Regional Computable General Equilibrium Models for Denmark

Three Papers Laying the Foundation for Regional CGE Models with Agglomeration Characteristics

Brømsøe Termansen, Lars

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Paper Abstracts

Taxes and Regional Transfers in an Economic Geography Setting

The paper analyses the effects of introducing taxes and regional transfers on the equilibrium properties in a standard Core-Periphery model. A central government levies taxes on production factors and redistributes the revenue to all agents regardless of their location. In the case of Core-Periphery economy this is in effect a re-allocation of agglomeration rents. Simulations show that taxes and transfers alter the Core-Periphery model's properties by moving the Break and Sustain points. The range of freeness of trade with Core-Periphery outcomes is reduced for transfers to the periphery, and increased for transfers to the core. The width of the overlap where the models exhibit hysteresis effects remains the same regardless of the transfers. The analysis reveals that in the Core-Periphery outcome the agglomeration rents can be taxed without exhausting the core's scale effects. The tax revenues can then be redistributed such that periphery regions and the central government have incentives in promoting core regions, which function as industrial locomotives for the whole economy.

Congestion, Fiscal Equalisation and Local Public Goods Provision

The paper extends the canonical two region Core-Periphery model of Krugman (1991) with congestion costs to capture negative effects of urbanisation. The congestion costs act as an extra dispersion force in the model, and this reduces the range of freeness of trade for which the economy exhibits agglomeration. In addition, a new symmetric stable equilibrium replaces the Core-Periphery state for high levels of integration. Then the model is extended by considering local governments supplying public goods. The production of public goods binds local factors and raises factor costs in the regions, thus enhancing the dispersing force even more. At the same time, however, supply of local public goods and services will attract mobile labour, concentrating economic activity. These extra effects change dramatically the properties of the standard Core-Periphery model. In particular, the range of freeness of trade for which the economy exhibits agglomeration is reduced.

Danish Regional Models

After the recent reform of the Danish municipal structure, the equalisation grant scheme in place also needed a reform. This paper constructs a regional computable general equilibrium model of Denmark to analyse the effects on regional income and the locational production structure from the reform. The equalisation grant reform transfers 900 million kroner from the regional public sector in East Denmark to West Denmark. Simulations show that the contraction of the regional public sector i Copenhagen creates room for the knowledge intensive clusters to expand. But the corresponding growth in the Western public sector squeezes the private industries in those regions. However, the scale effects inherent in the clusters in Copenhagen leads to production increase so that the national welfare increases as a result of the equalisation reform. The theoretical foundation used to build the CGE model is economic geography as described in Fujita, Krugman and Venables (1999), characterised by monopolistic competition assumptions and agglomeration characteristics. The paper introduces a methodology to regionalise national data using available information on regional supply of labour and capital. This is also used to calculate an interregional trade matrix.

Contents

Preface

The work put forth in this Ph.D. dissertation begun when I prepared my master's thesis at the University of Copenhagen. The focus was then on agglomeration economics and the forces driving urbanisation, but also to give the theory a *real* world application. During my graduate study I was employed in the Economic Modelling Unit at Statistics Denmark, helping maintain the ADAM model. Here, my interest was awoken for application of theory and the importance the *numbers* underneath. After graduating, I was employed in Copenhagen Economics where I worked on analyses firmly grounded in rigorous economic methods – and here the idea of building advanced tools for policy analysis through research was high on the agenda. Soon the Ph.D. proposal of constructing one or more CGE models of the regional Danish economy was born.

As the main entities behind me in this endeavour, I would like to thank Copenhagen Economics, Ministry of Science, Technology and Innovation, and the Department of Economics, Copenhagen Business School. In this respect I would like to mention Mikkel Egede Birkeland and Martin Hvidt Thelle, and in addition, numerous colleagues, both current and past, at Copenhagen Economics, and at Copenhagen Business School.

I would especially like to express my sincere gratitude to my two supervisors, Jesper Jensen and Pascalis Raimondos-Møller, for invaluable advice, guidance, encouragement and not least patience during my work on the dissertation at hand. I am also deeply indebted to Lena V. Larsen for the unconditional support, the many long and fruitful discussions and the seemingly endless proof readings. All remaining errors are my own.

Finally, I acknowledge the financial support through the public-private partnership of the Industrial Ph.D. programme and Copenhagen Economics, and being enrolled under the Ph.D. School in Economics and Business Administration, Department of Economics Copenhagen Business School.

Chapter 1

Introduction

Each year when the Danish government presents the yearly state budget, the proposal is attached a forecast and an impact assessment of the policies in the proposal. These calculations are based on complex economic models, such as the ADAM model and the DREAM model.[1] The former being a model based on econometric estimations and the latter being a computable general equilibrium model. The models' contributions lie in their ability to calculate the economic effects of policy changes or initiatives and, to some extent, forecast economic performance. And with these tools enable politicians to evaluate and decide what policies to follow. Thus, when the state budget is passed, the decision is well-informed.

The Danish economic production structure has a regional dimension, with almost half the production taking place in the Copenhagen region, and the rest being more evenly distributed. Also, there is a large part of Danish firms that engage in strong international trade and compete on the global markets. In addition, we can observe that these globally oriented industries has a

[1]Economic Modelling, Statistics Denmark (2008) and DREAM-group (2008).

tendency to cluster in small geographic areas. Since firms in these industries could have located themselves anywhere, there must be some kind of benefit of concentrating, see for example Porter (2003). The focus on clusters and agglomeration effects are an integral part of regional policies in other countries. Norway, Sweden, Finland and Austria all have *Centres of Expertise* that invest in promoting growth through active cluster policies. There is strong belief in scale effects from agglomeration of economic activity.

But the regional perspective and the agglomeration patterns of clusters cannot be accounted for in models built on national scale which the ADAM and DREAM models are. They are simply not built for the purpose of analysing regional effects, and cannot, therefore, give the level of information needed to evaluate policies with regional implications. For instance cluster policy initiatives.

To give such a foundation for policy evaluation, the present dissertation offers *regional* computable general equilibrium models built with agglomeration characteristics based on the economic geography literature. This topic is treated over the next three chapters. First, by analysing conceptual models of economic geography extended with features needed for the final policy analysis. These features include interregional transfers between local governments and supply of local public produced goods. The insights from the conceptual analyses are carried further when an applied regional model is constructed. The regional model is built around the Danish administrative regions and Danish production structure in order to be a tool for regional policy analysis. The presented model is then used to give a regional evaluation of the recent reform of the municipal and regional equalisation scheme in Denmark. In effect, the reform transfers extra money from the richer Eastern part of Denmark to the Western part, but the change in interregional transfers is relatively small compared to the local governments' budgets. In spite of this, the reform of the equalisation scheme does have significant effects on the regional production structure, especially the clustering sectors across the Danish landscape.

The next two chapters add extensions stepwise to the models in order to get a better understanding of how the textbook versions of agglomeration models change when introducing extra features. In chapter 2, the first set of extensions of taxes and regional transfers are introduced, and this is followed by an analysis of how the agglomeration pattern in the economy changes as a consequence of this introduction. In chapter 3, a further set of extensions are built into the modelling setup. These further extensions are costs associated with congestion in large urban areas, and the supply of local public goods from the local governments. Again, it is shown how these further features in the model change by reinforcing of diminish the concentration or dispersion forces of economic activity in the economy. With the results from these two chapters, a better understanding is established on how the economic forces work in an economy with regions and agglomeration characteristics such as the Danish economy. This leads to chapter 4, where as mentioned above, an applied model is presented and used. Finally, a few concluding remarks are given in chapter 5.

Chapter 2

Taxes and Regional Transfers in an Economic Geography Setting

The paper analyses the effects of introducing taxes and regional transfers on the equilibrium properties in a standard Core-Periphery model. A central government levies taxes on production factors and redistributes the revenue to all agents regardless of their location. In the case of Core-Periphery economy this is in effect a re-allocation of agglomeration rents. Simulations show that taxes and transfers alter the Core-Periphery model's properties by moving the Break and Sustain points. The range of freeness of trade with Core-Periphery outcomes is reduced for transfers to the periphery, and increased for transfers to the core. The width of the overlap where the models exhibit hysteresis effects remains the same regardless of the transfers. The analysis reveals that in the Core-Periphery outcome the agglomeration rents can be taxed without exhausting the core's scale effects. The tax revenues can then be redistributed such that periphery regions and the central government have incentives in promoting core regions, which function as industrial locomotives for the whole economy.

2.1 Introduction

In most nations there are some regions that are better off than other regions. The common example being that urban areas are wealthier than rural areas on a per capita basis. From an egalitarian point of view, these differences in income represent undesirable differences in welfare for agents in the regions, and policy makers have implemented various instruments to address this. This policy of *equalisation* is in place almost regardless of the regional scale; even small countries have transfers at the level of local governments – the municipalities – and in some cases transfers exist between nations in economic unions. Denmark, Sweden and Norway are examples of the former and The European Union of the latter.

The exact design of these transfers varies from grant programs to directly equalising tax revenue, but at the core they all serve the purpose of equalising welfare or income across regions. The issue is also to ensure that the less well-off regions have the *ability* to supply a minimum of public goods, whether it is health care services or basic infrastructure. The political desire to make citizens equally well-off is widespread across countries in the world and the most used instrument is directly transferring income from the *rich* to the *poor* regions. For instance in Denmark, the richer municipalities pay a fraction of their local tax revenue to the poorer municipalities, and the central government issues grants to the municipalities depending on what public services the local governments are required to supply.[1]

Returning to the underlying driver of equalisation policies: economic activity is typically concentrated in centres. Thus, the premise of equalisation is the observation of economic space being uneven. The focus of economic geography has been to understand concentration patterns of production across space. Much activity is placed at obvious locations, such as mining and oil production where the resources are extracted. Natural geography also determines locations for

[1] See Boadway (2003) for a survey on where transfers are used and the issues of equalisation, including considerations of efficiency and fiscal equity for agents.

harbours or transportation hubs, agricultural land or fishing banks. But economic activity concentrates much more than the natural geography warrants, and the study of economic geography relates to what else drives this concentration. So, whether concentration happens for obvious reasons through natural geography or there are other intrinsic drivers for the phenomena, space should be taken into account when analysing the effects of policy based on exactly the premise of equalising income.

The current paper addresses this issue as both space *and* regional transfers are integral parts. The theoretical framework is the *Economic Geography* (EG) literature, especially the work by Krugman (1991) and Fujita et al. (1999). It is a contribution to the research agenda requested in Fujita and Krugman (2003) (p. 158), namely constructing applied agglomeration models to better understand the agglomeration patterns across the world. Ottaviano (2002) (p. 15) also motivates this research agenda in addressing the need for using economic geography for policy analysis, and in the end be able to draw applied policy from what agglomeration models show, and on that note work with the models even if they have built in agglomeration forces. As they put it: "*...for policy analysis to proceed, the first step is precisely to take the models literally.*" There is a comprehensive coverage of various policy aspects in agglomeration models in Baldwin, Forslid, Martin, Ottaviano and Robert-Nicoud (2003), and they are also proponents of entering into the arena of policy analysis. Here I present a new extension to the economic geography models that accounts for regional transfer of tax revenue. Furthermore, I analyse what this does to our understanding of patterns of economic concentration when, for example, equalisation policies are implemented. Policies that, in a sense, try to counter the effects agglomeration of economic activity entails.

The analysis shows that equalisation schemes will alter concentration patterns of economic activity. In particular, regional equalisation policies *reduce* agglomeration forces in the economy. Concentrated regions become more vulnerable to losing the concentration altogether. In economic geography models it is the freeness of trade, manifested by transport costs, that is the decisive factor in determining the sustainability of an agglomeration. If freeness of trade is below a certain level, or equivalently if transport costs are above a certain level, the dispersing forces dominate, economic activity will move away from centres, and agglomeration breaks down. And with equalisation policies imposed, the point where agglomeration breaks down is moved to a higher level of freeness of trade. In other words, policy makers risk the viability of economic centres when imposing equalisation schemes, even though their goal is just to tax the economic centre – not dismantle it. The risk stems from the alteration of the economic forces, thus destabilising the prevalent equilibrium. The benefit of concentrated economic activity simply disappears. However, it is shown that it is possible to design the taxes and equalisation scheme so that the risk of a collapse of economic centres is removed.

I will refrain from recommending any optimal policy in the paper. Such a recommendation would require an assumption of an optimality criterion, e.g. a social welfare function that a government can maximise using the tax and transfer instruments. The purpose of this paper, then, is to analyse only the positive (and not normative) effects of different government initiatives.

The results reported here support the basic hypothesis that it is vital to take changes in agglomeration forces into account when designing regional transfers. For regional equalisation schemes, the results imply that a concentration of economic activity can be taxed and some of the revenue be transferred to a periphery, but only to a certain extent. And possibly, equalisation policy needs to be combined with other initiatives that increase freeness of trade as to avoid centres from breaking down.

In section 2.2, the paper continues by giving a brief overview of related literature. The following section 2.3 gives an outline of the basic model. In section 2.4, I describe the extension in the form of transfers and define several scenarios for analysis. This is followed by section 2.5, where I present the results of the simulations. Finally, section 2.6 offers conclusions and implications of the reported results.

2.2 Related Literature

There have been several investigations related to regional government actors in a spatial framework of economic geography. These have been mainly focused on tax competition and regional investments. Several authorities, each setting taxes, give rise to problems of tax competition to attract economic activity. Also as the regional expenditure can influence the agglomeration patterns of the economy, investment decisions of regional governments come into play.

Andersson and Forslid (2003) observe that agglomeration gives rise to rents and they show that a redistributive tax between mobile and immobile workers can be imposed, and such a tax reduces the incentive for tax competition. Baldwin and Krugman (2004) analyse a tax setting game of two regions where one region is already in an agglomerated state, and find that the concentrated region can set taxes higher than the other region without losing the concentration altogether. However, this positive tax gap is only present for a specific range of transport costs and is hump-shaped within that range. This 'hump' represents an *agglomeration rent* that can be taxed without the agglomeration breaking down. However, as the results in section 2.5 show, the tax instrument is a much stronger instrument than these papers suggest. Taxing the agglomeration rent actually reduces the *range* of transport costs where there is a hump to tax. Higher taxes not only drain the scale effects of agglomeration, but also weaken the forces of agglomeration.

Ludema and Wooton (2000) also analyse redistributive taxes and they find that agglomeration reduces tax competition between regions, so that the stronger the agglomeration forces are, the higher is the level of equilibrium taxes. Gaigné and Riou (2007) introduces fiscal equalisation schemes between regional governments. They show that when the regional tax revenue is equalised, tax competition is significantly reduced, thus promoting a rise in overall tax revenue. Gaigné and Riou (2004) find that revenue sharing between different levels of government may lead to efficient tax setting without coordination, but only for high levels of transport costs. For lower levels of transport costs the revenue sharing leads to a race to the bottom of the local taxes. The evidence on redistributive taxes thus seems inconclusive.

Welfare effects of public policy are studied in Charlot and Gaigné (2001). They show that policy toward the periphery region could be both equalising but also efficient in welfare terms, but *only* when transport costs are in the Core-Periphery range. If transport costs are outside that range, the authors cannot show justification of public policy using any welfare criterion. Contrary to the findings in the present paper, regional transfers do not improve overall welfare in the case of a dispersed economy, unless an agglomeration can be induced by the transfer, i.e. if the transfers are strong enough to strengthen the agglomeration forces such that a symmetric equilibrium becomes unstable – and an agglomeration ensures.

Charlot, Caigné, Robert-Nicoud and Thisse (2004) compare the two outcomes of the Core-Periphery model using the Pareto, utilitarian and Rawlsian welfare criteria. That is, if the Core-Periphery outcome is better or more efficient than the dispersed equilibrium. When there are compensation schemes they fail to determine which outcome is best, and the evaluation of the *best* outcome is too heavily dependent on social perceptions and values of equality. They do suggest, however, that there could be an *over*-concentration, i.e. governments should pursue a more even distribution of activity. In effect, they are proponents for equalisation schemes in the Core-Periphery outcome.

By considering regional transfers in an economic geography setting, the present paper extends the research papers related above. As the foundation, I use the standard *Core-Periphery* model from Krugman (1991). This choice is founded on the fact that the model describes the theoretical constructs in the most general form, whereas other versions of geography models add more complex structures, e.g. mixed factor inputs or international capital flows as in Forslid and Ottaviano (2003) and Martin and Rogers (1995), respectively. In fact, most of the papers mentioned above use the models of these two papers. In the standard version, used here, the underlying assumptions are less restrictive, but at the cost of not having closed form solutions, thus only being solvable using numerical methods. But since computational power is readily available this is not a problem, and the Krugman (1991) model is preferred. The next section describes the setup of the Core-Periphery model in more detail.

2.3 Benchmark Model

The analysis is that of Krugman (1991), i.e. a closed economy with two regions. There are two production sectors, one that produces a homogeneous good and one that produces heterogeneous, differentiated goods. There are two factors of production; skilled and unskilled labour. The consumers have identical homothetic preferences, and have a two-tier utility function where the top tier is a Cobb-Douglas function over the homogeneous and heterogeneous goods, and the bottom tier is a CES composite over all the varieties of the heterogeneous goods. In the following subsections only a single location is considered in order to keep the algebra manageable.

2.3.1 Consumers

The consumers' utility function is:

$$U = A^{1-\mu} M^{\mu}, \qquad M = \left(\sum_{i=1}^{n} m_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 1, \tag{2.1}$$

where A is the homogeneous good and M is the heterogeneous composite of the n varieties. A single variety is denoted as m_i. The cost share of the heterogeneous composite is μ, while σ is the elasticity of substitution between varieties. The consumers' problem is solved in the usual two step approach, first minimising expenditure of the composite and then maximising the utility of the top-tier function. This reveals the following uncompensated demand for a single variety:

$$m_i = \mu E p_i^{-\sigma} P^{\sigma-1}, \qquad P = \left(\sum_{i=1}^{n} p_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \tag{2.2}$$

where E is the total expenditure, p_i is the price of the variety and P is the CES price index of the composite. Assuming that the number of varieties is large, the price index is perceived by the agents to be unaffected by changes in the price of a single variety. Thus, the elasticity of demand is perceived to be σ. If the prices for each variety are the same, p_m, the CES price index reduces to

$$P = \left(\sum_{i=1}^{n} p_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}} = p_m n^{\frac{1}{1-\sigma}}. \tag{2.3}$$

It can be easily seen that if $\sigma > 1$, the index falls as the number of varieties increases. The size of this effect depends on the perceived elasticity of substitution between varieties. Turning to the homogeneous good, the uncompensated demand is derived from the usual cost share of the Cobb-Douglas function:

$$A = (1-\mu)E\frac{1}{p_a}, \tag{2.4}$$

where A is the demand and p_a is the price.

2.3.2 Producers

The sector that supplies the homogeneous good, produces under constant returns to scale using only unskilled labour as input. The other sector exhibits increasing returns to scale in producing varieties using only skilled labour. Firms maximise profits, and for the homogeneous sector, this means output price is equal to the unskilled wage level. With respect to the heterogeneous sector, the first order condition depends on the specific formalisation of the increasing returns technology. This is represented in the cost functions of firms. For firm i the cost function is defined as

$$c_i = (\alpha + \beta q_i) w_s, \tag{2.5}$$

where c_i is the total cost of producing q_i of variety i, and w_s is the skilled wage. α and β are the fixed and variable cost coefficients respectively. The firm acts as a monopoly in the market for the specific variety, so profit maximisation reveals the monopoly pricing rule

$$\begin{aligned} p_i\left(1 - \frac{1}{\sigma}\right) &= \beta w_s \qquad \Longleftrightarrow \\ p_i &= \beta w_s \frac{1}{\rho}, \end{aligned} \tag{2.6}$$

where σ is the perceived elasticity of demand and p_i is the output price of variety i. Furthermore, it is assumed that there are no barriers to entry. As long as there are opportunities for profits, new firms will establish themselves and produce new varieties. The free entry condition entails zero profits and this determines the output of each firm. The number of firms is derived from the input requirement in (2.5) and the available skilled labour force. The output q^* of an active firm in the sector is given by:

$$q^* = \frac{\alpha}{\beta}(\sigma - 1). \tag{2.7}$$

By symmetry of the cost functions and demand for varieties, all firms set the same price and level of output. The total number of firms is then the total skilled labour force divided by the input requirement of each firm. The input needed to produce is $l^* = \alpha + \beta q^*$ and inserting (2.7) gives $l^* = \alpha\sigma$. Dividing this into the available resources yields the following number of firms

$$n = \frac{L_s}{\alpha\sigma}, \tag{2.8}$$

where L_s is the endowment of skilled labour.

2.3.3 Many Locations, Transport Costs and Factor Mobility

Considering many locations, where a geography with physical distance is defined, it assumed that there are costs associated with transporting the heterogeneous goods between locations. Specifically, the costs are modelled as *iceberg* transport costs where a fraction of the good *melts* in transit from location c to d. The price in location d of a variety shipped from location c is $p_d = t_{c,d} p_c$. Then the price index from (2.3) becomes

$$P_d = \left(\sum_c n_c \left[p_c t_{c,d} \right]^{1-\sigma} \right)^{\frac{1}{1-\sigma}}. \tag{2.9}$$

Inserting the transport costs into the derivations of consumer demand for varieties, the uncompensated demand from (2.2) is rewritten. By symmetry, the demand is the same for each variety:

$$m_c = \mu E_d \left(p_c t_{c,d} \right)^{-\sigma} P_d^{\sigma-1}. \tag{2.10}$$

Notice that this does not change the perceived elasticity of demand. The price setting and output profile of the firms is, therefore, unchanged.

It is assumed that skilled labour is not tied to a specific location, skilled labour is 'footloose.' However, unskilled labour remains fixed to a location. The mobility of skilled workers is driven by the desire for the highest real wages, and they are willing to relocate to achieve this. However, the relocation of skilled labour is not assumed to be instantaneous – only a fraction of the labour force moves at a time, otherwise the model will become highly unstable. Denoting the share of skilled labour in location c as λ_c, the change in the share is given by:

$$\dot{\lambda}_c = \gamma (\omega_c - \bar{\omega}) \lambda_c, \qquad \bar{\omega} = \sum_c \omega_c \lambda_c, \tag{2.11}$$

where ω_c is the real wage in location c and $\bar{\omega}$ is the average real wage of the whole economy.

The equation is multiplied by the share to ensure that changes in all shares sum to zero. The speed of adjustment is given by the coefficient γ. If the real wage in a location is lower than the average, a fraction of the skilled workers will emigrate and – vice versa – if the real wage in a location is higher, then skilled workers will immigrate to that location. As the heterogeneous sector depends on the skilled labour force for producing, the location of the labour also determines where the firms will locate. Each firm uses the same amount of skilled labour and has the same level of output, so the share of the heterogeneous industry in a location is equal to the share of skilled labour, i.e. the concentration of skilled workers and the agglomeration of industry are equivalent results, and I will use the terms interchangeably in the rest of the paper.

The model contains three main forces that either concentrate or disperse activity. Following the naming in Krugman (1991), these are:

The first is the *backward* linkage effect, and it concentrates activity. Firms want to locate close to the consumers of their products, i.e. the biggest market. This increases the demand for the skilled factor and increases the real wage in that region. This induces more migration into the region and makes the market bigger.

Second is the *forward* linkage effect, and it also concentrates activity. skilled workers want to locate close to where their consumer goods are produced in order not to pay the transport cost mark-up. This increases the amount of skilled labour in a particular location and the number of firms increases. More varieties will be produced and the price index in the region falls, increasing the real wage. This again induces more migration.

Third, immobile unskilled workers' demand is spread evenly across regions and works as a dispersion force. At the same time the regional competition for consumers coupled with high real wages will drive companies away to the less concentrated region.

