7.7	29.7
Textiles manufacturing municipalities[b]	9.2	45.3	18.3	66.8
Chemical manufacturing municipalities[b]	5.0	40.8	-7.6	27.2
Wood & furniture manufacturing municipalities[b]	7.4	49.0	37.4	85.6
Electronics manufacturing municipalities[b]	15.0	56.5	19.2	55.1
Denmark in total	3.8	35.0	-2.4	27.2

Notes: A complete list of municipalities in the categories listed is available from the authors. The categories are defined as follows.

a) See appendix 2.
b) Location factor 4 used on gross value added in 1995 in each of the industries.
c) Comprises all of the seven counties of Jutland, including surrounding islands.
d) Location factor 4 used on primary income in 1980.
e) Location factor 2 used on primary income in 1980.

Table A2. Effects of changes in number of jobs (disregarding changes in employment composition) on primary income 1980-95.

Region/type of municipality	Real change 1980-95 (per cent) in primary income at location of work				
	Total primary income	Caused by change in number of jobs	Primary income in manufacturing industries	Caused by change in no. of jobs in manufacturing	Share (%) of manufacturing industries in total change
Rural municipalities[a]	46.4	3.1	79.8	4.7	28.4
Agricultural municipalities[d]	38.6	-0.1	65.9	0.0	-6.9
Peripheral municipalities[a]	31.6	-3.8	49.1	-2.0	8.8
West-Lolland[a]	-8.1	-27.0	-47.0	-27.9	33.9
CMR[a]	26.3	-3.4	-1.3	-2.0	10.7
Jutland[c]	44.0	9.9	52.6	10.8	25.8
General manufacturing municipalities[e]	34.9	5.9	29.7	6.6	62.1
Textiles manufacturing municipalities[b]	45.3	9.2	66.8	10.5	28.7
Chemical manufacturing municipalities[b]	40.8	5.1	27.2	5.8	34.3
Wood & furniture manufacturing municipalities[b]	49.0	7.8	85.6	8.7	27.5
Electronics manufacturing municipalities[b]	56.5	14.7	55.1	13.3	26.5
Denmark in total	35.0	3.3	27.2	4.5	27.7

Notes: See table 6.1.

Table A3. Effects of employment changes, incorporating changes in employment composition, on primary income 1980-95.

Region/type of municipality	Real change 1980-95 (per cent) in primary income at location of work				
	Total primary income	Caused by change in total employment	Primary income in manufacturing industries	Caused by change in manufacturing employment	Share (%) of manufacturing industries in total change
Rural municipalities[a]	46.4	3.6	79.8	31.1	162.8
Agricultural municipalities[d]	38.6	-0.8	65.9	26.3	-597.5
Peripheral municipalities[a]	31.6	-6.8	49.1	8.3	-20.4
West-Lolland[a]	-8.1	-28.6	-47.0	-61.4	70.6
CMR[a]	26.3	-4.8	-1.3	-28.6	110.5
Jutland[c]	44.0	8.0	52.6	14.3	42.4
General manufacturing municipalities[e]	34.9	0.8	29.7	-3.7	-244.3
Textiles manufacturing municipalities[b]	45.3	7.7	66.8	19.2	62.5
Chemical manufacturing municipalities[b]	40.8	4.5	27.2	-8.4	-56.0
Wood & furniture manufacturing municipalities[b]	49.0	8.0	85.6	38.4	118.7
Electronics manufacturing municipalities[b]	56.5	14.1	55.1	14.3	29.5
Denmark in total	35.0	1.2	27.2	-5.2	-107.1

Notes: See table 6.1.

Table A4. Effects of changes of terms of trade among industries on primary income 1980-95.

Region/type of municipality	Real change 1980-95 (per cent) in primary income at location of work				
	Total primary income	Caused by change in terms of trade	Primary income in manufacturing industries	Caused by change in manufacturing industries' terms of trade	Share (%) of manufacturing industries in total change
Rural municipalities[a]	46.4	-1.0	79.8	11.7	-223.3
Agricultural municipalities[d]	38.6	-2.6	65.9	11.4	-81.4
Peripheral municipalities[a]	31.6	0.3	49.1	8.3	838.2
West-Lolland[a]	-8.1	4.4	-47.0	13.7	102.8
CMR[a]	26.3	9.0	-1.3	12.1	24.9
Jutland[c]	44.0	5.9	52.6	12.1	48.2
General manufacturing municipalities[e]	34.9	9.1	29.7	13.8	83.8
Textiles manufacturing municipalities[b]	45.3	5.4	66.8	11.1	52.3
Chemical manufacturing municipalities[b]	40.8	9.4	27.2	11.9	37.9
Wood & furniture manufacturing municipalities[b]	49.0	1.4	85.6	11.4	195.7
Electronics manufacturing municipalities[b]	56.5	5.9	55.1	13.0	26.7
Denmark in total	35.0	7.2	27.2	12.1	36.0

Notes: See table 6.1.

Table A5. Effects of national labour productivity changes (incorporating terms of trade changes) on primary income 1980-95.