The final equilibrium of the model depends on the balance of these factors. If the concentrating forces dominate, the economy ends up in a Core-Periphery state, while a symmetric outcome will emerge if the dispersing forces dominate.

2.3.4 Implementation

The complexity of the algebra in the Core-Periphery model makes it impossible to solve analytically, therefore numerical methods have been applied to identify the model's properties. As mentioned in the introduction, other versions of EG models have been shown to be solvable, e.g. Forslid and Ottaviano (2003) and Martin and Rogers (1995), albeit only by adding further assumptions and restrictions to the framework. The availability of simulation software makes it possible to solve the original model quite easily, while giving the researcher room for adding extensions. This is the approach I have chosen in this paper and in general in this dissertation.

Numerical simulations require specific assumptions regarding the model's parameters, i.e. consumer preferences, production technology, level of transport costs, and factor endowments. The analysis presented in this paper uses the following values for the parameters. In the utility function the cost share of the heterogeneous good is $\mu = 0.4$ and the elasticity of substitution between varieties is $\sigma = 5$. The cost share is chosen for homogeneous goods at 60% to comply with the *no-black-hole* condition as mentioned in Fujita et al. (1999) p. 58, to avoid the scale and variety effects spinning out of control. The elasticity of substitution is chosen as a conservative level, which also is in line with Fujita et al. (1999). However in a Danish context, the chosen cost share of homogeneous goods in the present model here is not high, as the Danish share is approximately 80%, cf. chapter 4.

For the production technology, the parameters are normalised using σ such to simplify the expressions in (2.7) and (2.8), i.e. $\alpha = \frac{1}{\sigma}, \beta = \frac{\sigma-1}{\sigma}$. Finally, for the economy as a whole, there are two locations and there is more unskilled labour relative to skilled.

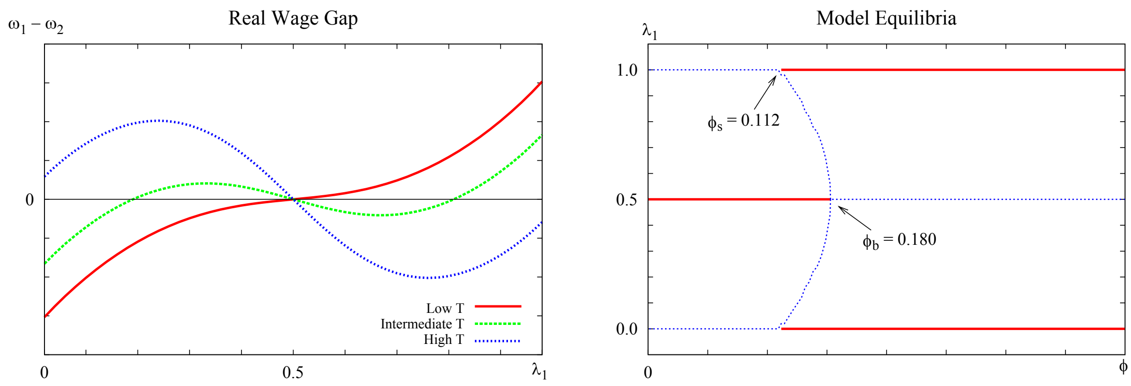
The model is solved for different levels of transport costs and distributions of the skilled labour. The resulting real wages in the two locations are calculated to determine any immigration pressure. For simplicity only three runs are shown in figure 2.2(a). The diagram is an implicit representation of the phase diagram belonging to (2.11) and displays the three major types of dynamic relationships the model exhibits.

Equilibria are identified where the schedules cross the horizontal axis and where they cross the diagram's boundaries. On the edges, the economy is completely agglomerated in one location. Above the horizontal axis the migration is toward location 1, λ_1 is increasing, moving to the right in the diagram. Equivalently, when the wage gap is below the axis, the migration is towards location 2, moving to the left. For low levels of transport costs, the economy has an unstable symmetric equilibrium and two stable agglomerated equilibria. In the case of intermediate transport costs there are three stable equilibria, the symmetric and the two agglomerated. In addition, there are two unstable with various distribution of labour. Finally, for high transport costs, there is one stable and two unstable equilibria, the stable is the symmetric while the unstable are agglomerated.

These patterns of equilibria are condensed into the next diagram, figure 2.2(b). Here the horizontal axis represents the *Freeness of Trade*, $\phi = t^{1-\sigma}$. At the leftmost point, $\phi = 0$, there are prohibitive transport costs ($t \to \infty$) while there is free trade at $\phi = 1$ ($t = 1$). The fully drawn lines show the stable equilibria while the dashed lines represent the unstable ones. This is the *Tomahawk Bifurcation* known from the literature and it gives a complete description of all equilibria present in the model, as shown by Robert-Nicoud (2005).

It can be seen that the model exhibits strong path dependency. If the economy is at a low level of

Figure 2.1: Dynamics of the General *Core-Periphery* Model



(a) The Wiggle Diagram (b) The Tomahawk

trade freeness, industry will be dispersed evenly in the two regions, the symmetric equilibrium. If a group of workers is relocated, they will experience a drop in the real wage and move back to regain the higher wage and the symmetric equilibrium is re-established. Raising the freeness of trade will not change the symmetric distribution of labour unless the initial relocation is of a significant size, i.e. enough to pass the unstable equilibrium. However, when the freeness of trade reaches a certain point, the symmetric equilibrium becomes unstable. This is denoted as the break point, ϕ_b. From this point onwards, the economy will always agglomerate toward the region where the first group of workers moved.

Starting from the other end with completely free trade, the industry will be concentrated in one region. Lowering the freeness, e.g. erecting trade barriers, the agglomerated equilibrium is stable until the freeness is reduced to the sustain point, ϕ_s. Here the dispersion forces dominate, i.e. the competition effect is the strongest, and the real wage of the skilled labour is the highest where it is most scarce. Migration will continue until the labour is evenly distributed and the symmetric outcome is again the stable equilibrium. Importantly, the break and sustain points overlap, such that either the agglomeration or dispersion of industry show a significant path dependency. If the trade freeness is in the intermediate zone, the exact distribution of industry crucially depends upon the previous state of the economy, i.e. *history matters* (Krugman, 1991).

So far, this is a replication of the literature on the Core-Periphery model. The rigidity of the labour force in the range of intermediate freeness of trade represents an agglomeration rent. A rent which can be extracted without causing the agglomeration to break down, but this extraction will influence the agglomeration forces at play. The next section extends the model with taxes and interregional transfers, as these will function as means of extracting the rent.

2.4 Extensions: Taxes and Transfers

The envisioned economy analysed in this paper, is an area with distinct regions, governed by a central authority. This could either be municipalities subject to a national government, or on a higher level, the member states in a union with some kind of supranational authority. The central authority levies and collects taxes on factor income, and all tax revenue is pooled into the treasury. Then the government re-distributes the revenue to the consumers in the regions. Depending on the profile of re-distribution, this will in effect be an interregional transfer system or even a full fiscal equalisation scheme. By keeping the transfer system in this simple form, the analysis actually encompasses a wide range of observed transfer regimes. From the case of the Canadian central authority that collects taxes and distributes to regions, to the case of Danish municipalities that collect local taxes and pay a fraction of their revenue to the central authority who then re-distributes the money.

As taxes are set and collected by a single government agent, there is no need for specifying a tax setting game as in Baldwin and Krugman (2004) and Gaigné and Riou (2007). In those papers, the regional governments play a game of maximising their local tax revenue subject to the tax setting of their opponent in a non-cooperative game. However in this paper, the central authority sets a national income tax rate, collects the taxes and then distributes the revenue to the regions according to a predefined rule. In fact, in the exact specification here there are no local authorities at all. The whole game theoretic aspect is left out of the analysis, because only the effects of policy initiatives are observed and that there are no policy recommendations. The consideration is purely on the effects from exogenous decisions by the government agent.

The taxes in question are levied directly on factor income of all agents in the economy using the same tax rate. The redistribution of tax revenue to consumers is treated as a lump sum transfer to the agents' income. Giving the consumers a direct income transfer instead of supplying a public good eliminates the specification of a public production sector, and especially its technology. The aspect of public goods is considered in chapter 3, where the model is extended further.

2.4.1 A Central Government

The central government levies taxes on factor income in both regions with the tax rate τ. The tax revenue, G, is

$$G = \sum_d \tau \left(wL_d^u + w_d^s L_d^s \right), \qquad 0 \leq \tau < 1, \tag{2.12}$$

where the first element in parenthesis is the region's total unskilled wage bill and the second element is the region's total wage bill for the skilled labour. All tax revenue is transferred back to consumers using a distribution coefficient: region d's consumers receive a fraction ξ_d of the total revenue. The consumer income less taxes and including transfers is the region's total expenditure

$$E_d = (1 - \tau) \left(wL_d^u + w_d^s L_d^s \right) + \xi_d G, \qquad \forall \xi_d \geq 0, \quad \sum_d \xi_d = 1. \tag{2.13}$$

Four types of transfer schemes are analysed to give an overview of the full spectrum of possible regimes. These four transfer regimes range from subsidising the concentrating region, denoted

All to the Core rule, to compensating the periphery region, denoted as the *All to the Periphery* rule. The first two represent end-points of possible transfer rules. The two other rules analysed can be considered as convex combinations of the end-point transfer rules. The spectrum of possible transfer rules is then covered by analysing these four rules, and the results will reveal a range of possible effects. Again, as there are no specific policy recommendations in the paper, the results will serve the purpose of understanding the workings of the economy subject to various policy initiatives, i.e. mixes of transfers and taxes. In the following sections I will go into more detail on each of the four transfer rules, starting with transfers towards the concentrated region, and ending with the full compensation to the periphery region.

All to the Core

First, when transfers are subsidising the concentrated region, the transfer of tax revenue follows the skilled work force migration pattern. Thus, when a concentration develops in a region, it is reinforced by transfers from the other regions. The transfers in this regime are not intended to compensate or offer any kind of equalisation to a region where firms leave. On the contrary, they are designed for boosting any tendency of agglomeration. If the economy is on the verge of agglomerating in one region, but cannot quite achieve the sustained concentration, the central government can induce and solidify such a concentration through a transfer subsidy. The rule is considered an end-point since there is no a priori selection of the concentrated region. The more simple rule of just transferring all tax revenue to one region, regardless of the migration pattern, requires a further assumption of which region the transfers initially should go to. The present rule of following migration eliminates the need for this. Formally,

$$\xi_d = \lambda_d, \qquad d = 1, 2. \tag{2.14}$$

In addition, this rule is neutralised in the case of the symmetric equilibrium, because in that case skilled labour is divided evenly between the two regions and so is the transfer.

No Transfers

Taxes are collected as if the local governments are completely autonomous. This is to get a benchmark as if there is no government at all. However, the regime is implemented as a rule in the model with a central government for easier comparison to the other cases with one tax collector and re-distributor. To allow for this, the amount to be transferred needs to be equal to the tax revenue from each region. The local government receives all tax revenue without any interregional transfer system. With migration, the tax revenue (and transfer) will follow the movement of the skilled labour. Formally the rule is:

$$\xi_d = \frac{\tau\left(wL_d^u + w_d^s L_d^s\right)}{G}, \qquad d = 1,2. \tag{2.15}$$

Inserted to (2.13) reduces to the standard model without a government sector. As the tax is imposed and given to the consumers as a lump sum transfer, it is as if there is no tax collection at all.

Equal Shares

This rule is the no-frills fiscal equalisation scheme in its simplest form. There is no consideration as to the size, endowments or tax base in the regions. The total tax revenue is simply divided into two equal chunks, and given to the regions' consumers. In effect, the rule will function as a moderate transfer from a concentrated region to a periphery region, since the tax revenue in the concentrated region is higher. Formally,

$$\xi_d = \frac{1}{2}, \qquad d = 1,2. \tag{2.16}$$

Thus, the rule takes no account of any migration pattern or location of production. In the case of a symmetric equilibrium, the rule reverts to the no transfers between regions.

All to the Periphery

Finally, I consider the case of full transfer to the poorest region. The rule is the reverse of the first rule as the transfers follow the opposite direction of migration. Technically, the tax revenue is distributed according to the "inverse" share of labour in each region. The fractions are:

$$\xi_d = 1 - \lambda_d, \qquad d = 1, 2 \tag{2.17}$$

Using this rule, a region that loses skilled workers from migration is compensated by receiving more of the tax revenue continuing up to receiving all tax revenue. The Core will contribute all to the Periphery – this is the full compensation to the Periphery of the agglomeration of activity in the other region. For the symmetric outcome, there are no transfers since each region receives what is collected in taxes.

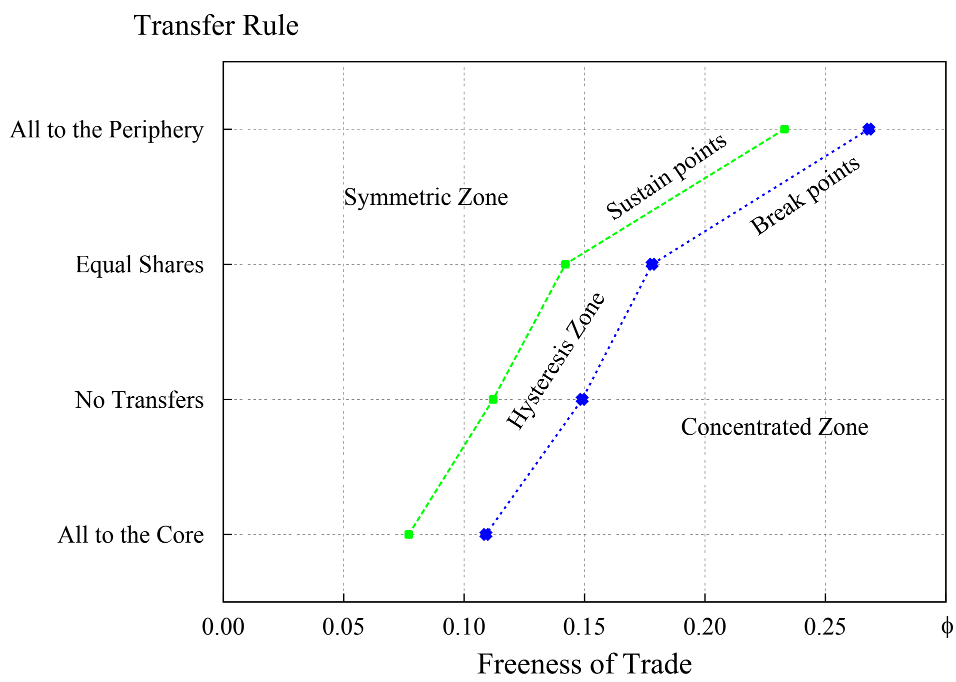
These four rules for the regional transfers represent the full range of possible transfers, from the *all to the core* rule, that is an agglomeration subsidy, to the *all to the periphery* rule, that is a full compensation to the periphery. Thus, by analysing these rules a complete representation of the changes in concentration patterns in the model is mapped and identified. In the next section, the results of simulations using these transfer rules are presented.

2.5 Simulation Results

For each of the interregional transfer rules, the model is solved numerically, and the wage differentials are found such that the migration forces, and ultimately the concentration patterns, can be deduced. The tax rate on factor income is set to 20%; about the average municipal tax rate in Denmark.

The analysis focuses especially on the impacts of transfer regimes on the break and sustain

Figure 2.2: Using Different Transfer Rules



points, which are crucial for the agglomeration properties of the model. This will highlight the issue of whether transfers of tax revenue are possibly forcing an agglomeration to break down.

The result of the simulations are compiled in figure 2.2, where the horizontal axis is the freeness of trade as in the tomahawk bifurcation. The vertical axis depicts the transfer rule ordered after the direction and level of transfers to the periphery region. Trade freeness increases when moving to the right in the diagram, while the amount transferred to the poor region increases when moving upwards. The *no transfer* rule is situated between the *all to the core* and *equal shares* and represents the zero transfer or baseline case.

The break and sustain points move considerably depending on the specific transfer rule in place.[2] As in the tomahawk diagram in figure 2.2(b), the economy has a symmetric equilib-

[2]The connecting lines are just drawn to emphasise the pattern as the vertical axis is not continuous and the

Table 2.1: Using Different Transfer Rules

	Trade Freeness, ϕ		Transport Costs, t	
	Sustain	Break	Sustain	Break
All to the Periphery	0.233	0.268	1.45	1.39
Equal Shares	0.142	0.178	1.63	1.54
No Transfers	0.112	0.149	1.73	1.60
All to the Core	0.077	0.109	1.90	1.74

rium left of the sustain points and an agglomerated equilibrium to the right of the break points. Between the two points either type of equilibrium is possible. I will denote the area left of the sustain points as the *symmetric* zone and the area right of the break points as the *concentrated* zone. The area in the middle will be called the *hysteresis* zone, where both symmetric and agglomerated outcomes are stable and the realised equilibrium depends on the previous state of the economy.

It can be seen that the break and sustain points move right as the transfers to the poor region is increased. Conversely, the points move to the left when the direction of transfers is reversed. Thereby, the divisions of the zones are slanted from the upper right corner down towards the lower left. In addition, the width of the *hysteresis* zone is the same for every rule, i.e. the width measured in freeness of trade which is an inverse exponential function of the transport costs. For reference, the numerical values of the break and sustain points in both trade freeness and transport costs are shown in table 2.1.

By introducing interregional transfers into the standard Core-Periphery model, the basic properties change while the path-dependency remains. It is clear that the economy's state can change dramatically by re-distributing wealth between regions, since the movement of break and sustain points can place the economy in a completely different zone of equilibria.

distance between the rules has not been scaled.

Regardless of whether the policy is to subsidise the concentrated region or to compensate the de-industrialised region, possible dramatic changes need to be taken into account when designing policies that alter the concentration and dispersion forces of the economy.

As mentioned in the introduction, Baldwin and Krugman (2004) show that the core region can set taxes to just extract an agglomeration rent, without the periphery *stealing* the agglomerating industry. In that paper they analyse different tax rates in the two regions, which can be achieved in the present paper by designing an appropriate transfer rule. In contrast, in this model the core's strategy is to have a transfer rule that does *not* move the economy into the *symmetric* zone. However, an important implication of the results from figure 2.2 is that such a tax will distort the agglomeration forces in the economy; in effect, it is possible that an extraction of the agglomeration rent will move the economy up in the diagram passing the sustain points line into the symmetric zone – thus the concentration collapses. In the framework of Baldwin and Krugman (2004) the strategy of the core economy has to be amended to not move the economy into the symmetric zone, thereby decreasing how much of the rent that can be extracted.

2.5.1 Policy

In figure 2.2 the two axes represent the two policy instruments available for the government. First, on the horizontal axis there is the trade freeness. In the usual interpretation in the international trade literature this represents transport costs, tariff and non-tariff barriers to trade. Here the regions in the economy are not considered to be subject to tariffs since they are part of the same country, so the trade freeness is a consequence of the costs associated with the costs of hauling goods between regions. These costs can either stem directly from the geographic distance impacting on fuel costs and transport time, or stem from a more complex array of factors. I will jointly denote these obstacles as the lack of integration between regions. Examples of the latter could be differences in the practice of the regional governments when giving authorisations for transporting dangerous goods, or if specific requirements are imposed on the transportation of goods, such as maximum lorry loads. The policy instruments that improve regional integration, e.g. investments in infrastructure, streamlining transportation rules, or reducing the authorisation bureaucracy, will move the economy along the horizontal axis in the figure, and show the government's possibilities to induce an agglomeration or move into symmetry by increasing or decreasing the regional integration, respectively. If the considered regions are in a union of nation states the aspect of tariff and non-tariff barriers are, of course, an issue with respect to the trade freeness in addition to regional integration.

Second, on the vertical axis is the degree of regional transfers. The position on the vertical axis is directly proportional to the level of transfers to the poorer region, thus it is a depiction of the actual policy instrument in use. By altering the transfer rule, the government can move the economy upwards and downwards in the diagram, and for specific intervals of trade freeness also use this instrument to either induce agglomeration or force a symmetric outcome. That is, the fact that there is a positive slope of the sustain line shows that large transfers from the core to the periphery can undermine the agglomeration if the sustain line is crossed.

Depending on the political agenda of the government, i.e. whether it is to induce agglomeration and compensate the periphery or to equalise regions by moving towards the symmetric zone, the government can choose an appropriate policy mix of regional transfers and regional integration to achieve the desired goal. Especially if the economy is in the *hysteresis* zone, there are a lot of possibilities for the government to influence the final outcome. The designed policy mix of the two instruments will enable the central government to move in all directions in the diagram. An example could be if the economy is in an agglomerated outcome in the *hysteresis* zone; the central government could compensate the periphery using transfers thus moving up in the diagram, but to avoid passing the sustain point, the transfer policy can be combined with enhanced regional integration to move right in the diagram and away from the sustain points line, thereby maintaining the Core-Periphery pattern. Equivalently, if the economy is in a dispersed state the introduction of transfers as a subsidy can induce a concentration of industry in one region (moving downwards in the diagram). Then, by utilising the inertia of the agglomerating forces the government can reverse the transfer policies and extract the agglomeration rents from the core to the periphery by designing the policy mix as not to cross the sustain boundary.

Thus, the introduction of regional transfers opens up a range of opportunities for a central government to influence the industrial concentration in the economy.

2.6 Conclusion

This paper extends the standard (canonical) model of Economic Geography with inter-regional transfers of tax revenues. Taxes are levied on factor income and pooled into the central government, who in turn re-distributes the revenue to the agents in the regions. The paper focuses on the impacts on the concentration patterns when using different rules of transfers.

The extension introduces an extra instrument for the central government to influence the concentration pattern in the economy. The unique part of this is the ability to construct a policy mix to fulfil the ambitions of the government. This is important because many governments strive to make their citizens equally well-off, whether it is to supply the same amount of public goods to all regions or to equalise the consumers' welfare. The paper shows that the equalisation schemes will alter the concentration patterns in the model; in particular the equalisation schemes reduce the range of Core-Periphery outcomes as this outcome requires still greater integration (freeness of trade) to be sustained. Thus, a core can be taxed and some of the revenue can be transferred to a periphery, but only to a certain extent, namely where the transfer moves the economy up to the sustain line. The transfers must be restricted as not to cross the line and initiate an effect that *bleeds* the core region dry.

However, if the ambition of the government is to maintain the Core-Periphery outcome, it can be achieved by combining the policy of transfers with policies that increase the integration between regions and thereby increase the trade freeness. More integration will *fortify* the agglomeration, and the transfer scheme policies can thus be utilised because the economy is far into the concentrated zone. This way, the core region functions as an industrial locomotive for the benefit of the whole economy as the periphery also experiences a gain in in income from agglomeration through the transfers.

With another perspective, starting from a symmetric pattern, the government can combine policies to induce an agglomeration of activity in a specific region. If increased integration is not enough to pass the break point, a policy of agglomeration subsidies – as in the *All to the Core* rule – moves the economy further, and possibly into the desired concentration outcome. In turn, when the concentration is established, the inertia of the hysteresis zone can be utilised through a reversal of the transfer rule to subsidise the poor region. As long as the economy remains in the *hysteresis* zone, the concentration is sustained – as such, the periphery region will have negative net transfers to start off. But, the periphery region will benefit from positive net transfers after the policy reversal. The problem, then, is to identify which region this type of policy should focus on first.

The extension of the spatial models of economic geography with interregional transfers, whether being equalisation grants or agglomeration grants, sheds some important light on the behavioural characteristics of the concentration patterns. The economic geography models' property of a sudden shift in economic concentration is not only given by the level of integration, but is highly influenced by governmental redistributive policies between regions.

It is not without consequences to take money from the economic centre in an economy and give it to peripheral regions. As this may not be surprising in itself, the results shown here are significant in the finding that the concentration pattern through break and sustain points *both* shift, and the overlap between them, given by the hysteresis zone, remains approximately constant measured in level of integration.

2.7 References

Andersson, Fredrik and Rikard Forslid (2003), 'Tax competition and economic geography', *Journal of Public Economic Theory* **5**(2), 279–303.

Baldwin, Richard and Paul Krugman (2004), 'Agglomeration, integration and tax harmonization', *European Economic Review* **48**(1), 1–23.

Baldwin, Richard, Rikard Forslid, Philippe Martin, Gianmarco Ottaviano and Frédéric Robert-Nicoud (2003), *Economic Geography and Public Policy*, Princeton University Press, Princeton, New Jersey.

Behrens, Kristian, Carl Gaigné, Gianmarco I. P. Ottaviano and Jacques-François Thisse (2005), Countries, regions and trade: on the welfare impacts of economic integration, Discussion Papers in Economics 05-01, Department of Economics, University of Strathclyde, Glasgow, Scotland, UK.

Boadway, Robin (2003), The theory and practice of equalization. mimeo.

Bureau van Dijk (2006), 'Amadeus database'.

Charlot, Sylvie, Carl Caigné, Frédéric Robert-Nicoud and Jacques-François Thisse (2004), Agglomeration and welfare: The Core-Periphery model in the light of Bentham, Kaldor and Rawls, CEPR Discussion Papers 4715, Centre for Economic Policy Research.

Charlot, Sylvie and Carl Gaigné (2001), Regional integration, inequalities and public policy, Working Paper 3, INRA-ENESAD.

Combes, P. and G. Duranton (2001), Labour pooling, labour poaching and spatial clustering, CEPR Discussion Papers 2975, Centre for Economic Policy Research.

Copenhagen Economics (2006), Den danske klyngedatabase. Unpublished.

Dahl, M. S. (2002), Embedded knowledge flows through labor mobility in regional clusters in denmark, Technical report, Eindhoven Centre for Innovation Studies (ECIS). Paper presented at the DRUID Summer Conference on "Industrial Dynamics of the New and Old Economy - who is embracing whom?".

Dixit, Avinash and Joseph E. Stiglitz (1977), 'Monopolistic Competition and Optimum Product Diversity', *American Economic Review* **67**(3), 297–308.

DREAM-group (2008), Danish Rational Economic Agents Model, Technical report, DREAM, Copenhagen, Denmark. http://www.dreammodel.dk.

Economic Modelling, Statistics Denmark (2008), Annual Danish Aggregated Model, Technical report, Statistics Denmark, Copenhagen, Denmark.

Forslid, Rikard (2004), Regional policy, integration and the location of industry, Technical report, Stockholm University, Department of Economics.

Forslid, Rikard and Gianmarco I.P. Ottaviano (2003), 'An analytically solvable core-periphery model', *Journal of Economic Geography* **3**(3), 229–240.

Fujita, Masahisa and Paul Krugman (2003), 'The new economic geography: Past, present and the future', *Papers in Regional Science* **83**(1), 139 –164.

Fujita, Masahisa, Paul R. Krugman and Anthony J. Venables (1999), *The Spatial Economy: Cities, Regions, and International Trade*, The MIT Press, Cambridge, Massachusetts.

Gaigné, Carl and Stéphane Riou (2004), Regional integration and tax competition under upward revenue sharing, Working paper, Universite Jean Monnet Saint-Etienne.

Gaigné, Carl and Stéphane Riou (2007), 'Globalization, tax competition and fiscal equalization', *Journal of Public Economic Theory* **9**(5), 901–925.

Hertel, Thomas W. and Marinos E. Tsigas (1999), Structure of GTAP, *in* T. W.Hertel, ed., 'Global Trade Analysis: Modeling and Applications', Cambridge University Press, Cambridge, NY, chapter 2, pp. 13–74.

Indenrigs- og Sundhedsministeriet (2005), Finansieringsudvalgets rapport om et nyt tilskuds- og udligningssystem, Rapport, Indenrigs- og Sundhedsministeriet, København.

Krugman, Paul (1991), 'Increasing returns and economic geography', *Journal of Political Economy* **99**(3), 483–499.

Krugman, Paul R. (1980), 'Scale Economies, Product Diffrentiation, and the Pattern of Trade', *American Economic Review* **70**(5), 950–959.

Ludema, Rodney D. and Ian Wooton (2000), 'Economic geography and the fiscal effects of regional integration', *Journal of International Economics* **52**(2), 331–357.

Martin, P. and C.A. Rogers (1995), 'Industrial location and public infrastructure', *Journal of International Economics* **39**, 335–351.

Möhr, Malte, William H. Crown and Karen R. Polenske (1987), 'A linear programming approach to solving infeasible RAS problems', *Journal of Regional Science* **27**(4), 587–603.

Murata, Yasusada and Jacques-François Thisse (2005), 'A simple model of economic geography à la Helpman-Tabuchi', *Journal of Urban Economics* **58**(1), 137–155.

National Accounts, Statistics Denmark (2006), *Danish Input-Output Tables and Analyses 2004*, Statistics Denmark.

Ottaviano, Gianmarco I.P. (2002), Regional policy in the global economy: Insights from new economic geography, HWWA Discussion Paper 211, Hamburg Institute of International Economics, Hamburg, Germany.

Pedersen, Niels Jørgen Mau (1995), *Decentralisering og kommunaløkonomi*, Jurist- og Økonomforbundet.

Porter, Michael E. (2003), 'The economic performance of regions', *Regional Studies* **37**(6–7), 549–578.

Robert-Nicoud, Frédéric (2005), 'The structure of simple 'new economic geography' models (or, on identical twins)', *Journal of Economic Geography* **5**(2), 201–234.

Rutherford, Thomas F. and David G. Tarr (2008), 'Poverty effects of russia's wto accession: Modeling "real" households with endogenous productivity effects', *Journal of International Economics* **75**(1), 131–150.

Samuelson, P. A. (1952), 'The transfer problem and transport costs: The terms of trade when impediments are absent', *The Economic Journal* **62**(246), 278–304.

Spence, Michael A. (1976), 'Product Selection, Fixed Costs, and Monopolistic Competition', *Review of Economic Studies* **43**(2), 217–235.

Statistics Denmark (2007), 'Ida-database'.

The Economic Council (2003), Erhvervsstruktur og produktivitet, *in* 'Dansk Økonomi', Det Økonomiske Råd, chapter 5, pp. 193–218.

The Global Trade Analysis Project (2000), 'The global trade analysis project, center for global trade analysis'.

Tirole, Jean (1994), *The Theory of Industrial Organisation*, The MIT Press, Cambridge, Massachusetts, London, England.

Venables, Anthony J. (1996), 'Equilibrium Locations of Vertically Linked Industries', *International Economic Review* **37**(2), 341–360.

Chapter 3

Congestion, Fiscal Equalisation and Local Public Goods Provision

The paper extends the canonical two region Core-Periphery model of Krugman (1991) with congestion costs to capture negative effects of urbanisation. The congestion costs act as an extra dispersion force in the model, and this reduces the range of freeness of trade for which the economy exhibits agglomeration. In addition, a new symmetric stable equilibrium replaces the Core-Periphery state for high levels of integration. Then the model is extended by considering local governments supplying public goods. The production of public goods binds local factors and raises factor costs in the regions, thus enhancing the dispersing force even more. At the same time, however, supply of local public goods and services will attract mobile labour, concentrating economic activity. These extra effects change dramatically the properties of the standard Core-Periphery model. In particular, the range of freeness of trade for which the economy exhibits agglomeration is reduced.

3.1 Introduction

Locally produced public goods and services are by their very nature not traded across regions or nations, but are bound to the location of the public sector. When local governments supply goods and services, the supply is directed at the local population. Services offered by municipal child care centres are for the benefit of local families. When municipal sewage treatment plants take care of waste water, the service's geographic coverage is the municipality itself. And when public schools teach, it is the local children who are educated. These are typical examples of public services that are offered by a local or regional government, and they are services that are offered only to the citizens of that specific location.

To finance this public production, local governments levy taxes on the recipients of the public services. But as some regions are more well-off than others, the differences in tax base give rise to different levels of public good provision. Local governments in richer urban areas receive a higher tax revenue and can, therefore, supply more than governments in poorer rural regions. From an egalitarian point of view, these differences in public provision represent undesirable differences in welfare, and policy makers have implemented various instruments to address this. The issue is also to make sure that the not so well-off regions have the *ability* to supply a minimum of public goods to their citizens, whether it is health care services or basic infrastructure. The desire to make citizens equally well-off is widespread across the world, and the most used instrument is to transfer income directly from the local governments in the *rich* to the governments in the *poor* regions.[1]

Equalisation through transfers of government revenue is in place almost regardless of the regional scale; countries have transfers on the level of local governments – the municipalities – and in some cases transfers exist between nations in economic unions. Denmark, Sweden and

[1] See Boadway (2003) for a survey on transfers used for equalisation, including considerations of efficiency and fiscal equity for agents.

Norway are examples of the former and The European Union of the latter. The exact design of these transfers schemes varies from central government grant programs to transfers that directly equalise tax revenue across regions. But in essence, all schemes serve the purpose of equalising welfare or income for agents across regions - to eliminate regional inequality. For instance, in Denmark the schemes combine transfers from the richer municipalities to the poorer municipalities with grants from the central government, grants that depend on what public services the local governments are required to supply.[2]

Richer regions are characterised by a concentration of economic activity that generates wealth for the region, where peripheral regions have less economic activity, and therefore do not generate as much wealth. In spite of the larger wealth creation, there are disadvantages of concentration in large urban centres. This is the issue of congestion costs. This is for example manifested through crowded infrastructure, inadequate housing and pollution. When workers need to live several hours drive from their workplace, it represents a cost of congestion. When pollution significantly shortens life expectancy, it is also a cost of congestion. The time spent commuting and the shorter lives both represent wasted resources. Wasted resources that should be taken into account when considering the effects of a concentration of economic activity.

The aspects of local public sectors, fiscal equalisation and congestion are all issues concerning spatial distribution of economic activity. And as these aspects are very much present in many western economies, it is of interest to analyse models that can take these issues into account. The point of departure in this paper is the agglomeration models used in the *Economic Geography* (EG) literature, where the theoretical framework is the work by Krugman (1991) and Fujita et al. (1999). The present paper presents a computational approach with extensions that account for the mentioned observations of local public goods, interregional transfers of tax revenue and costs of congestion. At the same time, this work is a contribution to the research agenda of

[2]In Denmark these instruments are termed *Kommunal udligning* and *Bloktilskud*.

constructing computable general equilibrium (CGE) versions of the EG models. As such, the paper is a step in the development of new tools for policy analysis using spatial models. Policy analysis that has been lacking the proper tools to take the equalisation and congestion issues into account. A comprehensive coverage of various policy aspects is presented in Baldwin et al. (2003). They are also proponents of entering into the arena of more direct policy analysis.

To understand the implications for public production, interregional transfers and congestion, this paper provides insights to the possibilities available for decision makers, but not least to shed light on possible pitfalls when designing policy. Policy that is to be effective in a economy characterised by geography, local governments, congestion and agglomeration. But in as much, the paper is also a contribution in understanding the effects of these characteristics in the spatial models before implementing computable versions calibrated to data – the task of the next chapter.

The research reveals that the costs of congestion creates an extra dispersion force in the model, which reduces the range of integration (freeness of trade) for which the economy exhibits agglomeration. In addition, a new symmetric stable equilibrium emerges and the Core-Periphery state disappears for high levels of integration, thus further reducing the range of agglomeration outcomes. The introduction of local public goods, financed partly by transfers from *rich* regions to *poor* regions, also create extra dispersion forces. These extra effects change dramatically the properties of the standard Core-Periphery model, at the same time giving the model more facets and characteristics in correspondence to the positive and negative effects of urbanisation we observe.

The paper treats the mentioned issues in reverse order. After a brief review of related literature in section 3.2, a recapitulation of the the workhorse *Core-Periphery* model is presented. This is followed by a section where the model is extended to take costs of congestion into account and the effects on the concentration pattern in the model is described. Then interregional transfers are introduced in section 3.5 and again how this affects the the model. The section is followed by section 3.6, where local public goods are introduced. Finally, the last section brings everything together, by summing up the implications for public policy if congestion costs, local public goods, and regional transfers all are present in an economy with agglomeration characteristics.

3.2 Related Literature

Murata and Thisse (2005) introduce congestion costs in a simplified version of an economic geography model. Workers are allowed to alleviate the disadvantages of urbanisation by dispersing to other regions, but the forces concentrating economic activity is left unchanged through transport costs and monopolistic competition. They show that high costs associated with concentrated economic activity leads to dispersion of economic activity, i.e. agglomeration becomes unsustainable even in a fully integrated economy. On the other hand, they show that low costs of congestion increase concentration of economic activity. The methodology of incorporating congestion costs used in Murata and Thisse (2005) is adapted in section 3.4 to the standard Core-Periphery model of Krugman (1991). When applying congestion costs in this manner, the similar result of dispersion under full integration emerges, and as shown later, the dispersion outcome remains for the non-integrated economy.

Concerning the aspect of public goods provision and regional investments, Forslid (2004) analyses two countries, where one country has two regions, and finds that improvements in *national* infrastructure speeds up concentration of manufacturing. Public goods, thus, enter and improve firms' efficiency. This effect comes from the lower inter*regional* transport costs as the inter*national* trade costs are held constant. In addition, he observes that regional subsidies only tend to be effective when the concentration forces are weak. This suggests that regional policies that increase regional integration strengthens concentration forces, but will lose their effectiveness when integration is at a high level. A similar setup of countries and regions is treated in Behrens, Gaigné, Ottaviano and Thisse (2005), where the authors show that a fall in interregional transport costs, e.g. by means of investments in national infrastructure, increases the possibility of agglomeration. An opposite effect is observed when international trade costs fall and interregional transport costs are constant. That is, lowering of tariff barriers will lead to regional dispersion. However, as the complexity of forces and interactions increase exponentially with the number of regions in such analyses, the present paper refrains from moving beyond the two region setup.

Turning to taxes and regional transfers, Andersson and Forslid (2003) observe that agglomeration gives rise to rents, and they show that a redistributive tax between mobile and immobile workers can be imposed, and such a tax reduces the incentive for tax competition between regional governments. Baldwin and Krugman (2004) analyse a tax setting game of two regions where one region is already in an agglomerated state, and find that the concentrated region can set taxes higher than the other region without losing the concentration altogether. However, this positive tax gap is only present for a specific range of transport costs. Gaigné and Riou (2007) introduces fiscal equalisation schemes between regional governments. They show that when the regional tax revenue is equalised, tax competition is significantly reduced promoting a rise in overall tax revenue. In an earlier paper, Gaigné and Riou (2004) find that revenue sharing between different levels of government may lead to efficient tax setting without coordination, but only for high levels of transport costs. For lower levels of transport costs the revenue sharing leads to a race to the bottom of the local taxes.

The present paper extends this research. As the basis, I use the standard *Core-Periphery* model from Krugman (1991), as it describes the theoretical constructs of agglomeration and geography in the most general form, whereas the versions of geography models mentioned by the authors above add more complex structures, e.g. mixed factor inputs or international capital flows as in Forslid and Ottaviano (2003) and Martin and Rogers (1995), respectively. However, opposed to these models, the standard version used here can only be solved numerically. But more importantly, extensions in the form of regional transfers, public goods production and congestion costs are easier to incorporate, a numerical implementation for this analysis is more appropriate.

3.3 Benchmark Model

The model of Krugman (1991) is quickly recapitulated here for reference, a more comprehensive description is given in the previous chapter. There are two regions in an economy otherwise closed with respect to international trade. There are two production sectors. One producing homogeneous goods under constant returns to scale and one producing heterogeneous varieties of another good. There are two factors of production; skilled and unskilled labour. The consumers in both regions have identical homothetic preferences represented by a two-tier utility function. The upper tier is a Cobb-Douglas function over the homogeneous and a composite of the heterogeneous goods. The lower tier aggregates the heterogeneous varieties in a composite, where there is constant elasticity of substitution between the varieties. The consumers' utility function in a region is:

$$U = A^{1-\mu} M^{\mu}, \qquad M = \left(\sum_{i=1}^{n} m_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{3.1}$$

where A is the homogeneous good and M is the heterogeneous composite of the n varieties. A single variety is denoted as m_i. The cost share of the heterogeneous composite is μ, while σ is the elasticity of substitution between varieties. The consumers maximise their utility subject to their budget, that consist of the sum of factor payments.

The sector supplying the homogeneous good produces under constant returns to scale using only unskilled labour, thus profit maximisation equates the unskilled wage with the price of the homogeneous good. The heterogeneous sector exhibits increasing returns to scale in producing varieties, but only uses skilled labour. The first order condition for these firms depends on the specific formalisation of the increasing returns technology, which is represented in their cost functions. In the Core-Periphery model the cost function for firm i is defined as $c_i = (\alpha + \beta q_i) w_s$, where c_i is the total cost of producing amount q_i of variety i, and w_s is the skilled wage. The parameters α and β are the fixed and variable costs respectively. The firm acts as a monopolist in the market for the specific variety, thus the pricing rule is

$$p_i = \beta w_s \frac{1}{\rho}, \quad \rho = \frac{\sigma - 1}{\sigma}, \tag{3.2}$$

where σ is the perceived elasticity of demand[3] derived from (3.1) and p_i is the output price of variety i. It is assumed that there are no barriers to entry, so as long as there are profit opportunities, new firms will establish themselves and produce new varieties. The free entry condition entails zero profits. By symmetry of the cost functions and demand for varieties, all firms in the heterogeneous sector set the same price and level of output. The number of firms is derived from the available supply of skilled labour and each firm's input requirement. The total number of firms in a region is then the total available skilled labour in a region divided by the input requirement of a firm, and each firm produces a single variety, so the number of firms gives the number of varieties.

When there are several locations where goods are produced, there are costs associated with importing and exporting the heterogeneous goods to satisfy supply and demand across space. Specifically, the costs are modelled as *iceberg* transport costs where a fraction of the good *melts* in transit from location c to d. The price in location d of a variety shipped from location c becomes $p_d = t_{c,d} p_c$, where $t_{c,d}$ is the iceberg cost. Inserting the transport costs into the derivations of consumer demand for varieties, the uncompensated demand function changes,

[3] The consumer's price reaction is perceived, as consumers do not consider price changes in a single variety to affect the overall price index for the heterogeneous composite.

but the perceived elasticity of demand remains σ. And the price setting and output profile of the firms are, therefore, unchanged. For clarification, the transport costs are inverted into an index of regional integration, ϕ, where a value of one is completely integrated regions, i.e. no transport costs, while ϕ tends to zero as transport costs go to infinity.[4] For the remainder of this paper, the level of ϕ is termed the level of *integration* between regions.

As opposed to the unskilled labour, the skilled labour is assumed to be 'footloose'. Skilled workers are not tied to a specific location. They seek the highest possible welfare and relocate to get it.[5] However, this mobility of workers are assumed to be somewhat sticky, that is, the relocation of labour does not happen instantaneously. Only a fraction of the skilled labour force moves at a time. This assumption is required to put a damper on the agglomeration forces, as full mobility will render the model completely unstable and not useful for any analysis. Denoting the share of skilled labour in location c as λ_c, the change in the share is given by

$$\dot{\lambda_c} = \gamma(\omega_c - \omega_d), \tag{3.3}$$

where ω_c is the utility per capita in region c. The *speed* of adjustment is given by the coefficient γ. If the utility in one location is lower than in another location, a fraction of the skilled workers will emigrate – and vice versa – if the utility in one location is higher, then skilled workers will immigrate to that location.

As the heterogeneous sector depends on the skilled labour in order to produce, the location of the labour force also determines where the firms will, and can, locate in that region. As each firm uses the same amount of skilled labour and has the same level of output, the share of the heterogeneous industry in a location is equal to the share of skilled labour in that location. Thus,

[4]The level of integration is defined as $\phi = t^{1-\sigma}$.

[5]In the classic Core-Periphery model it is the desire for the highest real wage that motivates immigration. In the benchmark case in this section this mobility assumption is equivalent, but when public goods provision are introduced the welfare, measured in utility, is more important.

the concentration of skilled workers and the agglomeration of industry are equivalent results, and I will use the terms interchangeably in the remainder of the paper.

In Krugman (1991) there are three main forces that either determine the concentration or dispersion patterns of economic activity.

First, firms want to locate close to the consumers of their products. This force is the *backward* linkage effect, and it concentrates activity.

Second, skilled workers want to locate close to where their consumer goods are produced. This force is the *forward* linkage effect, and it also concentrates activity.

Third, competition between firms for skilled labour drives up wages and will drive companies away to the less concentrated region. This force is the *competition effect.*

The final equilibrium of the model depends on the balance of these factors. If the concentrating forces dominate, the economy ends up in a agglomerated Core-Periphery state, while the economy will end in a symmetric outcome if the dispersing force dominates.

3.3.1 Implementation

The complexity of the algebra in the Core-Periphery model makes it impossible to solve analytically, so numerical methods is applied to identify the model's properties. Numerical simulations require specific assumptions regarding the model's parameters, i.e. consumer preferences, production technology, level of transport costs, and factor endowments.

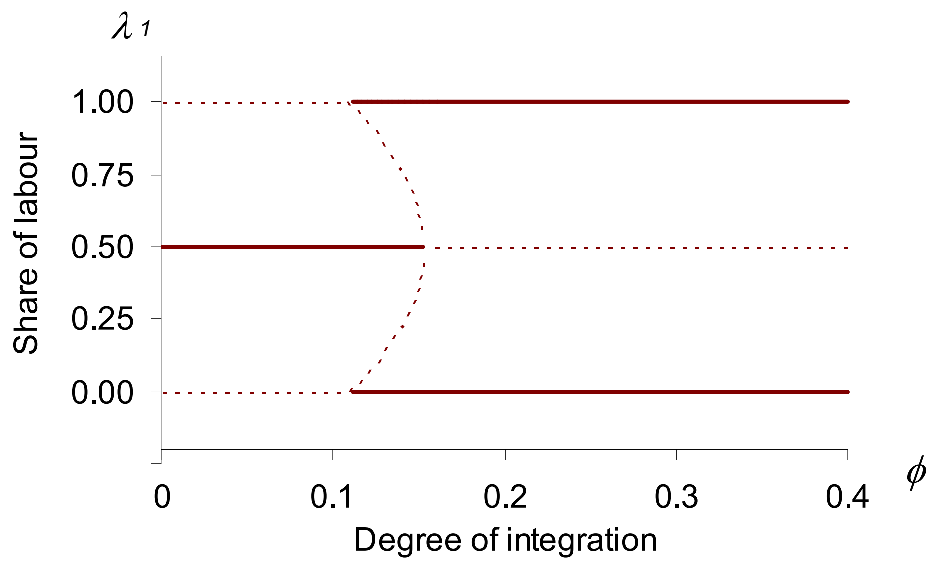
As mentioned by Fujita et al. (1999), the output from the heterogeneous sector, i.e. the number of varieties, can go toward infinity if there is not imposed a bound on the cost-share of heterogeneous to homogeneous goods – a *no-black-hole* condition. The cost share of heterogeneous goods is, therefore, chosen to be $\mu = 0.4$. The elasticity of substitution between varieties is also tied to the same issue and is chosen at a relative conservative level of $\sigma = 5$. For the production technology the parameters are normalised using σ such to simplify the expressions, i.e. $\alpha = \frac{1}{\sigma}, \beta = \frac{\sigma-1}{\sigma}$, which implies that firms produce one unit of output. Finally, for the economy as a whole, there are two locations and overall there is more unskilled labour relative to skilled labour.