Region/type of municipality	Real change 1980-95 (per cent) in primary income at location of work				
	Total primary income	Caused by change in national labour productivity	Primary income in manufacturing industries	Caused by change in nat. labour productivity in manuf. ind.	Share (%) of manufacturing industries in total change
Rural municipalities[a]	46.6	38.0	79.8	30.7	15.3
Agricultural municipalities[d]	38.6	38.8	65.9	30.8	14.6
Peripheral municipalities[a]	31.6	35.6	49.1	30.8	14.2
West-Lolland[a]	-8.1	33.7	-47.0	29.8	29.2
CMR[a]	26.3	28.6	-1.3	30.5	19.8
Jutland[c]	44.0	31.6	52.6	30.5	22.8
General manufacturing municipalities[e]	34.9	31.6	29.7	29.8	52.1
Textiles manufacturing municipalities[b]	45.3	32.0	66.8	30.9	24.4
Chemical manufacturing municipalities[b]	40.8	29.7	27.2	30.6	30.9
Wood & furniture manufacturing municipalities[b]	49.0	35.7	85.6	30.8	21.3
Electronics manufacturing municipalities[b]	56.5	32.8	55.1	30.1	26.7
Denmark in total	35.0	30.5	27.2	30.5	21.5

Notes: See table 6.1.

Table A6. Effects of local labour productivity changes (incorporating changes in terms of trade) on primary income 1980-95.

Region/type of municipality	Real change 1980-95 (per cent) in primary income at location of work				
	Total primary income	Caused by change in total employment	Primary income in manufacturing industries	Caused by change in manufacturing employment	Share (%) of manufacturing industries in total change
Rural municipalities[a]	46.6	39.0	79.8	35.5	17.3
Agricultural municipalities[d]	38.6	38.8	65.9	32.0	15.1
Peripheral municipalities[a]	31.6	35.7	49.1	33.3	15.5
West-Lolland[a]	-8.1	32.4	-47.0	42.3	43.0
CMR[a]	26.3	30.5	-1.3	36.9	22.4
Jutland[c]	44.0	30.7	52.6	31.3	24.1
General manufacturing municipalities[e]	34.9	25.3	29.7	21.3	46.6
Textiles manufacturing municipalities[b]	45.3	32.2	66.8	40.0	31.3
Chemical manufacturing municipalities[b]	40.8	33.4	27.2	38.3	34.3
Wood & furniture manufacturing municipalities[b]	49.0	36.6	85.6	35.8	24.2
Electronics manufacturing municipalities[b]	56.5	34.1	55.1	33.4	28.5
Denmark in total	35.0	30.5	27.2	33.0	23.2

Notes: See table 6.1.

Table A7. Decomposition of changes of disposable income. Per Cent Change.

Decomposition step: Change caused by… ↓		All industries		Manufacturing industries	
		Rural[a]	Peripheral[a]	Rural[a]	Peripheral[a]
1	Change in number of jobs	1.4	-0.2	*	*
2	Change in employment, including composition	-0.1	-2.6	0.6	0.2
3	Change in relative prices	2.3	1.7	0.4	0.2
4	Change in national productivity	26.3	25.0	5.3	4.3
5	Change in local productivity	26.1	24.4	5.2	4.6
6	Change in population size and composition	4.0	0.0	*	*
7	Change in labour force activity rate	-1.2	-2.6	*	*
8	Change in commuting pattern	-0.0	-0.4	0.5	0.2
9	Change in educational composition of population	0.6	0.5	*	*
10	Change in transfer rates	7.3	8.0	*	*
11	Change in transfer structure	8.0	8.0	*	*
12	Change in tax rates	-6.5	-5.8	*	*
13	Change in tax structure	-1.1	-1.4	*	*
	Total change in disposable income	33.7	26.4	*	*

Notes: See table A1.
*: Not relevant.

Table A8. Growth of gross value added (GVA) and employment in all industries and manufacturing industries 1993-97.

	Real change 1993-97 (per cent).					
Region/type of municipality	Gross value added, all industries	Gross value added, manufacturing industries	Share of manufacturing industries in change	Employment all industries	Employ-ment, ma-nufacturing industries	Share of manufactu-ring industries in change
Rural municipalities[a]	14.7	28.9	35.8	0.0	5.4	2676.2
Agricultural municipalities[d]	15.6	30.1	33.2	-1.5	2.3	-30.0
Peripheral municipalities[a]	10.7	18.6	27.8	0	5.3	f)
West-Lolland[a]	8.9	21.0	40.6	-1.9	-10.7	74.8
CMR[a]	17.2	31.2	21.0	6.0	-3.9	-8.2
Jutland[c]	14.2	19.3	29.4	4.1	2.7	14.2
General manufacturing municipalities[e]	10.1	0.0	0.1	4.2	1.8	20.4
Textiles manufacturing municipalities[b]	17.4	22.3	34.0	-0.8	-9.2	336.1
Chemical manufacturing municipalities[b]	24.2	41.5	44.8	7.3	6.4	19.1
Wood & furniture manufacturing municipalities[b]	17.7	30.2	42.7	1.0	4.3	110.6
Electronics manufacturing municipalities[b]	23.4	27.6	32.1	4.8	2.9	15.6
Denmark in total	15.9	23.3	24.6	4.6	0.6	2.3

Notes a-e: See table 6.1.

f: Zero denominator!

Appendix 2: Definitions of municipality groups and regions.

Rural municipalities: Municipalities with no towns larger than 3000 inhabitants as of Jan. 1, 1984.

Peripheral municipalities: Municipalities on Bornholm and smaller islands except Fanø plus rural municipalities with

- a distance of more than 40 kilometres to the closest strong geographical centre in turn defined as having a commuting intensity of more than 2.0 and more than 40000 jobs as of Jan. 1 1984; and
- a distance of more than 30 kilometres to the closest geographical centre, defined as having *either* more than 20000 jobs *or* more than 10000 jobs *and* a commuting intensity of more than 2.0.

West-Lolland comprises the municipalities Højreby, Nakskov, Ravnsborg and Rudbjerg.

The CMR consists of the Municipalities of Copenhagen City and Frederiksberg and the counties of Copenhagen, Frederiksborg and Roskilde.

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