The equilibria characteristics of the standard Core-Periphery model is usually best summarised in the *Tomahawk* diagram, cf. figure 3.1. The figure represents stable equilibria by the full drawn lines, and unstable equilibria by the dotted lines. For high levels of integration, the economy has an two stable agglomerated equilibria. In the case of intermediate integration there are three stable equilibria, one symmetric and two agglomerated. In addition, there are two unstable equilibria with various distribution of labour. Finally, for low integration, there is one stable symmetric equilibrium.

The model exhibits strong path dependency. This is the case both when the the starting point is at a low level of integration, in the symmetric state, and when the starting point is at a high level of integration, the agglomerated state.

If the economy is at a low level of integration, the heterogeneous industry will be dispersed evenly across the two regions, that is the symmetric equilibrium. In this case, if a group of workers are relocated, they will experience a drop in the welfare and move back to regain the higher welfare and the symmetric equilibrium is re-established. A small increase in integration will not change the outcome of a symmetric distribution of labour. However, when the level of integration reaches a certain level, the symmetric equilibrium becomes unstable. This is

Figure 3.1: Tomahawk Bifurcation in the Core-Periphery Model



Note: Full drawn lines are stable equilibria while dashed lines are unstable equilibria.

denoted as the break point – the point when the symmetry breaks into a core and a periphery. From this point onwards, the symmetric equilibrium is always unstable and the economy will always agglomerate toward the region where the first group of workers moved, the core region.

Starting from the other end with completely integrated regions, the industry will be concentrated in one region. Decreasing integration, for instance by introducing road tolls, the agglomerated equilibrium is stable until the integration is reduced certain level. This is denoted the sustain point – the lowest level of integration where an agglomeration can be sustained. The welfare of the skilled labour is the highest where it is most scarce. Migration to the periphery will continue until the labour is evenly distributed, and the two regions are symmetric. From there on, any further reductions in integration has no other effect than increasing the dominance of the dispersion force, solidifying the symmetric distribution of activity.

Importantly, the break and sustain points overlap, such that either the agglomeration or dispersion of industry show a significant path dependency. If the level of integration is in the intermediate zone, the exact distribution of industry crucially depends upon the previous state of the economy – a hysteresis effect. Whether agglomeration or dispersion is a stable outcome, depends crucially on the the concentration pattern in an earlier period. As Krugman (1991) puts it: *history matters*.

The rigidity of the labour force in the range of intermediate integration, the overlap between the sustain and break points, represents an agglomeration rent. A rent which can be extracted without causing the agglomeration to break down. But as mentioned in the introduction, there are also costs associated with concentration, namely the congestion costs. In the next section, the model is extended with these costs and how this affects the agglomeration pattern is analysed.

3.4 Congestion Costs

The costs of congestion are in essence costs associated with crowding. If it is health problems from polluting industries or wasted time in traffic, they stem from the concentration of economic activity and the concentration of people. In most spatial models of economic geography, these negative effects are not taken into account. The purpose of this section is to extend the Core-Periphery models to account for congestion problems.

Costs of congestion are introduced as iceberg costs on the supply of skilled labour. There is a negative externality on the effective supply of skilled labour the more concentrated workers are. A straightforward interpretation is that a worker needs to spend time in his car commuting to work. Because of crowded streets the worker spends more time waiting, and thus, the hours at work are effectively reduced, cf. Murata and Thisse (2005). Skilled workers cannot live on top of each other, and have to settle next to each other away from the workplace. They need to commute to work and the cost is linear in distance, x. Furthermore, all workplaces are assumed to be situated in a central business district (CBD). If every worker can supply one unit of labour and they locate in one dimension from the CBD, the effective labour supply is,

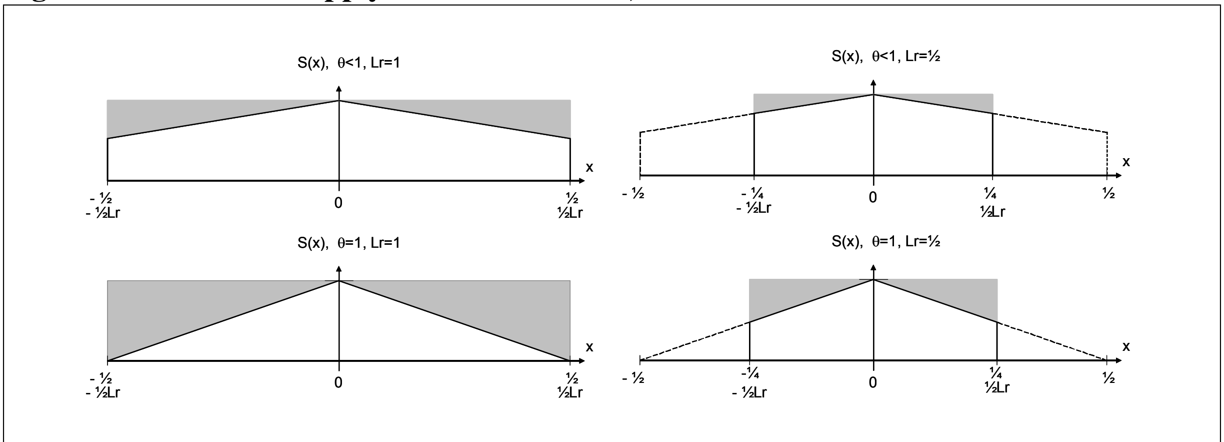
$$s(x) = 1 - 2\theta|x|, \qquad x \in \left[-\frac{L}{2}; \frac{L}{2}\right], \tag{3.4}$$

where $s(x)$ is the supply of one worker living at distance x. The parameter θ is the congestion costs parameter and lies in the range, $0 \leq \theta < 1$. The total amount of skilled labour living in a region, L, locates around the CBD, then the total effective supply of skilled labour becomes,

$$S = \int_{-L/2}^{L/2} s(x)dx = L\left(1 - \theta\frac{L}{2}\right). \tag{3.5}$$

A visual representation of the labour supply is given i figure 3.2. The shaded areas represent the congestion costs in region r. The share of skilled labour is L_r, which can be either equal to one, the agglomerated state, or equal to 0.5, the symmetric state.

Figure 3.2: Effective Supply of Skilled Labour, Different Outcomes



The two left panels are for the agglomerated Core-Periphery outcomes, and the two right panels are the situation of the dispersed outcomes. The top panels show the effective labour supply for medium congestion costs, while the lower panels are for the cases of high congestion costs.

In the concentrated outcome and highest congestion costs, $\theta = 1$, the bottom left panel, the worker living just on the city boundary is the marginal worker with zero labour supply, and the worker living in the middle can supply the full amount of labour.

When the economy is dispersed, the city boundary lies halfway out compared to the concentrated case, since only half the skilled workers live there. The worker on the boundary will always have a positive supply of labour. From this, it is apparent that the least cost to the labour supply happens when the skilled labour is fully dispersed across regions. Thus, total congestion costs across the whole economy are lowest when there is no agglomeration and highest when the economy is concentrated.

Since the number of firms producing heterogeneous products depend on the supply of skilled labour, iceberg congestion costs, that reduce labour supply, imply that the overall number of firms in the economy is reduced, cf. Murata and Thisse (2005). And as consumers have *love-of-variety* preferences, a reduction in the number of varieties means lower welfare for all consumers. Congestion costs also shift the labour supply curve downwards, thereby lowering wages. Both the reduction in welfare and the lower wage are dispersion forces, in addition to the competition effect already present in the model.

3.4.1 Concentration Patterns with Congestion Costs

Murata and Thisse (2005) show in a cut'down version of the Core-Periphery model that these congestion costs *flip* the Tomahawk diagram around. This means that in the case of high integration, the benefits of locating close to the market is outweighed by the costs from congestion, thus the economy is dispersed – where the standard Core-Periphery model is agglomerated for high integration. The model presented in this paper has similar properties as Murata and Thisse (2005), however there are significant differences.

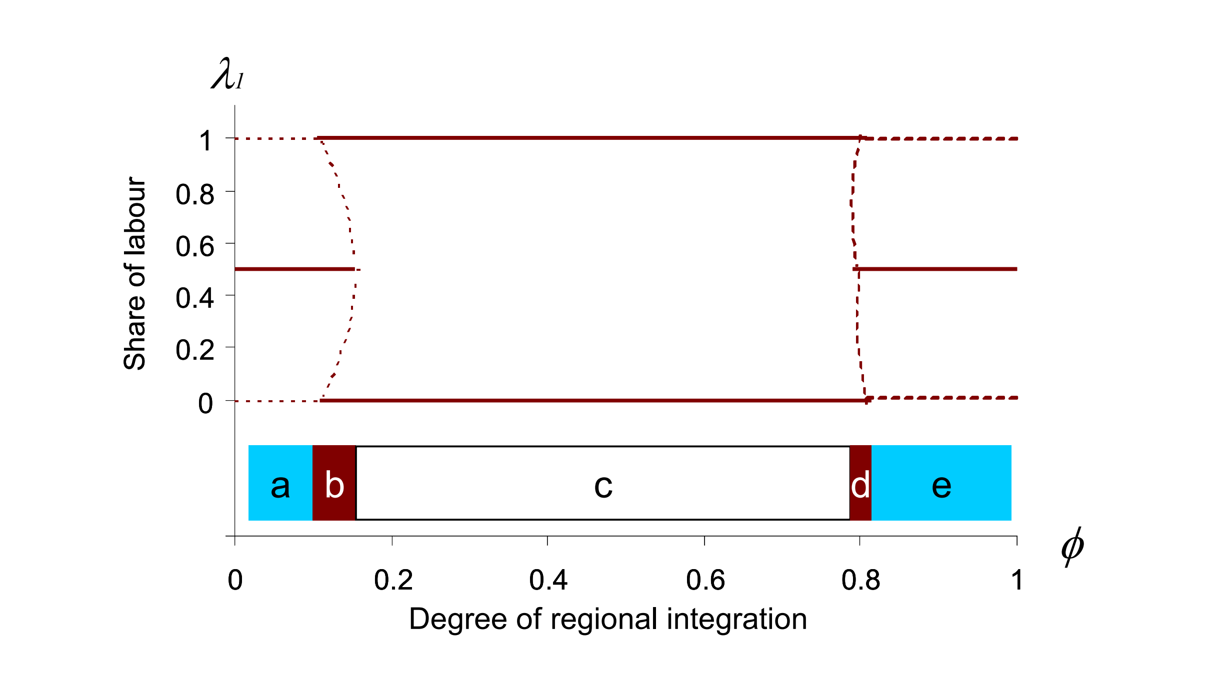
The results shown here are obtained by numerical simulations for different combinations of transport costs (levels of integration) and congestion costs. From the simulations the migration patterns are calculated and the concentration patterns are identified for the congestion costs and transport costs combinations. Analysing the range of congestion costs from zero and upward, the agglomeration properties change as follows:

At zero congestion costs the model reverts to the standard Core-Periphery model. There is agglomeration at full integration, there is dispersion at low integration, and there is path dependency in the outcome. Exactly the properties as in the Krugman Core-Periphery model in the previous section.

For positive congestion costs the agglomeration pattern changes. Both the break and sustain points are shifted to higher levels of integration. The dispersed outcomes for low levels of integration last longer, so integration needs to be increased more in order to spur a concentrated outcome. Furthermore, the concentrated outcomes are more vulnerable. It will now take a smaller reduction in integration before an agglomeration becomes unsustainable. Thus, the range of agglomeration equilibria is reduced, and they are only possible at higher levels of integration.

However, another stable dispersed outcome emerges for very high levels of integration and the agglomerated outcomes disappear from that range. When the regions are fully integrated and there are costs of congestion, the disadvantages in relocating to a rural area is outweighed by the reduction in costs associated with urban crowding. The extra dispersion force from congestion costs is directly identified in the new dispersion outcomes at high levels of integration. This effect is in line with Murata and Thisse (2005), where they identify a symmetric equilibrium for the full integration (free trade) case. Although Murata and Thisse (2005) do not identify the dispersion outcomes for low levels of integration.

Figure 3.3: Tomahawk with Congestion Costs



The agglomeration pattern and the properties of the break and sustain points are shown in figure 3.3 for an arbitrary intermediate level of congestion costs.[6] There are now *two* break points and *two* sustain points in the economy. Examining the diagram, different equilibrium zones are identified. These are shown by the bar in the lower part of the diagram.

For high levels and low levels of integration the economy has only stable outcomes when activity is dispersed. These two zones, at the ends of the integration scale, are denoted the *Symmetric* zones, labelled *a* and *e* in the diagram.

[6]The next section will deal with the characteristics when the congestion costs θ varies. For this illustration the exact level of congestion costs is not relevant.

The stable outcome of agglomeration in one region, the Core-Periphery outcome, is the sole equilibrium for an *intermediate* range of integration. For this range of integration is the *Concentrated* zone, label *c* in the diagram.

There are two ranges of integration where the economy has more than one stable equilibrium, both the dispersed and the agglomeration outcomes are possible. The realised outcome is determined by the history of the economy. That is, there is path dependency of the locational pattern. These are the *Hysteresis* zones, labelled *b* and *d* in the diagram. If the economy is concentrated before moving into the hysteresis zone, it will stay concentrated - and vice versa - if the economy is in a symmetric equilibrium it will stay dispersed if moved into the hysteresis zone. It's only when the economy passes the break and sustain points that the outcome of the economy changes. The naming convention of the different zones of outcome is in line with the naming in the previous chapter.

Walking through the diagram yields insights to the effects at play, from left to right. For very low levels of integration, the regions are far apart in terms of costs. In order to supply the other region, goods incur large transport costs. It is expensive to supply goods to other regions. At the same time, congestion costs reduce the effective labour supply increasing the competition for labour. These dispersion forces dominate the forward and backward linkages, so a region is unable to sustain an agglomerated outcome. Labour and firms relocate to even out the distribution of economic activity. The only stable equilibrium is the dispersed outcomes – the economy is in the symmetric zone *a*.

When the level of integration moves the economy into the (first) hysteresis zone *b*, the forward and backward linkages begin to increase in strength, making it possible for on agglomeration to be sustainable. But the dispersion forces are still strong enough to keep the economy in the dispersed outcome.

In the intermediate range of integration, the positive linkages dominate. The economy is in the concentrated zone *c*. Skilled labour migrates to the agglomerated region to get access to cheaper goods without having to pay transport costs mark-up, and firms want to locate close to their consumers and where there is abundant labour. This happens in spite of the fact that there are transport costs associated with supplying unskilled labour in the other region, and than the effective labour supply is reduced because of the congestion costs.

Moving further along the integration axis, the economy lies in the second hysteresis zone *d*. Here the dispersed outcome again becomes a stable equilibrium. Now the higher level of integration makes it possible for firms to locate in both regions, since the transport costs needed to supply goods to the other region are low. Equivalently for the skilled labour, the higher integration reduces the costs of buying goods from the other region. At the same time the congestion costs reduce their effective labour supply, so there is a benefit in dispersing to increase their labour income.

Finally, in the second symmetric zone *e*, the benefit of market access for firms and skilled labour disappear because the transport costs become insignificant. In this case the congestion costs of concentration completely dominate, dispersing the labour and economic activity.

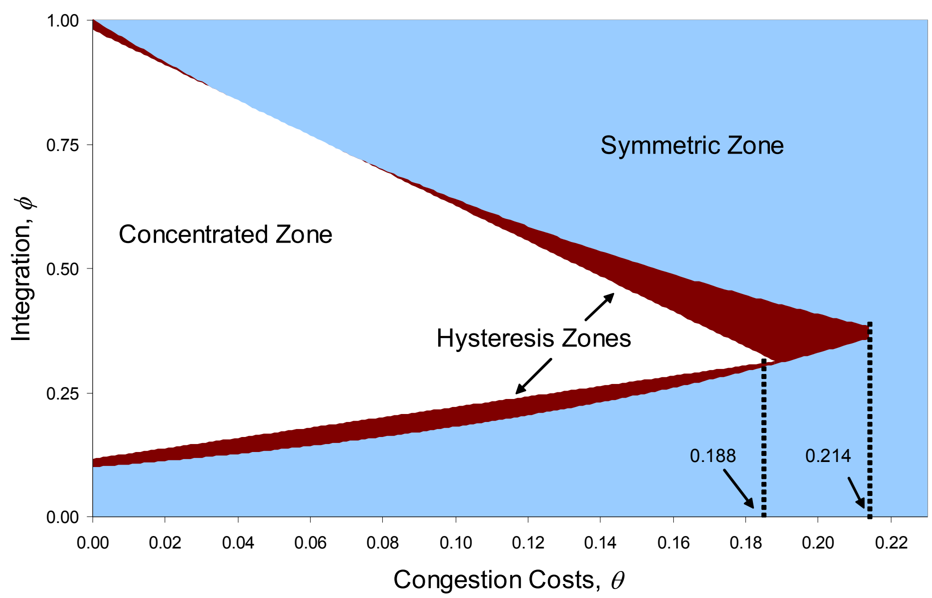
3.4.2 Dynamics with Changing Congestion Costs

The above example was shown for an intermediate level of congestion costs. However changing the level of congestion costs, reveals new dynamics in the concentration patterns in the model.

Increasing the congestion costs adds to the dispersion forces. This has an effect at both ends of the integration scale, that is, it moves the leftmost break and sustain points to higher levels of regional integration, but also moves the rightmost break and sustain points to lower levels of integration. This narrows the band of agglomeration outcomes.

In order to visualise this, the dynamics of the break and sustain points for the economy are condensed in a single diagram. This is the central illustration of the properties of the model. Drawing the integration on the vertical axis and the congestion parameter along the horizontal axis, the full properties of the model are revealed for all combinations of congestion costs and levels of integration, cf. figure 3.4. In the diagram, the three zones are replicated with the same

Figure 3.4: Dynamics with Congestion Costs



Note: The small hysteresis zone in the top left corner is due to rounding.

colours. The concentrated zone is shown in complete white, the symmetric zone in blue/light grey and the hysteresis zone in burgundy/dark grey. At the leftmost part of this diagram there are no congestion costs and the model is the standard Core-Periphery model. Moving right along the primary axis increases the congestion costs, θ, and the leftmost break point in the tomahawk, now the lower part of the concentrated zone, moves to higher levels of integration.

At the same time the rightmost break points in the tomahawk, now the upper points, move to lower levels of integration. It is the break points that sets the boundary of the dispersed outcome, so in the concentrated zone *only* the Core-Periphery outcomes are stable, and the dispersed are unstable. The shifting of the two break points closer together when increasing congestion costs, narrows the concentrated zone forming a *cone* shape of agglomeration outcomes. At the tip of the cone both break points meet, and agglomeration as the sole outcome in the economy disappear.

As the sustain points from the Tomahawk closely follows the break points, these also shift toward each other. The sustain points are the outer boundary of the hysteresis zone, and this zone also forms a zone where both agglomerated and dispersed outcomes are possible in the economy. The hysteresis cone is a bit larger than the concentrated cone.

As the congestion costs increase, the symmetric zone takes over where the other zones withdraw. In the symmetric zone, only dispersed outcomes are stable in the economy. The symmetric zone takes over completely, when the congestion costs reach a level beyond the tip of the hysteresis cone. From that point onward, agglomeration can not be sustained, regardless of the level of regional integration.

The shape of these cones gives clear evidence that increasing the dispersion forces, the congestion costs, reduce range of outcomes where the economy has stable agglomerated equilibria. This happens at both ends of the spectrum of integration. Concentrated economic activity has difficulty to sustain itself both for very high levels of integration and for very low levels of integration. In the case of the fully integrated economy, it does not matter for firms where they produce in order to supply their customers. They can ship their goods anywhere, but the costs associated with concentration are that a lot of the labour supply is wasted. A waste that hurts the income of the affected workers, and the overall welfare of the economy from the lower production of varieties. This is the reason for the symmetric zone beginning to dominate the top part of the diagram.

These income and welfare effects associated with the congestion costs are something that should be considered if policies of agglomeration are put forward. The results also show that an effort invested into reducing congestion costs would help policies promoting agglomeration. By combining increased integration with lower congestion problems, one can move the economy far into the concentrated zone.

With the characteristics of the Core-Periphery model extended with congestion costs established, the next section turns to implementing interregional transfers of income.

3.5 Taxes and Transfers

The model represents an economy with two distinct regions, governed by one central authority. This could either be municipalities subject to a national government, or on a higher level, the member states in a union with some kind of supranational authority. The central authority levies and collects taxes on factor income, and all tax revenue is pooled into the central treasury. Then the central government redistributes the revenue to the local governments. Depending on the profile of redistribution, this will in effect be an interregional transfer system or even, as a special case, a full fiscal equalisation scheme. By keeping the transfer system in this simple form, the analysis encompasses a wide range of observed transfer regimes; from the case of the Canadian central authority that collects taxes and distributes to regions, to the case of Danish municipalities that collect local taxes and pay a fraction of their revenue to the central authority who then redistributes the money. In this paper the central authority sets a national income tax rate, collects the taxes and then distributes the revenue to the regions according to a predefined rule. Therefore, the game theoretic aspect in e.g. Baldwin and Krugman (2004) and Gaigné and Riou (2007) is left out of the analysis and only the effects of the single central government agent's decisions are considered.

The analysis follows the previous chapter. The focus is on the impacts of different policy rules, but will refrain from recommending any specific policy. Such recommendation would require assumptions of optimality criteria, e.g. a social welfare function, and this is not the purpose of this paper. Here the purpose is to analyse the direct effects of different government initiatives using instruments of transfers and instruments that increase integration.

The taxes are levied directly on factor income of all agents in the economy using the same tax rate. The redistribution of tax revenue to local authorities is treated as a lump sum transfer to the local consumers' income.

3.5.1 A Central Government

The central government levies taxes on factor income in both regions with the tax rate τ. All tax revenue is transferred back to consumers using a distribution coefficient: region d's governments receive a fraction ξ_d of the total revenue. The tax revenue, G, is

$$G = \sum_d \tau \left(wL_d^u + w_d^s L_d^s\right), \qquad 0 \leq \tau < 1, \tag{3.6}$$

where the first element in parenthesis is the region's total unskilled wage bill and the second element is the region's total wage bill for the skilled labour. The consumer income less taxes and including transfers is the region's total expenditure

$$E_d = (1-\tau)\left(wL_d^u + w_d^s L_d^s\right) + \xi_d G, \qquad \forall \xi_d \geq 0, \quad \sum_d \xi_d = 1. \tag{3.7}$$

One type of transfer scheme is analysed to give an overview of the effects of the transfer system. As there are no specific policy recommendations in the paper, the results will serve the purpose of understanding the workings of the economy subject to various policy initiatives, i.e. mixes of transfers and taxes. The scheme considered is the *equal shares* regime where the total tax revenue is divided equally between the regions. The details of the rule is as follows:

Equal Shares

The equal shares regime is the no frills fiscal equalisation scheme in its simplest form. There is no consideration as to the wealth or income of the consumers. The total tax revenue is simply divided equally and given to the regions' consumers. The lump sum transfer to each consumer is exactly the same. In effect, the regime will function as a moderate transfer from a concentrated region to a periphery region since the tax revenue in the concentrated region is higher. Formally, the share to each consumer is given by:

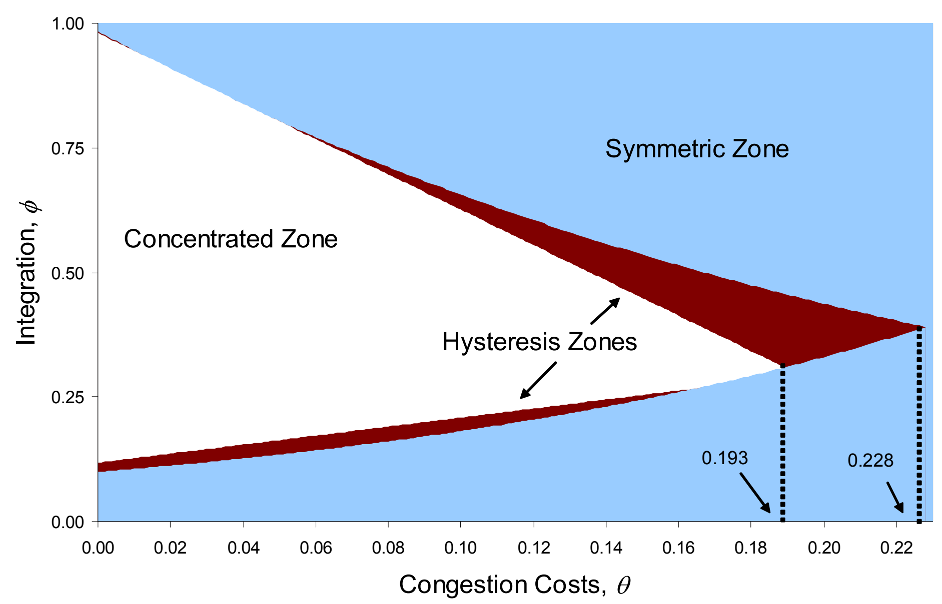
$$\xi_d = \frac{1}{L_s + L_u}, \qquad d = 1,2. \tag{3.8}$$

Thus, the rule takes no account of any migration pattern or location of production. In the case of a symmetric equilibrium the rule reverts to the no transfers between regions.

Effects of Transfers

When the model is extended further with these transfers, the following results are revealed. When the transfer moves income from the *rich* to the *poor* region, i.e. from the core to the periphery, the lower part of the cones in the diagrams shift upwards. The relatively mild redistribution of income imposed by the transfer rule means that the shift is relatively small. This means that the width of the concentrated zone is further reduced, however, the transfers do not change significantly the properties of the upper part of the cones.

Figure 3.5: Dynamics with Transfers



As shown in the previous chapter, a transfer of income from the core to the periphery shifts the break and sustain points to higher levels of integration, leaving less room for a sustainable agglomeration to happen. This result emerges here as well, with the lower parts of the cones shifting upwards, the lower parts of the cone being the original break and sustain points from the standard Core-Periphery model. The results reported here with congestion costs added are, therefore, as expected in line with the effects shown previously.

Thus, the introduction of interregional transfers to satisfy an equalisation agenda has the effect that it narrows the concentrated zone further, risking a concentration to break down. A policy of equalisation, therefore, warrants an evaluation of how much money can be extracted from the concentrated economic centre, and if such a policy should be combined with initiatives for increased integration. And with the congestion issue incorporated, as shown here, the concentration force is even more 'vulnerable'. But the results also show that policies that reduce congestion costs can reinforce the agglomeration forces such that economy is shifted into the concentrated zone.

This section dealt with passive government agents that issue lump sum transfers to consumers in the regions. However, local and national governments engage in direct production of public goods, whether they are of the scale of national defence or smaller scale as local schooling. The following section takes the issue of government involvement through public production further by introducing local public goods.

3.6 Supply of Local Public Goods

Local public provision supplies some form of public goods to the citizens of the region in question. It is not just a transfer of income to and from consumers in different regions. The interregional transfers are in fact targeted at local governments to help them supply public production. And public production ties resources to the production. In addition, the level of public production or the amount of resources going into the public sector is a politically decided issue, and therefore fixes the public use of resources, and the private producers have to adapt to the level of residual level of available resources. In essence, the resources available to the private sector is the total available resource of factors less the factors used for public production. This also has the consequence that public production influences the factor payments.

Local governments are introduced to the model as an extra sector. The local governments produce locally consumed public goods and receive a grant from the central authority. The public good enters the utility function in an additive separable way, as it is standard in assumed in the literature. The utility function of the representative consumer then becomes,

$$U = A^{1-\mu} M^{\mu} + H, \qquad M = \left(\sum_{i=1}^{n} m_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{3.9}$$

where H is the public provided good received by the consumer, measured in utility. For simplicity, the public good enters the utility function additively so the public good just raises the level of utility without changing the consumer's maximisation problem. The first order conditions and the consumption bundle of the consumers are left unchanged.

It is assumed the public sector produces the public good using a constant returns to scale technology. The government uses both skilled and unskilled labour in equal proportions.

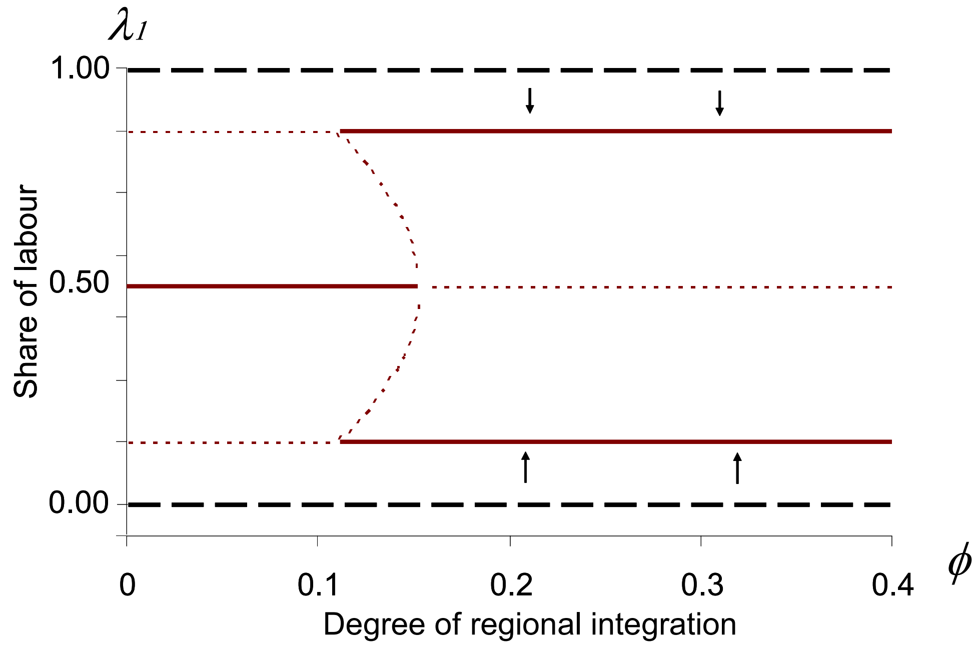
$$H = L_s^{\delta} L_u^{\delta}, \qquad \delta = 0.5. \tag{3.10}$$

The exact formulation of the public sector's technology is, of course, arbitrary and the formulation here is chosen for its simplicity. The skilled labour is assumed to be used in the production in order to tie down some of the skilled labour in the regions. This implies that a region will always have some skilled labour employed in the public sector, even if the region is the periphery measured in the share of heterogeneous firms present.

Simulations with this setup reveals exactly this: a fraction of skilled labour is employed in the public sector in the periphery region. In the case of no congestion costs and no transfers between regions - the standard Core-Periphery model - the agglomeration outcomes have less than 100% of the skilled labour concentrated in the core. The government production, financed by taxes revenue, draws some skilled labour by offering high wages. But at the same time, the wages are too high for the heterogeneous firms to locate there. The break points of dispersion and the sustain points of the agglomeration remain in the place as in the standard model. This means that the tomahawk diagram is similar, but with the edges, signifying the core and periphery outcomes, are closer to the middle line, cf. figure 3.6.

As the local government need financing to provide public goods, the model is based on the

Figure 3.6: The Tomahawk With Public Production - No Transfers, No Congestion Costs



version presented earlier, however with no congestion costs. Thus, factors of production are levied taxes and the tax revenue is used by the local governments for local public production.

Now the analysis is focused on two different transfer regimes. The first being the rule of no interregional transfers and in the second the same amount per citizen is given to each region. Recall that the overall tax rate for both regions is the same. The local governments are not allowed to levy different taxes, either as subsidies or otherwise.

The rule of no interregional transfer entails that the budget of the local government is equal to the total collected tax revenue from the respective region. But note that the level of utility added to the consumer's welfare, H_d, may differ between regions - even for the same budget. This is because local government production uses both factors, and since the skilled wage can differ between the regions, the cost of producing is not necessarily at the same level.

In the second regime, tax revenue is transferred according to the population sizes in the region. Hence, each local government receives the same amount of revenue per citizen and gear public production after this. In a concentrated state, the equal grant to each citizen represents a small transfer from the centre to the periphery since the unskilled immobile labour, as well as the skilled labour used in public production, pay a smaller amount in taxes than that given to the local government's budget. The budget in the periphery's local government is larger than what they could have had if they only received revenue from the local tax base.

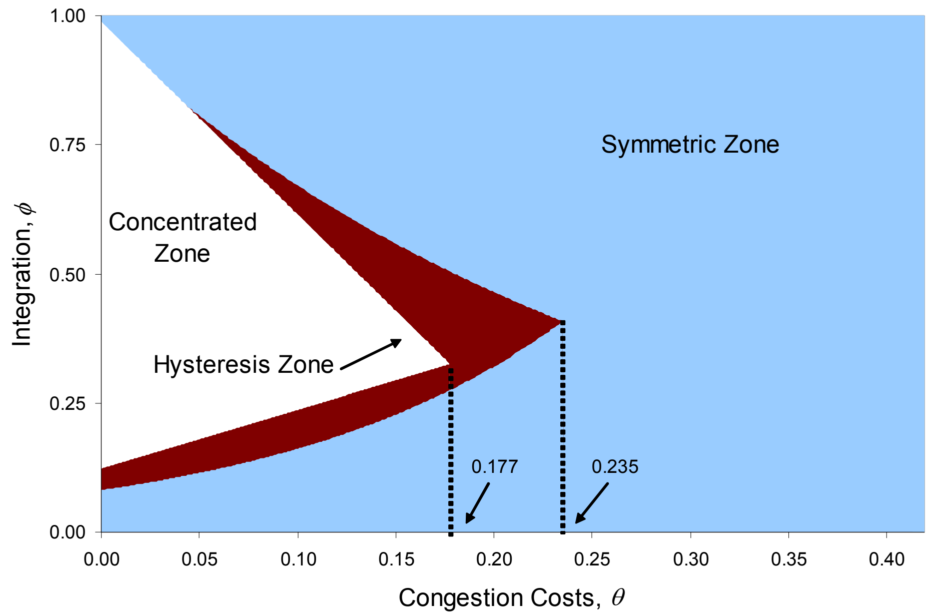
The provision of public goods in periphery regions financed partly by the core regions introduces an extra dispersion force in addition to the competition effect and the costs of congestion. Therefore the *balance of power* between these effects shifts the economy towards the dispersed equilibria. The agglomeration characteristics of the models are diluted when these extra dispersion forces come into play. These effects are shown in figure 3.7 and 3.8.

The regime with no transfers almost replicates the earlier results shown in figure 3.4, where the tip was at $\theta = 0.2$ in the case of the model with only congestion costs and no taxes or transfers. Equivalently, the intercepts of the cones, in this regime with public production and no transfers, are at the same levels of integration as in the case in section 3.4, i.e. the standard Core-Periphery model.

It is apparent that the binding of skilled labour in a periphery region by the public production, does not in itself change the agglomeration pattern in the economy as long as there are no transfers between the regions. The only thing that changes is the level of concentration, that is there is less than 100% concentration of skilled labour in one region.

Allowing for small transfers between regions changes the concentration patterns significantly, cf. figure 3.8. When concentration exists there will be a small transfer of money from the core to the periphery.

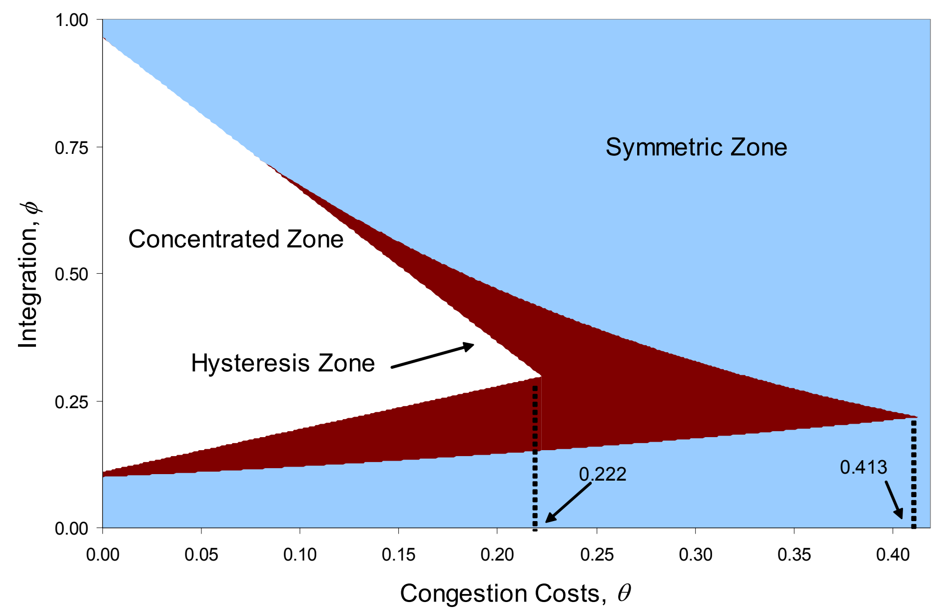
Figure 3.7: Dynamics with Public Goods Production, No Transfers



Note: The scale of the x-axis has changed from the previous figures. This eases the comparison with the next figure.

In this case, the hysteresis zone is expanded horizontally. The tip of the cone now spans to the level of congestion costs at about $\theta = 0.41$. At the same time the tip of the concentrated zone is a bit further out at $\theta = 0.22$. In the hysteresis zone the economy stays in the concentration pattern, whatever changes happen to the level of integration between the regions. If the economy is in a Core-Periphery state in this zone, the transfer of money to the periphery does not make the concentration unsustainable. The skilled labour that is bound to the public production in the periphery region ensures that the tax base, and thus the revenue collected, is sufficiently large so the transfers required by the regime are minor. But the transfer of money away from the core, reduces the size of the core government's budget and reduces the level of public production. This frees resources to the private sector in the core and the scale effects in the heterogeneous sector is strengthened. The concentration forces, therefore, still dominate and they are more robust towards increasing congestion costs.

Figure 3.8: Dynamics with Public Goods Production, Equal Grants



On the other hand, the symmetric outcome is also fortified by the expanding hysteresis zone. Again, this is a consequence of the bound skilled labour. The presence of at least some skilled labour in a region in addition to the immobile unskilled labour, increases the minimum demand for varieties. In the models without bound skilled labour it is only unskilled labour's demand for varieties that are left in a periphery region. Now the larger minimum demand for varieties will attract firms and increase the dispersion forces.

By introducing local public production in the model, some skilled labour is bound to both regions. However, the concentration pattern only changes when transfers are introduced.

3.7 Concluding Remarks

The analysis presented in this paper shows that adding extra features to the standard Core-Periphery model has profound implications for the concentration patterns in the model. These features introduce the following extra forces.

First, concentration of skilled workers will reduce the labour supply wasting resources. This will in fact reduce the available varieties for the whole economy and will be overall welfare reducing. Thus, via the overall welfare reduction, workers may want to relocate to offset this loss in welfare. This is an *indirect* dispersion force. The congestion costs of concentration thus reduces the concentration zone of the model from both sides of the integration spectrum, as the costs also have the effect that symmetric outcomes emerge for high levels of integration. The domination of the concentrating forces when there is full integration between regions, which is the case in the standard Core-Periphery model, disappears and the dispersion forces take over. Increasing congestion costs squeezes the concentration zone from both sides, while the hysteresis zone still remains around the concentrated zone retaining the property of path dependency in the model.

Second, transfers between regions taps resources from economic centres for the benefit of consumers in poorer regions. This increases the dispersion forces in the model. This further reduces the area of the concentration zone as the dominance of the concentration forces are weakened. The shape of the different zones, however, remain.

Third, the provision of public goods increase the utility of agents in a region. More immigration will increase the tax base and help finance more public provision. This will work as an concentrating force. But the production of public goods will draw factors away from the private sectors and drive up wages, working toward dispersion. Besides reducing the full agglomeration to partial agglomeration, the concentration patterns of the economy is only changed when introducing transfers in addition to public production. And this changes the concentration patterns dramatically, creating much more path dependency expressed through the increased area of the hysteresis zone.

In the model used here, more observed facts are introduced to the benchmark Core-Periphery model. Facts that are present, for example, in the European economy. Many urban centres suffer from costs of congestion, most countries have transfers schemes or policies of subsidising poor regions, and local governments supply goods for the benefit of the local populace only. When all these factors are taken into account, the analysis shows that the design of public policy does impact the production patterns of the economy.

Most importantly, a concentration of economic activity could become unsustainable if interregional transfers are applied and if the congestion cost of the concentrated region are high. Provision of public goods can attract more labour, but public investments could reduce the costs of congestion by for example improving infrastructure. This emphasises the fact that policies concerning public provision, interregional transfers, congestion and regional integration all influence the concentration and dispersion forces in the economy, and in the right combination the policies can reinforce or counter each other.

3.8 References

Andersson, Fredrik and Rikard Forslid (2003), ‘Tax competition and economic geography’, *Journal of Public Economic Theory* **5**(2), 279–303.

Baldwin, Richard and Paul Krugman (2004), ‘Agglomeration, integration and tax harmonization’, *European Economic Review* **48**(1), 1–23.

Baldwin, Richard, Rikard Forslid, Philippe Martin, Gianmarco Ottaviano and Frédéric Robert-Nicoud (2003), *Economic Geography and Public Policy*, Princeton University Press, Princeton, New Jersey.

Behrens, Kristian, Carl Gaigné, Gianmarco I. P. Ottaviano and Jacques-François Thisse (2005), Countries, regions and trade: on the welfare impacts of economic integration, Discussion Papers in Economics 05-01, Department of Economics, University of Strathclyde, Glasgow, Scotland, UK.

Boadway, Robin (2003), The theory and practice of equalization. mimeo.

Bureau van Dijk (2006), ‘Amadeus database’.

Charlot, Sylvie, Carl Caigné, Frédéric Robert-Nicoud and Jacques-François Thisse (2004), Agglomeration and welfare: The Core-Periphery model in the light of Bentham, Kaldor and Rawls, CEPR Discussion Papers 4715, Centre for Economic Policy Research.

Charlot, Sylvie and Carl Gaigné (2001), Regional integration, inequalities and public policy, Working Paper 3, INRA-ENESAD.

Combes, P. and G. Duranton (2001), Labour pooling, labour poaching and spatial clustering, CEPR Discussion Papers 2975, Centre for Economic Policy Research.

Copenhagen Economics (2006), Den danske klyngedatabase. Unpublished.

Dahl, M. S. (2002), Embedded knowledge flows through labor mobility in regional clusters in denmark, Technical report, Eindhoven Centre for Innovation Studies (ECIS). Paper presented at the DRUID Summer Conference on "Industrial Dynamics of the New and Old Economy - who is embracing whom?".

Dixit, Avinash and Joseph E. Stiglitz (1977), 'Monopolistic Competition and Optimum Product Diversity', *American Economic Review* **67**(3), 297–308.

DREAM-group (2008), Danish Rational Economic Agents Model, Technical report, DREAM, Copenhagen, Denmark. http://www.dreammodel.dk.

Economic Modelling, Statistics Denmark (2008), Annual Danish Aggregated Model, Technical report, Statistics Denmark, Copenhagen, Denmark.

Forslid, Rikard (2004), Regional policy, integration and the location of industry, Technical report, Stockholm University, Department of Economics.

Forslid, Rikard and Gianmarco I.P. Ottaviano (2003), 'An analytically solvable core-periphery model', *Journal of Economic Geography* **3**(3), 229–240.

Fujita, Masahisa and Paul Krugman (2003), 'The new economic geography: Past, present and the future', *Papers in Regional Science* **83**(1), 139 –164.

Fujita, Masahisa, Paul R. Krugman and Anthony J. Venables (1999), *The Spatial Economy: Cities, Regions, and International Trade*, The MIT Press, Cambridge, Massachusetts.

Gaigné, Carl and Stéphane Riou (2004), Regional integration and tax competition under upward revenue sharing, Working paper, Universite Jean Monnet Saint-Etienne.

Gaigné, Carl and Stéphane Riou (2007), 'Globalization, tax competition and fiscal equalization', *Journal of Public Economic Theory* **9**(5), 901–925.

Hertel, Thomas W. and Marinos E. Tsigas (1999), Structure of GTAP, *in* T. W.Hertel, ed., 'Global Trade Analysis: Modeling and Applications', Cambridge University Press, Cambridge, NY, chapter 2, pp. 13–74.

Indenrigs- og Sundhedsministeriet (2005), Finansieringsudvalgets rapport om et nyt tilskuds- og udligningssystem, Rapport, Indenrigs- og Sundhedsministeriet, København.

Krugman, Paul (1991), 'Increasing returns and economic geography', *Journal of Political Economy* **99**(3), 483–499.

Krugman, Paul R. (1980), 'Scale Economies, Product Diffrentiation, and the Pattern of Trade', *American Economic Review* **70**(5), 950–959.

Ludema, Rodney D. and Ian Wooton (2000), 'Economic geography and the fiscal effects of regional integration', *Journal of International Economics* **52**(2), 331–357.

Martin, P. and C.A. Rogers (1995), 'Industrial location and public infrastructure', *Journal of International Economics* **39**, 335–351.

Möhr, Malte, William H. Crown and Karen R. Polenske (1987), 'A linear programming approach to solving infeasible RAS problems', *Journal of Regional Science* **27**(4), 587–603.

Murata, Yasusada and Jacques-François Thisse (2005), 'A simple model of economic geography à la Helpman-Tabuchi', *Journal of Urban Economics* **58**(1), 137–155.

National Accounts, Statistics Denmark (2006), *Danish Input-Output Tables and Analyses 2004*, Statistics Denmark.

Ottaviano, Gianmarco I.P. (2002), Regional policy in the global economy: Insights from new economic geography, HWWA Discussion Paper 211, Hamburg Institute of International Economics, Hamburg, Germany.

Pedersen, Niels Jørgen Mau (1995), *Decentralisering og kommunaløkonomi*, Jurist- og Økonomforbundet.

Porter, Michael E. (2003), 'The economic performance of regions', *Regional Studies* **37**(6–7), 549–578.

Robert-Nicoud, Frédéric (2005), 'The structure of simple 'new economic geography' models (or, on identical twins)', *Journal of Economic Geography* **5**(2), 201–234.

Rutherford, Thomas F. and David G. Tarr (2008), 'Poverty effects of russia's wto accession: Modeling "real" households with endogenous productivity effects', *Journal of International Economics* **75**(1), 131–150.

Samuelson, P. A. (1952), 'The transfer problem and transport costs: The terms of trade when impediments are absent', *The Economic Journal* **62**(246), 278–304.

Spence, Michael A. (1976), 'Product Selection, Fixed Costs, and Monopolistic Competition', *Review of Economic Studies* **43**(2), 217–235.

Statistics Denmark (2007), 'Ida-database'.

The Economic Council (2003), Erhvervsstruktur og produktivitet, *in* 'Dansk Økonomi', Det Økonomiske Råd, chapter 5, pp. 193–218.

The Global Trade Analysis Project (2000), 'The global trade analysis project, center for global trade analysis'.

Tirole, Jean (1994), *The Theory of Industrial Organisation*, The MIT Press, Cambridge, Massachusetts, London, England.

Venables, Anthony J. (1996), 'Equilibrium Locations of Vertically Linked Industries', *International Economic Review* **37**(2), 341–360.

Chapter 4

Danish Regional Models

After the recent reform of the Danish municipal structure, the equalisation grant scheme in place also needed a reform. This paper constructs a regional computable general equilibrium model of Denmark to analyse the effects on regional income and the locational production structure from the reform. The equalisation grant reform transfers 900 million kroner from the regional public sector in East Denmark to West Denmark. Simulations show that the contraction of the regional public sector i Copenhagen creates room for the knowledge intensive clusters to expand. But the corresponding growth in the Western public sector squeezes the private industries in those regions. However, the scale effects inherent in the clusters in Copenhagen leads to production increase so that the national welfare increases as a result of the equalisation reform. The theoretical foundation used to build the CGE model is economic geography as described in Fujita et al. (1999), characterised by monopolistic competition assumptions and agglomeration characteristics. The paper introduces a methodology to regionalise national data using available information on regional supply of labour and capital. This is also used to calculate an interregional trade matrix.

4.1 Introduction

A critique of agglomeration models is that they predict what is termed *catastrophic* agglomeration. The results from the theoretic models are, that either there is complete symmetry of production or there is only production in one region, and the change is not gradual. However, Ottaviano (2002) dismiss the concerns and states: *"...for policy analysis to proceed, the first step is precisely to take the models literally.'* In other words, accept the drawbacks of modelling agglomeration through monopolistic competition and transport costs, and understand what policy conclusions can be drawn. And as I show on the following pages, expanding the model with more regions and more sectors, each with different agglomeration patterns, the agglomeration models can indeed be used for policy analysis. Baldwin et al. (2003) have a comprehensive coverage of various policy aspects and are also proponents of entering into the arena of policy analysis, but none offer any applied models for the analysis. The present paper remedies this.

The previous two chapters analysed regional agglomeration models in simple two by two setups. Those models gradually introduced key aspects of a real local economy: space, taxes, congestion costs and local public production, and the analyses gave insight to how these aspects change the agglomeration patterns in economic geography models. Turning to an application of these concepts to the Danish economy, the present paper offers a methodology and an implementation of a regional computable general equilibrium model with agglomeration effects. Although, the element of congestion costs is left out of the modelling setup, and left for future analysis.

The presented model is applied to give a regional evaluation of the recent reform of the municipal and regional equalisation scheme in Denmark. The reform transfers extra money from the richer Eastern part of Denmark to the Western part, but the change in interregional transfers is relatively small compared to the budgets of local governments. In spite of this, the reform of the equalisation scheme does have significant effects on the regional production structure and especially on the clustering sectors across the Danish landscape.

The results from the simulations show benefits of implemented policies that have not been shown earlier. In Denmark the regional differences in income and the resulting differences in welfare, however, can be somewhat off-set by the provision of local public sectors and the interregional transfers of public revenue. Some regions are blessed with rich cities while other more remote regions are devout of economic activity. At the risk of stating the obvious, rich regions can afford more than poor regions. Although, countries strive to overcome this using policies of transferring income between regions, thus opening the possibilities for poorer local governments to supply more services than they otherwise could have supplied. As a result, the higher public provision in poor regions raise the welfare for local citizens and, in fact, the simulation show that aggregated welfare for the whole economy is also increased.

In the following section, 4.2, a description of the Danish economy is given, with emphasis on the public sector. Section 4.3 goes in to more detail on the specifics concerning the modelling of the economy. This is followed by section 4.4 that cover the empirical foundation used for the calibration of the model. The section also deals with the methodology taken in order to disaggregate into the regional setup of the model. Section 4.5 sets up the counterfactual experiment of reforming the equalisation grant scheme which was implemented recently in Denmark. Finally, the chapter is summed up in section 4.6.

4.2 Economic Backdrop of Denmark

Getting an overview of the Danish economy, and the division of government between local and central authorities, is vital in the process of constructing a CGE model of the economy. This section briefly describes the workings of the Danish economy with special focus on the public sectors, as these sectors in Denmark account for almost 40% of the national income, and employ approximately 30% of the work force. The description lays the foundation for the formal mathematical specification of the equations in the model.

4.2.1 Overall Economy

The Danish economy is a small open economy, participating in the European Union. Thus, the Danish government has little or no influence on the world markets, their development, prices or interest rates. Danish firms compete as price takers and the international markets are insatiable to Danish exports, i.e. there are no upper constraints on export volume from the viewpoint of the buyers. The Danish exchange rate is technically free floating, but the central bank is committed to keeping a fixed exchange rate vis-a-vis the Euro, and cooperates with other European central banks in this respect, although not in the common currency area. Simultaneously, the fiscal policy of the Danish government is also strictly committed to the goals put forth in the European Union's Growth and Stability Pact, a commitment that supports and facilitates the goal of a *de facto* fixed exchange rate.

As the Danish economy has next to no influence on the world economy, that part of the model is treated exogenously. The computable model is closed by assuming an unchanged trade balance using a common effective foreign exchange as nominator. This means that, in order to increase imports, exports have to be sold to buy the extra imports. In the short run this is too restrictive, but even in the medium run a significant trade imbalance will be inconsistent with a fixed exchange rate. In addition, since the rest of the world is treated exogenously, the foreign exchange rate is chosen as the model's overall numeraire. All changes in the model's prices are reported relative to the price of foreign exchange.

4.2.2 Public Sector

Denmark has a relatively large public sector compared to other countries. The government is split into three layers of authority each with a different set of obligations and autonomy. The lowest level is the municipality followed by administrative regions, and finally, the national government. The recent structural reform of the regional governmental system, with the effect from 2007, has reduced the number of municipalities from 275 to 98, and reduced the 14 regions[1] to 5 regions. The municipalities supply publicly available goods to their citizens. These goods encompass day care centres, schools, retirement homes, renovation services, emergency services, local roads planning, unemployment centres, business service centres, etc. The regions are solely in charge of the public health care system and regional business development. The top level government supplies schooling at high school level and upwards, national defence, sets overall guidelines and so forth.

The municipality and the administrative regions are free to choose the level of public provision they want to supply their citizens. Despite certain minimum requirements being set by the central government, the main philosophy is that the local authority knows best, e.g. being elected, the local governments are most aware of local preferences and circumstances. In addition, the lower levels of government have been entrusted to implement the social benefits schemes.

All the public provision supplied by the three levels of government is financed by taxes and duties. The municipalities' source of income comes primarily from imposing tax on their citizens' income and housing and from property tax on businesses. And to cover the imposed minimal level of public provision and supplied social benefits, the central government issues general grants to the municipalities budgets. Turning to the regions, they do not have the authority to raise income through taxes or duties, so they are completely dependent on government grants to finance the supply of their public provision. Finally, the central government charges taxes on

[1]The previous name for these entities were *Counties*. The post-reform naming is *Region*.

labour income, collects corporate taxes, earns consumption taxes (VAT) and excise duties, and extracts import duties.

The system of local taxes combined with general grants does not necessarily enable municipalities to supply the same levels of public provision. Clearly, a municipality with citizens that are well off is able to collect more taxes than a municipality with citizens that are not so well off. Thus, the differences in municipalities' tax bases do not give them equal opportunities to supply amenities and public goods to their citizens. The area harbouring the richer tax base can set tax rates lower in order to supply a similar level of public provision compared to poorer areas. In order to alleviate this problem and to adhere to the principle of similar citizens have to be treated equally, regardless of residence, Denmark has imposed an equalisation scheme.

The municipal equalisation scheme is, briefly stated, a large transfer system that moves funds from rich regions to poor regions, and this in order to fulfil the principle of equals should be treated equally. The bare inter-municipal transfer system is built as a zero sum relocation of money, but due to the complexity and introduction of certain exemptions it is in effect a negative sum system, where the central government makes up for the difference.[2] The principle of *equals being treated equally* is formulated as keeping the ratio of tax revenues to the level of public provision the same for all. If a municipality chooses a high level of public provision, it also has to choose a high tax rate to reclaim the cost, and vice versa, if they choose a low level of provision they should be allowed to lower taxes. This is based on the assumption of the tax base being unchanged, in the short run, by changes in public provision. Thus, the equalisation system needs to transfer funds such that the ratio is the same across all municipalities. This eliminates the case of a municipality with a poor tax base needing to tax their citizens hard in order to collect a minimum of revenue.

[2] The exact calculation is based on a combination of a cost burden and a tax-provision ratio. The formulation leaves the sum of required money to the receiving municipalities larger than the sum of money from the paying regions, see Pedersen (1995).

The exact calculation of the nominator and, not least, the denominator for the tax to service ratio is a hugely complex matter, see Pedersen (1995) and Indenrigs- og Sundhedsministeriet (2005). It is based on a wide range of factors including a calculation of an area expenditure requirement. The modelling setup put forth in this paper refrains from endogenously calculating the equalisation scheme in itself, but will treat it exogenously given. In this respect, the proposed CGE model in the next sections will not take endogenous changes to equalisation into account. This choice is also based on the fact that the scheme itself is not a result of rational behaviour on behalf of any agent, but purely is a politically decided chosen instrument. Although, the scheme could create incentives that do change the behaviour of e.g. local government agents, however these are disregarded.

To sum up, the public sector in Denmark is split in three administrative levels of government each responsible for a part of the public provision to their citizens. The financing of the local provision is a mix of the individual municipality's own tax collection, a centralised grant and an equalisation scheme between all the municipalities. For the purpose of the modelling exercise, the public sector is modelled two tier: central and regional public production. The regional public production thus encompasses both the municipal and the regional level.

4.2.3 Clusters in the Private Sectors

The non-public part of the Danish economy remains to be described. For the purpose of this paper, the private sector is characterised into three main types of activities, these are resource based, locally oriented and globally oriented activities. The work by Porter (2003) and others have shown that the globally oriented activities tend to cluster together in order to take advantage of scale effects on the industry level.

The most apparent evidence that space is important for firms' decision of where to locate is the existence of industrial clusters. Several studies have shown that many industries show signs of firms placing their production in close proximity to each other, see Porter (2003), Copenhagen Economics (2006), and Combes and Duranton (2001). These researchers have also found evidence of non-pecuniary externalities between groups of industries when these are located close to each other.

Since these positive effects are prevalent within localised clusters, they can be described as monopolistic competitive sectors in a new economic geography model. Sectors in these models are exactly formulated to catch positive externalities from closeness. Copenhagen Economics (2006) shows that clusters of globalised industries are present in the Danish economy, and that they contribute significantly to the economy. Furthermore, they create a regional income base for the locally oriented activities. The cluster sectors' output amount to almost 25% of Danish Gross Value Added (GVA). The globalised sectors are also spread unevenly across the Danish geography, with most production, about 40%, taking place in the Copenhagen region. Using the information gathered in the above mentioned studies, the cluster sectors are constructed for the model. Section 4.4 will return to the empirical observations on the industrial make up and spatial distribution of these clusters.

The present paper uses the sector classification that have been identified in the Danish regional economy in Copenhagen Economics (2006). This yields both a grouping of which industries form into the various clusters and a cluster map of where the clusters are located Denmark. The details of the method applied is treated in section 4.4.

Table 4.1 shows the 11 identified clusters. These are grouped into two meta-clusters, *Knowledge Intensive Production* and *Manufacturing Production.*

The first columns in the table report the absolute values of output, rents to factors and foreign

Table 4.1: National Structure of Sectors in Denmark – 2003

	GVA per capita 1,000 DKK	*In billion DKK* GVA	Wage Bill	Capital Rents	Total Exports	Total Imports	Share of total GVA	*Relative to sector's GVA* Wage Bill	Capital Rents	Total Exports	Total Imports
Knowledge intensive clusters											
Business Services	6.3	33.7	17.5	16.2	4.8	6.3	2.8%	52%	48%	14%	19%
Entertainment	2.8	15.2	10.2	5.0	8.5	12.6	1.3%	67%	33%	56%	83%
Financial Services	4.5	24.1	15.2	8.8	4.8	13.9	2.0%	63%	37%	20%	58%
IT and Telecommunication	9.8	52.6	38.6	14.0	37.3	40.2	4.4%	73%	27%	71%	77%
Tourism	2.4	13.0	7.7	5.2	1.2	0.8	1.1%	60%	40%	9%	6%
Manufacturing clusters											
Building Materials	4.4	23.6	18.0	5.6	27.4	29.8	2.0%	76%	24%	116%	126%
Chemical and Pharmaceutical	7.5	40.1	23.6	16.6	68.9	70.9	3.3%	59%	41%	172%	177%
Foodstuff	7.6	40.6	28.1	12.5	72.4	31.7	3.4%	69%	31%	178%	78%
Machinery and Engineering	5.0	27.0	20.7	6.3	30.2	52.1	2.2%	77%	23%	112%	193%
Textiles, Wood and Furniture	4.4	23.4	16.5	7.0	30.4	31.4	2.0%	70%	30%	130%	134%
Non-cluster sectors											
Transport and Logistics	7.9	42.3	23.0	19.3	110.9	40.4	3.5%	54%	46%	262%	96%
Local Private Production	102.4	549.7	287.8	261.9	99.2	69.6	45.8%	52%	48%	18%	13%
Natural Resource Based	6.8	36.4	7.2	29.2	22.3	14.6	3.0%	20%	80%	61%	40%
Public Production	24.4	131.0	118.5	12.5	1.9	0.7	10.9%	90%	10%	1%	1%
Regional Public Production	27.4	147.2	130.7	16.5	0.5	0.5	12.3%	89%	11%	0%	0%
Total	223.5	1199.8	763.3	436.5	520.6	415.7	100.0%	64%	36%	43%	35%

Source: Own calculations based on Copenhagen Economics (2006) and National Accounts (2006).

trade, while the next columns give the national distribution of sectors in percentages and the individual sectors' split of between capital and labour as well as the importance of foreign trade for each sector.

The clusters account for about 24.5% of the total output of the Danish economy, with 11.6% coming from the knowledge intensive clusters, where the largest is the *IT and Telecommunications* sector accounting for 4.4% of gross value added, followed by *Business Services* and *Financial Services* with 2.8% and 2.0% respectively. In addition, the sectors in this meta-cluster are relatively labour intensive compared to the non-clustering private sectors.

The manufacturing clusters account for 12.9% of total value added and are in general more labour intensive in production than the knowledge intensive clusters. The most important manufacturing clusters are the *Foodstuff* sector and *Chemical and Pharmaceutical* production, with 3.4% and 3.3% of total Danish value added respectively. The manufacturing clusters exhibit the most labour-intensive production of all private sectors with a capital-labour ratio of 23 to 77 (measured in value added) in the *Machinery and Engineering* cluster as the most extreme case. The manufacturing clusters also have high export ratios in terms of their value added, with export volumes well above total value added of the clusters. These sectors show a high dependency on international trade. This element of a high degree of export dependence is rooted in the fact that it is one of the defining characteristics of a cluster – that they are globally oriented industries, cf. Porter's (2003) methodology of identifying clusters.

The rest of the economy's total value added is produced in non-clustering sectors, with 45.8% being locally produced goods and services and 23.2% being public service goods from either central or local and regional governments. The remaining value added is split between *Transport Services* and resource extraction[3], which produce 3.5% and 3.0% of national output of

[3]Resource extraction are for example farming and fisheries

value added, respectively.

The Danish public sector is relatively large in an international comparison, and more than half of the public service is supplied at the regional or local level. The public production sectors have wage shares about 90%, and they are by far the most labour intensive of all the sectors in the Danish economy . The international trade shares for the public sectors are practically non-existing by the nature of the public provision being non-traded internationally.

After a short examination of the trade volume in the sectors, it is apparent that clusters account for far the largest part of international trade. The manufacturing clusters have total trade volumes that are more than double their value added. In total the manufacturing clusters account for 44% of total exports from Denmark and for 52% of all imports to Denmark, despite their relatively modest share of the overall value added. The knowledge intensive clusters account for 11% of total exports and 18% of total imports. With the exception of the *Tourism* sector, the knowledge intensive clusters thus have trade shares which correspond more closely with their shares of total value added. However, these trade volumes are still high compared to the non-clustering sectors of the economy. It is the globally oriented firms, in both the knowledge intensive clusters and the manufacturing clusters, that are assumed to have scale effects in the modelling setup.

The transport sector represents 3.5% of national value added, but it has importance in facilitating the physical connection between producer and consumer in the economy. The sector supplies all the interregional trade services used for the interregional trade flows. The sector also stands out because of the very large international export volume of 262% relative to value added. This characteristic is partially inherited from the Danish sea transport industry which is embedded in the sector.

4.2.4 Regional Make-up of Production in Denmark

The recent reform of the Danish municipal structure in 2007 gave birth to five administrative regions in Denmark. These regions are used to define the regional structure in the modelling setup and they are Copenhagen, Zealand, Southern Denmark, Mid-Jutland and Northern Jutland. The spatial make-up of Danish production is not readily available from statistical resources, and as a consequence is an imputed distribution of industry. The methodology of this regionalisation is described in detail in section 4.4. The imputed split of the production structure by region is presented in table 4.2.

With close to 40% of the country's value added, the Copenhagen region accounts for the largest share of the economic activity in Denmark. Two other fairly active regions are the Mid-Jutland and Southern Denmark accounting for 23% and 18% of total value added respectively. The regions with the lowest shares of value added are Zealand and Northern Jutland, with 12% and less than 10%, respectively.

Some of the differences in the distribution of value added across regions are connected naturally to the distribution of the population. Northern Jutland also has the smallest population of the five Danish regions, and Copenhagen has the largest, so it is hardly surprising that Copenhagen has a larger share of value added than Northern Jutland.

The regional distribution of the clustering sectors varies. The knowledge intensive sectors are primarily centred in the Copenhagen region, where they account for 16 % of value added in all. In no other region do these clusters exceed 10% of the economic activity. The manufacturing clusters are slightly more evenly distributed cross the country, albeit the main parts are in the regions Mid-Jutland and Southern Denmark. Together the five manufacturing clusters account for between 15% and 18% of the value added in all regions, except Copenhagen, where just 7%

Table 4.2: Regional Distribution of Sectors – 2003

	Denmark	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	
	Sector's share of region's GVA						*Region's share of sector's GVA*					
— *Knowledge intensive clusters* —												
Business Services	2.8%	3.6%	1.9%	2.2%	2.7%	2.1%	50.4%	8.2%	14.0%	21.2%	6.2%	100%
Entertainment	1.3%	1.0%	0.9%	2.0%	1.4%	0.7%	32.7%	8.5%	28.9%	25.4%	4.5%	100%
Financial Services	2.0%	3.6%	0.6%	1.4%	0.9%	0.7%	70.2%	3.8%	12.4%	10.6%	3.0%	100%
IT and Telecommunication	4.4%	6.6%	1.5%	2.1%	4.0%	3.7%	59.6%	4.1%	8.7%	20.6%	7.0%	100%
Tourism	1.1%	1.3%	0.6%	1.4%	0.7%	1.2%	46.0%	6.4%	23.3%	14.7%	9.5%	100%
— *Manufacturing clusters* —												
Building Materials	2.0%	0.6%	1.9%	4.0%	2.6%	2.6%	11.0%	11.4%	36.6%	29.9%	11.1%	100%
Chemical and Pharmaceutical	3.3%	3.8%	5.5%	2.7%	2.5%	1.7%	45.3%	19.3%	14.3%	16.9%	4.3%	100%
Foodstuff	3.4%	1.4%	5.0%	5.2%	3.6%	5.9%	16.0%	17.6%	27.7%	24.2%	14.6%	100%
Machinery and Engineering	2.2%	0.8%	1.9%	3.6%	3.3%	3.7%	14.8%	9.7%	28.8%	32.8%	13.9%	100%
Textiles, Wood and Furniture	2.0%	0.6%	1.0%	2.4%	4.1%	3.1%	11.3%	6.2%	22.0%	47.4%	13.0%	100%
— *Non-cluster sectors* —												
Transport and Logistics	3.5%	3.3%	1.7%	4.1%	4.7%	2.9%	36.5%	5.6%	20.8%	30.2%	6.8%	100%
Local Production	45.8%	48.3%	45.1%	41.8%	46.4%	42.0%	41.6%	11.6%	16.4%	22.7%	7.6%	100%
Natural Resource Based	3.0%	3.1%	5.0%	2.6%	2.2%	3.3%	39.7%	19.5%	15.4%	16.5%	9.0%	100%
Public Production	10.9%	11.5%	11.3%	10.7%	9.2%	12.5%	41.6%	12.2%	17.7%	19.0%	9.6%	100%
Regional Public Production	12.3%	10.6%	15.9%	13.7%	11.4%	13.9%	34.2%	15.3%	20.1%	20.9%	9.4%	100%
Total for all sectors	100%	100%	100%	100%	100%	100%	39.5%	11.8%	18.0%	22.5%	8.3%	

Source: Own calculations based on Copenhagen Economics (2006), National Accounts (2006), Statistics Denmark (2007) and Bureau van Dijk (2006).

of the activity stems from the manufacturing clusters.

The knowledge intensive *Financial Service* cluster, in particular, is heavily concentrated in the Copenhagen region. More than 70% of the sector's value added is generated in Copenhagen. Also the *IT and Telecommunication* sector has a disproportionately high concentration in Copenhagen, as close to 60% of the sector's value added is in this region. The distribution of the *Entertainment* cluster reflects some of the larger urban areas in Denmark, i.e. the highest concentrations are in Copenhagen, Odense, Esbjerg and 'the triangle area' (Southern Denmark) and Århus (Mid-Jutland).

The manufacturing clusters of *Building Materials*, *Machinery and Engineering* and *Textiles, Wood and Furniture* are concentrated in Southern Denmark and Mid-Jutland. Together, the two regions generate 60 to 70% of the value added in these clusters. Almost half (47%) of the national value added in *Textiles, Wood and Furniture* is generated in Mid-Jutland, which is more than double of the region's share of total value added. *Machinery and Engineering* is also concentrated in Mid-Jutland, as close to a third of the cluster's value added stems from this region. The concentration for this sector is not as deep, though, as Southern Denmark follows closely, accounting for 29% of activity. In turn, Southern Denmark has the majority share of the *Building Materials* cluster with 37% of the value added, and Mid-Jutland accounts for an additional 30%. The Copenhagen area generates only a substantial share of the value added in one manufacturing cluster, the *Chemical and Pharmaceutical* sector. Thus 45% of activity in this sector is located in the Copenhagen region. In addition, the Zealand region, accounting for 19% of the value added, also has a fairly large share of *Chemicals and Pharmaceuticals*. The only other cluster – knowledge or manufacturing – with a fair concentration in Zealand is *Foodstuffs*, which is also the most evenly distributed of all the clusters.

The non-clustering sectors are all spread among the five regions along the same lines as the distribution of total value added. Although, Southern Denmark and Mid-Jutland have a slightly larger share of *Transport and Logistics*, than their share of total value added. Recall that the non-clusterings sectors are aggregated into the local and resource based sectors, so these sectors represent a wide range of firms, e.g. hair dressers, restaurants and supermarkets for the local type; and mining, forestry and agriculture in resource based sectors.

Public production has a small bias towards the Copenhagen region, a reflection of the Capital's administrative institutions. Zealand and Northern Jutland have a larger share of both public production and regional public production than of their overall share of value added.

4.3 Modelling Framework

With the Danish economic backdrop outlined in the previous section, the following section goes into detail with respect to the mathematical representation of the economy. The purpose is to give a formal representation of the mathematics behind the computable model that is reader friendly compared to the CGE modelling language. This entails definitions of the agents' problems, a description of the geographic space, and derivations of the necessary equilibrium conditions. However, to give an overview of the framework, the following sets out a brief recapitulation of the theory before diving into the exact mathematical formulation. The topics are dealt with in the following order: First, a presentation of the consumers' preferences and their optimal behaviour. Second, an outline of the different types of producers and their optimal production plans. Third, a description of the setup of the public sector. And finally, a presentation of how the Danish geography is dealt within the model.

4.3.1 Modelling Background

The model in this paper is based on a version of the New Economic Geography model presented by Krugman (1980) and extended by Venables (1996) to cover a real geography.[4] The original model from Krugman deals with two countries engaged in trade in two types of goods, produced under perfect and monopolistic competition respectively. Goods from the perfect competitive industry are traded free of cost, while there are transport costs on the goods from the monopolistic competition industry. Together with labour mobility across countries this creates a general equilibrium model with agglomeration characteristics. The strengths of the model are, as he puts it in Krugman (1980): *"to shed some light on causes of trade between economies with similar factor endowments, and the role of a large domestic market in encouraging exports."* Especially, the first strength is exactly the characteristic of the interactions between regions in the Danish economy.

The transport costs used throughout the literature of New Economic Geography are of the Samuelson Iceberg type, cf. Samuelson (1952). The assumption is that only a fraction of a good that is exported reaches the destination, i.e. some of it melts during transportation. However as this paper calibrates a CGE model to the Danish economy, iceberg costs are an unsatisfactory assumption for describing costs of transportation for the specific reason that disappearance of goods, when they are traded, is not compatible with CGE models' need for closure. Thus, in this paper the assumption is that transport services enter into a Leontief aggregate with the traded good. In order for the trade flow to occur, it requires a specific amount of transport services. And the cost accrues the transport sector supplying the service. The importing agent still pays for the goods shipped, while the exporting agent does not 'receive' all the money. Formulating the transport costs in this manner retains the property of unchanged perceived elasticities of demand of the final consumers, and eliminates the disappearing of goods from the model. The implementation of the transport sector is similar to the methodology used on a national basis by

[4] A real geography in the sense that there are well defined distances between many regions in the model.

Hertel and Tsigas (1999).

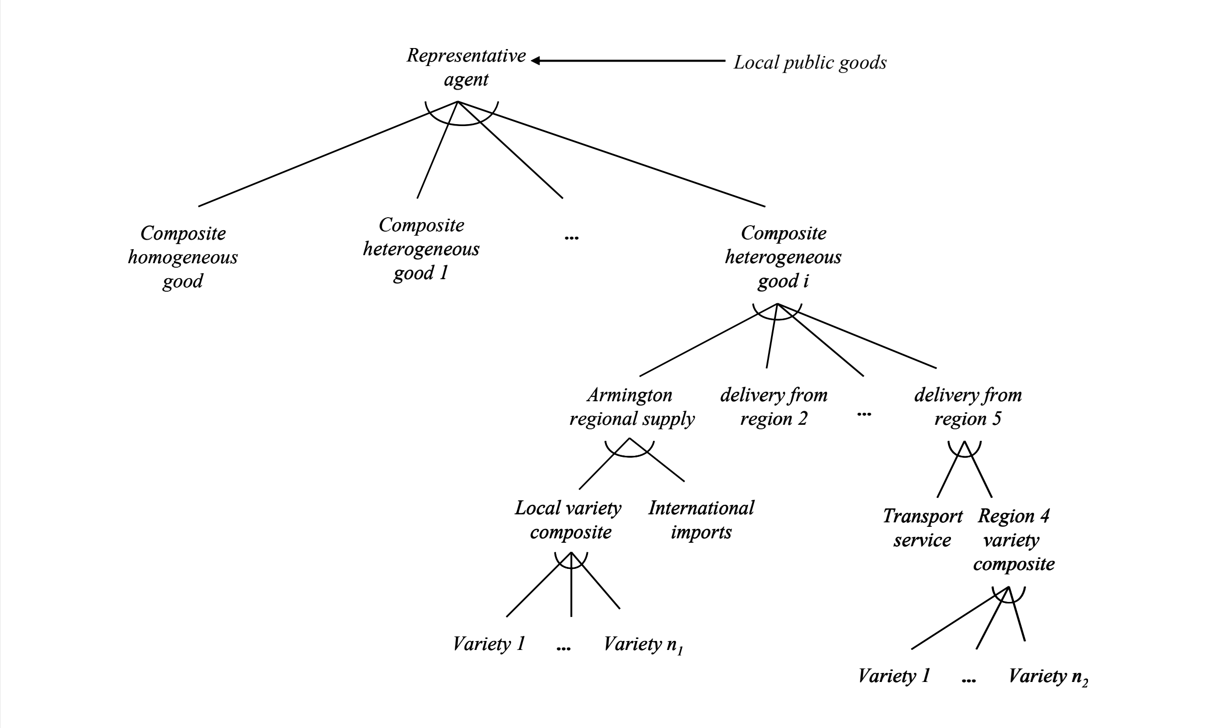
The two primary factors, capital and labour, are assumed not to be mobile. Since firms use intermediate goods as inputs in production, factors are implicitly traded through factor content of the intermediates. The factor content substitutes for the mobility of the primary factors (to a certain degree). However, as complete regional specialisation of sectors, an Armington assumption is imposed on goods from different regions, which also constrains the equalisation of factor prices from the theorem of the factor price equalisation. The analysis performed by Venables (1996) show that models of economic geography retain the properties of agglomeration when factor mobility is replaced by use of intermediate inputs.

At least one good is produced under perfect competition and is allowed to be traded without incurring transport costs. These goods are the homogeneous goods in the model. The other main types of goods are produced in separate industries exhibiting monopolistic competition, such that each type is produced in a range of similar varieties. They are the heterogeneous goods.

4.3.2 Consumers

In each region there is a representative consumer, and all agents have homothetic preferences. Their preferences are the *love-of-variety* kind, as introduced by Spence (1976) and Dixit and Stiglitz (1977). The utility is represented by two-tier function: The top tier is a Cobb-Douglas function across the main types of goods, i.e. the homogeneous goods and the heterogeneous goods. The bottom tier is for each of the main types of heterogeneous goods constructed as a composite of varieties of that good. The composite is a CES function across the varieties for that specific type of heterogeneous goods. By this, it is assumed that consumers value equally each variety within the main types, but with a substitution effect imposed from the CES function.

Figure 4.1: The Representative Agent's Consumption Bundle



When using a CES function for the composite utility function the consumers will always receive higher utility when more varieties are available, and as a result, will always demand some amount of all the types of varieties. In addition, the consumer is assigned an amount of local public goods from which he derives utility, but is unable to decide how much to consume. The local public goods enter as an additive term in the utility function. National public goods from the central government are treated exogenously and are left out. The composition of the consumers' utility bundle is visualised in figure 4.1. Formally, the consumer gets utility, U, from the a types of homogeneous goods, A_a, and s types of heterogeneous goods, B_s:

$$U = \left(\prod_a A_a^{\mu_a}\right)\left(\prod_s B_s^{\mu_s}\right) + LPG, \quad \sum_a \mu_a + \sum_s \mu_s = 1, \quad 0 < \mu_a < 1, \quad 0 < \mu_s < 1, \quad (4.1)$$

where μ_a are the shares of income spent each type of homogeneous goods, and μ_s are the shares of income spent on each composite of heterogeneous goods. The local public provision is denoted LPG. Each B_s is a composite good constructed as a CES aggregate over the n_s

varieties. The CES function takes the form:

$$B_s = \left(\sum_{n_s} b_{n_s}^{\rho_s} \right)^{\frac{1}{\rho_s}}, \qquad \forall s, \quad 0 < \rho_s < 1, \tag{4.2}$$

where b_{n_s} is the consumption of variety n from sector s. Defining $\rho_s \equiv 1 - \frac{1}{\sigma_s} = \frac{\sigma_s - 1}{\sigma_s}, \sigma_s > 1$, then σ_s is the elasticity of substitution between varieties of type s heterogeneous goods, and low sigma entails low substitution and greater differentiation.

The consumer maximises utility subject to prices and his budget, and as this decision is unaffected by what level of public provision he receives, local public goods are eliminated in the derivation of the demand functions. The consumer's problem is solved in two stages, first by minimising the expenditure on the heterogeneous composites, then by maximising utility over homogeneous goods and the heterogeneous composites. The demand functions are

$$A_s = \mu_a \frac{I}{p_a}, \qquad b_{n_s} = \mu_s \frac{I}{G_s} \left(\frac{p_{n_s}}{G_s} \right)^{\sigma_s}, \qquad G_s = \left(\sum_{n_s} p_{n_s}^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}} \tag{4.3}$$

Where, p_a is the price for the homogeneous good a, p_{n_s} is the price of a single variety and G_s is the price of a composite from the heterogeneous sector s. These prices are the prices facing the consumer. The price for the same good or variety are allowed to vary at different markets, i.e. the same good has different prices depending on the region where it is sold. Finally, I is the consumer's total income from ownership of labour and capital $I = wL + rK$. It is assumed that the heterogeneous sectors have large number of varieties, such that the overall price index of the varieties is perceived to be unaffected by changes in prices for a single variety. Thus, the variety's elasticity of demand with respect to its own price is simply σ.

4.3.3 Private Sectors

Turning to the private sector the production technology is specified in the following paragraphs. First, with an outline of the general production function used, then with a description of the main types of sectors, i.e. the homogeneous and heterogeneous sectors.

General Input Composite

All sectors use a similar type of composite inputs for their production technology. The input composite is formulated as a two-tier function. The bottom tier aggregates the primary factors in an expression of the value added, and the top tier aggregates the value added from the primary factors with the use of intermediates. The bottom tier is a Cobb-Douglas constant returns to scale aggregation over capital and labour, giving the value added aggregate, VA_i, in sector i the functional form of

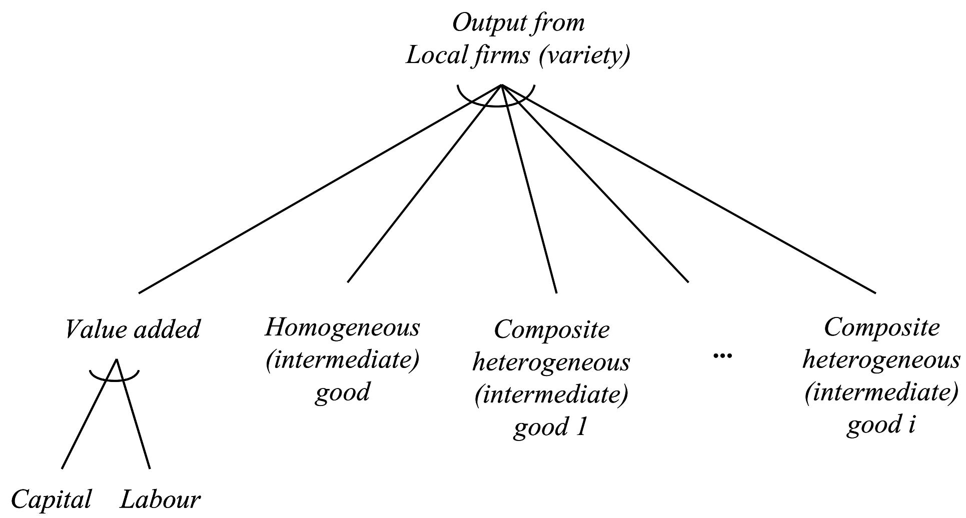
$$VA_i = \Psi_i K_i^{\alpha_i} L_i^{1-\alpha_i}, \qquad 0 < \alpha_i < 1, \tag{4.4}$$

where Ψ_i is the scaling factor for the technology, K_i and L_i is capital and labour employed, while α_i is the cost share of capital in the production for sector i. The top tier is a Leontief fixed proportions production function for output, Y_i, and is given by

$$Y_i = \min\left(\frac{1}{\beta_i^{VA}} VA_i, \frac{1}{\beta_i^1} X_i^1, \ldots, \frac{1}{\beta_i^j} X_i^j, \ldots, \frac{1}{\beta_i^N} X_i^N\right), \qquad \beta_i^{VA} + \sum \beta_i^j = 1, \tag{4.5}$$

where the β's are the proportions of the value added aggregate and intermediate inputs, X_i^j. Intermediates are supplied from all other sectors, j, to the producing sector i. The functional form of the production functions, thus, allows for substitution between the primary factors, but not between the intermediate inputs. The input composite is visualised in figure 4.2. Minimising expenditure for the composites yields the corresponding unit-demand functions for the value

Figure 4.2: Generalised Input Composite for all Firms



added as

$$K_i = \alpha_i \frac{1}{P_K} \left(\frac{P_K}{\alpha_i}\right)^{\alpha_i} \left(\frac{P_L}{1-\alpha_i}\right)^{1-\alpha_i}, \qquad L_i = (1-\alpha_i)\frac{1}{P_L} \left(\frac{P_K}{\alpha_i}\right)^{\alpha_i} \left(\frac{P_L}{1-\alpha_i}\right)^{1-\alpha_i}, \tag{4.6}$$

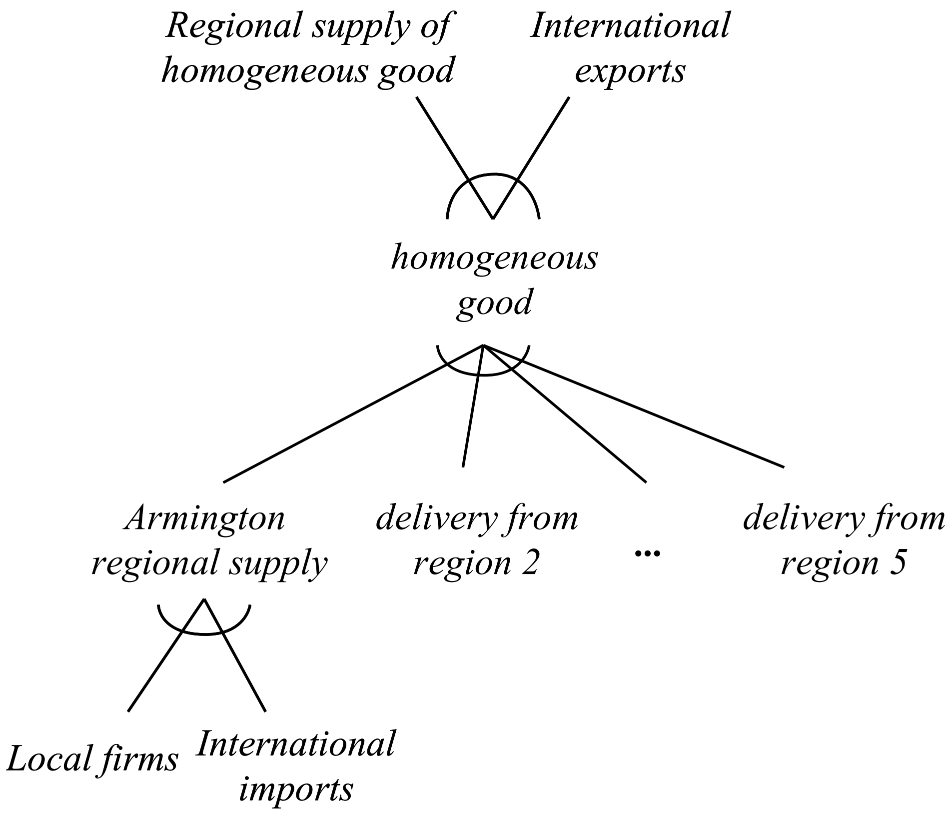
and the top level unit demand functions for the inputs are

$$VA_i = \beta_i^{VA} Y_i, \qquad X_i^j = \beta_i^j Y_i. \tag{4.7}$$

For each unit of general input i requires β_i^j units of input from sector j and β^{VA_i} times the demand functions of primary inputs given by (4.6).

Perfect competition prevails in the homogeneous sectors, and the firms produce with constant returns to scale. The production function for the firms is equal to the general input function. One unit of composite input yields one unit of output. Maximising profits yields prices equalling the marginal cost of producing, and no profits for the firms. The homogeneous goods composition in the economy is given in figure 4.3.

Figure 4.3: The Homogeneous Goods 'composite' in a Region 1



Heterogeneous sectors

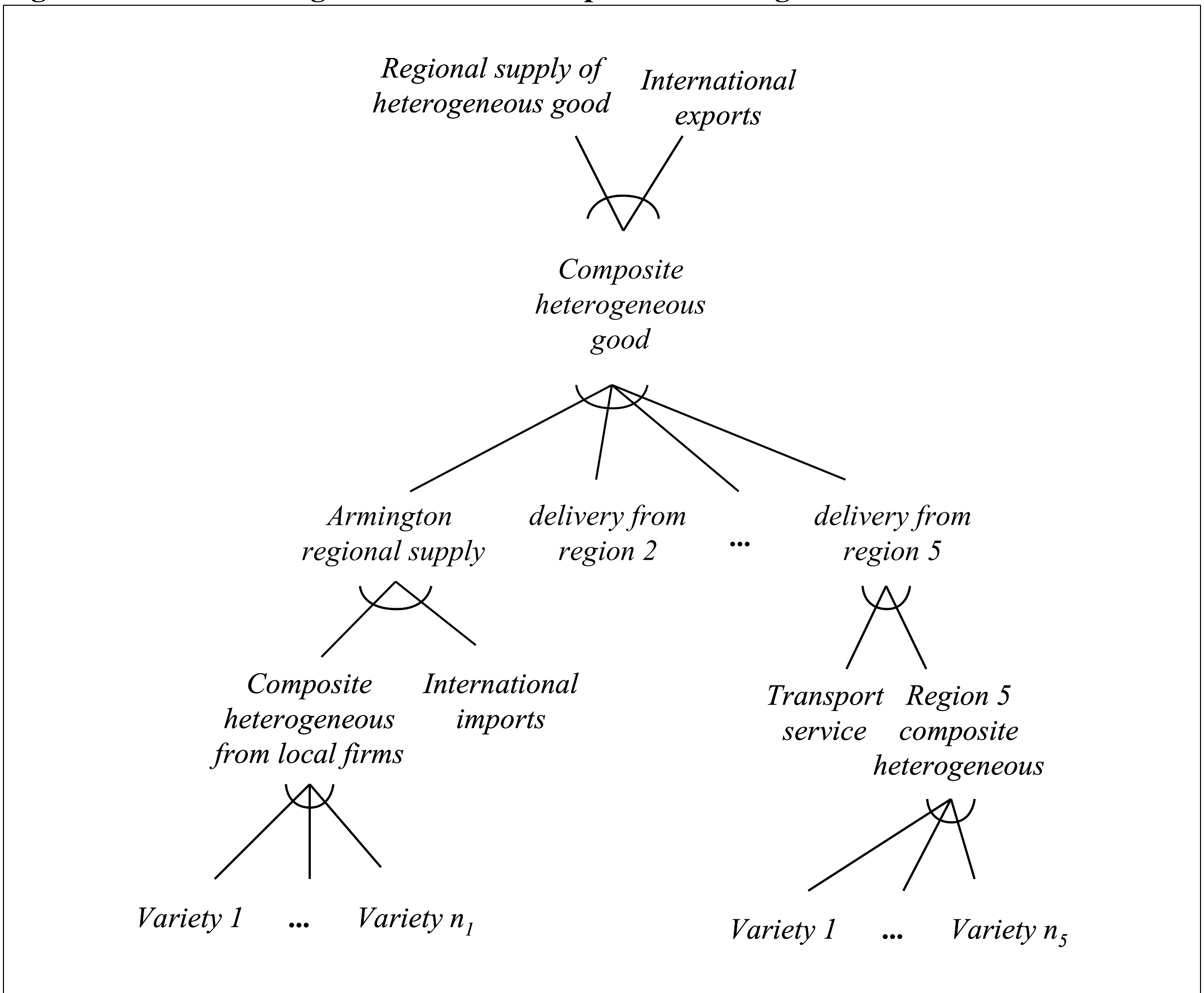
To specify the production functions for the model, it now remains to quantify the exact scale effects of the identified clusters. There are no studies of scale effects based on the industry classification as used in this paper, so for the purpose here, the clustering industries are assumed to exhibit increasing returns to scale, while the resource based and local industries are assumed to produce under constant returns to scale. Thus clustering industries are heterogeneous sectors, and local and resource based industries are assumed to be homogeneous sectors. The production structure is the monopolistic competition structure of Spence (1976) and Dixit and Stiglitz (1977).

The firms in the heterogeneous sectors are assumed to exhibit increasing returns to scale in producing a single variety. It follows from this property, that a firm already producing a variety will always have a cost advantage over any new and existing firms trying to produce the same variety. Each variety is then produced by one firm only and in effect a monopoly exists for each variety.

In addition, the individual firm does not consider the production of other varieties to influence their market decision, so their pricing as a monopolist is determined by the *perceived* elasticity of demand for the variety, which is given by the consumer's demand function as σ. On top of this, it is assumed there is free entry allowing new firms to introduce new varieties. Firms will enter an industry if there are profit opportunities, thereby forcing profits down to zero. Thus the number of varieties is endogenously determined. The usual monopoly market power is transferred from determining the level of output to how many varieties are produced. The composite of heterogeneous goods is depicted in figure 4.4.

The increasing returns technology is implemented through assuming the production function is

Figure 4.4: The Heterogeneous Goods 'composite' in a Region 1



decreasing in average cost by setting a fixed input requirement for production to take place.

The heterogeneous firms maximise profits given the demand structure and the factor markets, and they choose output to satisfy the Lerner index[5] of prices set at marginal cost times the inverse of the elasticity of demand for the varieties, that is:

$$p = \frac{\sigma}{\sigma - 1} MC \tag{4.8}$$

All firms, both homogeneous and heterogeneous firms, compete on factor markets for labour and capital.[6] In addition, they demand intermediate inputs from the goods markets in each region.

This paper assumes that firms that exhibit this increasing returns technology are firms in globalised sectors. They are faced with international competition and are able survive through exploiting the scale advantages inherent in each variety for which they act as monopolists. The sectors previously identified as clustering sectors are exactly this kind of types and they are classified as the heterogeneous industries in the model implementation.

4.3.4 Public Production

As mentioned in the section dealing with the consumer, only the regional public provision is modelled. The national supply of public provision is fixed exogenously. For technical reasons, the regional government is split into producing and a consuming part. The regional public production is modelled as a cost minimising homogeneous sector. Technically, the primary final customer of the production is the regions' local government agent. The local government agent then supply the goods as local public goods, but some of the output is also used in the

[5] See for example ch. 1 in Tirole (1994) for derivation of the Lerner Index.
[6] The Core-Periphery model used by Krugman (1980) uses only labour as a production factor.

local sectors as intermediate inputs. As the local government is the main buyer of the goods from the regional public producing sector, the local government agent's budget determines the size of the sector. In addition, it is assumed that the those goods are non-traded across regional borders. Thus, any change in the local government's consumption directly affects the regions' production of regional public goods.

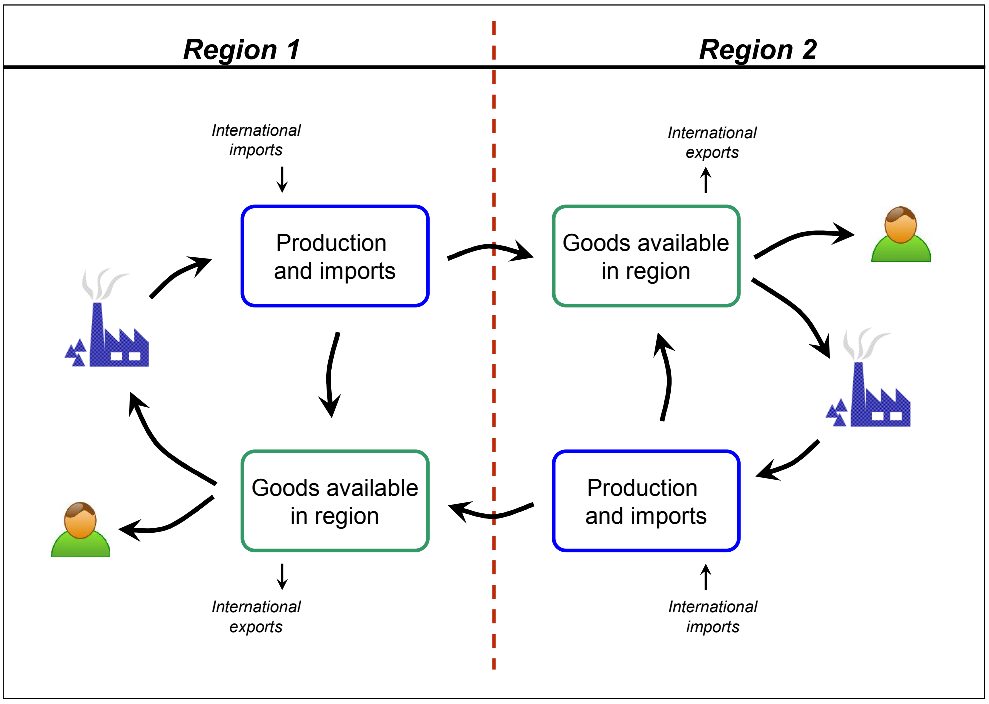
The regional public production technology is the same as for the private homogeneous sectors, i.e. a Cobb-Douglas aggregation of the primary factors, labour and capital, and a Leontief aggregation of the value added composite of factors and intermediate goods. Intermediates can be both from the homogeneous sectors, the heterogeneous sectors, as well as own supply of regional public production. The production exhibits constant returns to scale, so profit maximisation entails zero profits.

The regional government agent's budget consists of an initial endowment of income, given by the benchmark data. But a central redistributive authority is constructed to allow for extra transfers of money between the regional governments – thus mimicking the equalisation grant reform.

4.3.5 Regions

The model consists several regional economies, and these economies engage in interregional trade. This ensures that all regions have access to all types of goods, regardless of place of production, except for the regional public production. The setup of the regional trade of goods is as follows. International imports and regional production is pooled into a regional supply. This supply delivers goods to the region's available goods as well as interregional exports to other regions' available goods. From the region's available goods delivery goes to the region's representative consumer as final demand, to the region's firms as intermediate inputs, and to

Figure 4.5: Flow of Goods, Two Regions



international exports. The international imports and the regional production is aggregated using the Armington assumption, i.e. there is substitution between foreign and local goods. Furthermore, there is an Armington assumption when compiling the interregional trade into a region's available goods. The flow of goods, in the case of two regions, is illustrated in the figure 4.5:

The Armington assumption entails some substitution between goods from different regions, ensuring that there will not be specialisation of production in specific regions. This is a standard technical solution in order to get a working model, and to account for import and export of the same type of goods in the trade data and avoid complete specialisation, cf. The Global Trade Analysis Project (2000).

Goods from the homogeneous sectors do not incur transport costs, but for the varieties from the heterogeneous sectors a markup is applied using a transport service Leontief function on the varieties crossing regional borders.[7] For technical reasons the transport services sector, thus applied to the interregional trade flows, is difficult to label with regards to place of production. So, the transport sector is treated as a national homogeneous sector. The sector can locate anywhere and the service is completely homogeneous since there is no Armington aggregation at all. This is equivalent to the method used in the GTAP model (Hertel and Tsigas, 1999), however they use five different types of transport services, which are global. Having a transport sector that engages in a very large foreign trade does not influence the modelling properties as the international markets are kept fixed in the model.

4.3.6 Properties of the Applied Setup

Crucial to Krugman (1980) and other Economic Geography models are the dynamics of agglomeration and diversification. The dynamics are typically introduced via labour mobility, where labour relocates according to real wage differentials. When many firms concentrate in a country, they increase wage competition, thus increasing the real wage which in turn leads to an influx of labour. Conversely, when there is a low concentration of firms, the lower wage competition decreases the real wage, and induces labour to migrate.

As mentioned earlier, this model substitutes the labour mobility with intraindustry trade, (Venables, 1996). The factor content embedded in the traded goods ensures the model has an indirect mobility of factors, thus retaining the properties of the initial setup by Krugman (1980) and others. Now, the allocation of the heterogeneous firms across regions defines the agglomeration pattern, as opposed to the concentration of skilled labour in the Core-Periphery geographic setups.

The model in this paper exhibits the following important characteristics:

[7] International trade is *fixed* in the sense of a balanced trade budget, so international transport costs can be disregarded.

First, agglomeration forces work through intraindustry trade, which arises from the fact that consumers in all locations demand all varieties. There is interregional trade in heterogeneous goods, but it is restricted by transport costs.

Second, there is increasing returns to scale in the imperfectly competitive industries which produce varieties, and there is free entry and exit of new firms.

Third, the introduction of a new firm to a location will result in a reduction of the consumer price index in that location. This stems from the fact that the new firm's variety is available to the consumers and he receives the full extra utility from the variety without paying the transport cost mark-up. Furthermore, firms will tend to locate in regions that are situated centrally to achieve the best possible market access. However, a large concentration of firms will raise demand for labour in those regions and the resulting wage increase will encourage firms to relocate. In short, the centripetal force is market access and the centrifugal force is factor and product competition. A more thorough description of the characteristics of this type of model can be seen in Fujita et al. (1999).

With the modelling setup outlined, the paper continues with a description of the data used to calibrate the model. The next section will go into detail on the Danish data.

4.4 Empirical Foundation

Now that the specification of the equations of the model is complete, it remains to calibrate the parameters to the case of the Danish regional economy. The following sections describe in detail the empirical foundation that is set up before the calibration.

There is a trade-off between spatial detail and computational complexity. The finer the geographic resolution, the more complex the model becomes, e.g. a doubling of the number of regions leads to a doubling of all markets, a doubling of agents, but a quadratic increase in the number of trade flows. Thus, the number of equations in the model increases exponentially with the number of regions. In addition, the availability of data on municipal level with a satisfactory number of sectors is scarce, and finally, some of the Danish municipalities are so small, that it is questionable to model them as separate economic entities. For instance, the recent Danish municipal reform recommended that each municipality should encompass at least 20,000 citizens. Therefore, the level of spatial detail is chosen as the five Danish administrative regions and not the individual municipalities.

With the level of spatial aggregation decided, the following section describes another dimension. Namely, the specification of the aggregation level for sectors which is based on regional clustering of industries.

4.4.1 Identification of Clusters

Positive spillover effects within localised cluster have been identified, cf. Porter (2003), and such clusters can be interpreted as monopolistic competition sectors in a new economic geography model. Sectors in these models are formulated exactly to catch positive externalities of closeness.[8] It can be argued that clusters group firms wrong, since they produce very different types of goods. In the setup used in the present paper, this objection is disregarded and output from clusters are interpreted as variants of the same type, i.e. firms in a cluster produce variants from a cluster-composite, if you like. Equivalently, the concept of a firm in a monopolistic competition sector is not the same as a physical firm in the economy, but an abstraction of a representative firm in the observed cluster. Henceforth, I will refer to the model's monopolistic competition sectors as clusters and interpret them as such.

[8] Although, it needs to be stressed that the use of monopolistic competition sectors is an abstraction in order to capture the mentioned effects.

In Copenhagen Economics (2006) eleven such clusters are identified. The study uses two methods for this identification. First, by applying Porter's (2003) methodology of analysing industrial co-location patterns in order to uncover which industries tend to locate in the same area. The hypothesis is, that closeness yields an intangible gain for the mutual benefit of firms. These gains or spillovers can happen horizontally within the same type of industries, e.g. by imitating products or cooperating in developing new product. Spillovers between firms can also happen vertically between different industries, e.g. through the value chain of subcontractors. Second, the study uses the ideas of Dahl (2002), which analyse labour mobility to determine which industries share the same labour pool. By using the same labour pool, firms can utilise knowledge embedded in the skilled labour they share. The next paragraphs briefly summarises these two methods for identifying clusters in the Danish economy.

Porter's Method

Porter (2003) focuses on industries that supply on the global market, because firms in these industries, in principle, are free to choose their location. Firms are not dictated by their supply conditions to produce in a specific location. Opposed are firms that have to be local to reach their market, e.g. hair dressers or tradesmen. The freedom of locational choice for global industries give them the possibility of locating close to each other or far from each other. Then, if firms belonging to specific industries tend to build their factories in the same region, it must be because there are more gains than drawbacks from that closeness. Those groups of industries are identified as clusters. Statistically the clusters are found by examining the correlation in concentration of industries, a positive correlation signifies that they cluster together. The industry make-up of each cluster is then evaluated subjectively to determine whether they form meaningful and coherent clusters. The method captures both the horizontal and vertical elements of spillovers.

Dahl's Method

The above results are combined with an analysis based on the work by Dahl (2002). He looks into the mobility of labour across industries. A driving force in the success of clusters is the prevalence of a large supply of highly skilled and specialised labour. In clusters, firms from specific industries will locate to be able to recruit talented workers – they all recruit from the same labour pool. Therefore, it is expected that, within a cluster, labour has a high rate of job switching, i.e. workers move to jobs in other industries, but stay within the same kind of industries that make up the cluster. So, by examining the whole labour force's pattern of mobility, it is possible to group industries that share the same labour pool, and thereby identify clusters. The method captures the horizontal element of spillover effects, spillovers that happen within the same type of firms, but the vertical element is also, to a certain degree, captured by this method.

Finally, the results from these two methods are merged into a unique description of Danish clusters. A description of which industries belong to what type of cluster. The result is a detailed mapping from industry classification into a range of clusters. The work by Copenhagen Economics (2006) is ground breaking in the mapping of clusters since it utilises tacit information about non-pecuniary externalities inherent in the cluster – information which lies in the observed co-location patterns of firms as well as the pattern of workers switching jobs. Thus, it is possible for a cluster to encompass firms from different industries, both vertically and horizontally. The study to identify clusters and quantify the spillover effects using the combination of Porter's and Dahl's methods continues under the auspices of FORA in the InnoNet project. The focus is now on clusters, their industry mix and their location in the Baltic Sea region.

Earlier studies of industrial clusters in Denmark have not been able to identify clusters, e.g. The Economic Council (2003) that analyse clustering using firm level data. They use Statistics

Denmark's 53-industry classification as the cluster classification.[9] Thus, both local and resource based industries are mixed with globally oriented industries. In addition, this classification only considers the horizontal dimension of clusters and neglects the vertical dimension. Finally, the Economic Council analyse clusters in 51 separate regions in the Danish economy which is a too narrow geographic scale for most clusters.

This paper defines the key to translate the 4-digit NACE industry classification to the clusters in Copenhagen Economics' (2006) cluster classification. This is used across the five regions in the setup, and since it is the clusters that exhibit economies of agglomeration , they are, as mentioned before, interpreted as the monopolistic competition sectors in the applied model.

Non-cluster industries are defined as producing under constant returns to scale, and are combined into two broad sectors, resource based production, e.g. forestry and mining, and locally supplied goods, e.g. grocery stores, hair dressers, and tradesmen. Lastly, the public sectors, both local and national, are kept separate from the private sectors.

The transport sector is modelled in a special way. From the cluster identification process, the transport sector *is* flagged as a clustering sector, however, for the purpose of the model, it is separated from the other clusters and assumed to exhibit constant returns to scale. In addition, the transport services supplied by the sector are treated as a nationally homogeneous good that is available everywhere in the country.

4.4.2 Calibration Requirements

A large amount of data is required for calibrating a multi-regional CGE model. The process uses information for all markets and all agents, and this for each region in the model. Thus, the data needs to cover each region's composition of total local supply. The supply consists of

[9]The 53-group is an aggregated version of 4-digit NACE codes.

international imports, supply from other regions, and supply from local production. Similarly, the data needs to cover each region's total demand, which is split in-to international demand, other regions' demand, and demand from local agents. Local agents' consumption levels and their budget constraints are needed in order to quantify the agents' optimisation problems. In addition, data needs to cover the level of local public provision and the regions' factor endowments as well as how big each sector is in a region. Data for all these components is used in the calibration process to quantify the equations in the model.

Most of this data, however, does not exist on a regional level at the level of detail required for the model. There is no Danish regional data for the input-output flows and there is no data for the regional trade flows. There is production data for aggregate sectors at the regional level, but this is not detailed enough which is needed for the cluster classification. The next section describes, in detail, how the lack of data problem is overcome. Briefly, the shortcomings of the data are solved by assuming that the Danish economy is relatively small and integrated. Therefore, it is reasonable to apply a top down approach in getting the required information. The method is along the lines of Rutherford and Tarr (2008), who take the nationally aggregated information from Russia and split it into regional data using information of capital and labour endowments in Russian regions. That is, using national data and then regionalising them using a range of micro-level data that is available on both the regional level and on the sector level.

4.4.3 Regionalisation of Supply and Intermediate Demands

The Danish national input-output table (National Accounts, 2006) is the main source of data. The input-output coefficients represent the aggregate, i.e. national, flows of goods and services between sectors. As a column reports the mix of inputs needed in producing a sector's output, the table is an expression of the aggregate technology for that sector. In addition, the table reports the allocation of all sectors' supply to final demands, whether private consumption, government consumption, investments or international exports. The exercise is to regionalise the national data from the input-output table.

Statistics Denmark reports calculated labour shares in sectors across regions (Statistics Denmark, 2007). It is the employment, reported as the number of full time equivalent workers, for each sector for each region. The labour share is then the region's share of employed workers compared to the full number employed in all regions for a sector. The shares tell how much of an sector's national employment is located in each of the five administrative regions.

The accountancy database, AMADEUS (Bureau van Dijk, 2006), supplies the stock of regional production capital. The database covers 145,000 public companies employing 2,850,000 workers, which is a representative selection of Danish companies. Again, this is used to calculate a region's share of fixed assets in a sector compared to the total fixed assets in Denmark. Thus, the shares report how much of a sector's capital stock is located in each of the five regions. However, when using accounting data a few issues have to be mentioned. First, data is only available for public companies, since private companies are not required to disclose their accounts. Second, reported accounts are tied to the location of the firm's headquarters, which is not necessarily the same as where the production actually takes place. Third, only tangible fixed assets are used in the calculation, thus sectors using more intangible assets, e.g. sectors with service industries, may be skewed. Finally, reported accounts do not necessarily report the real value of assets, as they are originally published for bookkeeping purposes. However, as the firm level data is aggregated and only sector-wide ratios between regions are used, the possible bias in data is minimised since any such bias will occur in both nominator and denominator of the ratios. In addition, the firms covered by the database employ about 85% of the total employed work force and is considerede representative of firms present in Denmark. The data is, therefore, deemed usable for regionalising captial stock in spite of the caveats reported above.[10]

[10]It is the total capital stock that is used. The mention of the number of workers covered by the database is only

Following Rutherford and Tarr (2008), the regional shares of employment and regional shares of capital give a spatial make-up of the distribution of sectors in the Danish economy, i.e. where the sectors are located. The employment shares are used for splitting the national input-output table's labour expenditure into regional employment of labour. This creates a correspondence between the national accounts' reported labour costs in a sector to the regional level of employment in that sector. By using the employment shares for regionalising, there is an implicit assumption that workers across regions have the same productivity for each sector, i.e. the marginal product of labour is the same across the country. The national labour force in the input-output table is given as the total value of the used labour, the value is reported as the total compensation to workers, whereas the employment from Statistics Denmark is reported as the number of equivalent full time workers employed. Thus, the regionalisation uses the value of work multiplied by the share of workers in the region, and the consequence of this is that labour productivity is the same across regions.

Equivalently, the capital shares from AMADEUS are used for splitting the national usage of capital into each region. It is the share of a sector's total assets in a region compared to all the assets of the sector applied on the input-output table's payment to capital owners. Note again, that the input-output table reports the value of payments, i.e. the total value of rents accruing to the capital input, while the capital stock is calculated from the total of fixed assets. Regionalising is carried out using the rents multiplied by the region's share of the stock. As for the labour force, this method implies the assumption that the productivity of capital in a sector is the same across regions, i.e. the marginal product of capital is assumed to be the same across the country.

The above steps yield a spatial mapping of how much (value) of the primary inputs are employed in each sector for each region, i.e. the distribution and levels of labour and capital across regions.

for the purpose of showing how representative the data is of Danish companies.

Restating the regionalisation formally, the two primary factors in the input-output table are distributed in two dimensions, by region and by sector, using the following formula:

$$L_d^i = L_{nation}^i \frac{Emp_d^i}{\sum\limits_d Emp_d^i}, \qquad K_d^i = K_{nation}^i \frac{Cap_d^i}{\sum\limits_d Cap_d^i}, \tag{4.9}$$

where L_{nation}^i and K_{nation}^i are the national endowments of labour and capital from the input-output table. Emp_d^i is region d's total number workers employed in sector i, and Cap_d^i is region d's total value of assets in sector i.

The flows of intermediate goods and services between sectors also need regionalising. These flows are given by the national input-output coefficients, which can be interpreted as the intermediate technology in production. The coefficients report the mix of intermediate inputs chosen by each sector in the economy, thus, the mix represents what is required of intermediates in order to produce one value unit of output. Assuming technology is completely diffused implies that all regions have access to the same technology, or that all regions have the same input-output coefficients. The mix of intermediate inputs in a sector is the same regardless of location, and the amount of required intermediate input is proportional to the size of that region's sector. Using the regions' labour shares as proxies for the size of the regions' sectors, the input requirement of intermediates is regionalised.

4.4.4 Differences in Capital Labour Ratios

The regionalisation using the regions' capital and labour shares means that the capital-labour ratios will be specific for each region within the sectors. The ratio of capital and labour in an industry in one region is not necessary the same as the ratio in a different region for that same sector. For example, the clothing sector has a higher capital-labour ratio in Copenhagen compared to Northern Jutland, or said differently, the sector is more capital intensive in Copenhagen. Similarly, for the rest of the sectors in the model; the intensities will vary across regions. This does not mean that there are differences in available technology in regions, only that firms have chosen different mixes of the primary factors. The firms in different regions have chosen differently on the same production possibility frontier for the primary inputs as a result of the difference in endowments. This also means that the relative prices of wages to rents are different across regions in the benchmark.

With each sector's use of capital, labour and intermediate inputs accounted for, the regions' local supply from local firms is given as the column sum in the new regional input-output tables. The rest of the regional total supply comes from international imports. These are calculated from the total national imports divided among regions using the size of region's sectors. Thus, if most of the clothing sector is located in Jutland, then international imports of clothing is mainly imported to Jutland. As the underlying assumption of the applied model is to fix the balance of payments, this way of splitting the imported goods is just of technical character in order to maintain a balanced dataset, i.e. supply equal demand, and the assumption does not affect the analysed properties of the model.

The row sum of intermediate input also yields the local intermediate demands, and it remains to regionalise final demands to complete the dataset.

The final demands in the national input-output table reports the national level of private consumption, the national government consumption, total investments, all stock changes and international exports. All these components also have to be split into regional values. The method used follows in the next paragraphs.

Private consumption is given as the total value of household consumption of goods supplied nationally and through international imports. Given that households have homothetic preferences over goods and services, they will have the same proportional composition of goods in the consumption basket. Since homothetic preferences imply a linear expansion path of consumption in income, the only difference between households in different regions will be the size of their baskets, which depend on their incomes. Using data on family incomes from Statistic Denmark reveals the spatial distribution of household income. A region's share of total family income is used to scale the private consumption basket, thus regionalising private final demand.

Continuing the same line of reasoning for local governments, the regional governments' demands can be extracted. If all the local governments' composition of demand for government consumption is the same, it is only the size of the total basket that differs between regions. And the size of regional government demand is equivalent to the size of the regional government. This is derived from the employment figures that were used for regionalising labour. Again it is assumed that governments consume the same per employed worker, regardless of which region the government is. In addition, the demand from the local government is transferred as a publicly provided good to the benefit of the local agents, see the discussion of how the public provision is treated in the model.

Finally, the investment demand and international demand are split into regions using the size of the local production in each region, the same method used for splitting import supply into regions. Since the CGE models' setup fixes the investment levels as exogenous and fixes the current account, the regionalisation of investment and export demands is reduced to make sure all the numbers add up. The resulting spatial make-up of the sectors was previously presented in table 4.2 on page 85.

With the calculation of each region's total demands and supplies, only the exchange of goods between regions is unaccounted for. The regionalisation maps the national accounts to regions, but using a range of micro-level information this results in an imbalance in how much each region supplies compared to how much it consumes. Following the bookkeeping rules of national data, we know that any excess demand in one region is necessarily covered by supply from another region. But, the new regional input-output tables only report the net flow excess demands and supplies. They do not contain information on how much is bought and sold to and from which region. The bilateral trade is missing. The following section describes a method to calculate these gross bilateral flows of goods and services.

4.4.5 Calculating the Interregional Trade Matrix

With only data on net trade, and without data on bilateral trade, the calibration of interregional trade patterns will result in a clear understatement of the real trade, and even worse to a deletion of flows in the final model. From the net flows it follows that if there is net import of goods to a region, there is no net exports. This will be carried into the calibration where the equation governing import is understated and the equation governing exports is completely dropped. Thus, if net trade flows are used, it means that half of the interregional trade flows are dropped from the model and the rest are understated. A dropped equation implies that the economic mechanism described by that equation is completely removed and it will not re-emerge.

To alleviate the problems of underestimating and dropping trade flows, an extra assumption on the regional demand behaviour is made such that a full matrix of gross interregional trade flows is found. Thus, it is possible deduce the shipments of goods between regions for all possible trade flows. The assumption builds on the fact that the regions form a relatively small and coherent economic sphere. The regions in Denmark are very closely integrated and they are able to supply each other easily with goods from all industries. The assumption deals with the consumers' tendency toward preferring locally produced goods, or their degree of home-bias in their choice of the consumption bundle. Two versions, the no-home-bias and the home-bias, are tried to evaluate the outcome on the model's properties.

The no-home-bias version assumes that consumers do not care from where a good or service originates. When the consumer decides on the composition of his consumption basket, he will choose how much of each good he wants to consume, and not consider region of origin of the goods. At the same time all regions supply the good through their local production, so for each type of good the amount imported will be reflected by the production size is in each region. An agent in Southern Denmark consuming Entertainment services, buys it and has it delivered from all five regions in the country. But the share imported from each region is the same as the regions' share of the national supply. So, when 40% of the Entertainment sector is located in Copenhagen, then a consumer will import 40% of the Entertainment consumption from Copenhagen, even if he lives in Southern Denmark. Equivalently, the sector in Copenhagen will always supply 40% of any agent's total consumption of Entertainment. And as consumers are homothetic and the sizes of their consumption baskets are given by their incomes, the pattern of regional exports from Entertainment produced in Copenhagen is the same as the regional distribution of income. The share of export to Southern Denmark is equal to the income share of Southern Denmark. Thus by this assumption, both the import and export pattern of each type of good can be established, i.e. all bilateral trade flows can be found.[11]

The home-bias version of calculating the bilateral trade flows, takes the above approach, but twists the observed consumption of goods in favour of locally supplied goods. This means that the demand of goods with respect to region of origin is different in comparison to the regional production structure. In the example of the Entertainment sector, the agent in Southern Denmark will have a smaller share than 40% of entertainment originating from Copenhagen.

[11] Note that these assumptions on home bias in consumption are only relevant in the calculation of the interregional trade flows. They do not carry over into the behavioural specification of the consumer problem, i.e. the consumer will still maximise utility subject to the availability and prices of varieties from regions. However during the calibration process, the baseline of the economy calibrates the parameters controlling the agents' behaviour, e.g. cost shares and substitution elasticities of consumers.

Equivalently, the share of goods from Southern Denmark is increased, as well as the shares from regions closer than Copenhagen. The pattern of exports from Copenhagen will also change to being a kind of distance-weighted-income pattern.

I propose to adopt the straight forward methodology of re-balancing matrices. In order to solve the problem of calculating balanced bilateral trade matrices, the accepted method of re-balancing input-output tables, the RAS[12] procedure (Möhr, Crown and Polenske, 1987) can be readily applied. The procedure is typically used to balance input-output tables where new row and column sums are available without new information about the matrix's individual elements. Thus, the matrix content can be considered as a 'seed' that combined with new row and column sums create a new table. A table, where the row and column sums fit the new information.

In particular, an element, a_{ij}, in the bilateral trade matrix is the trade flow from region i to j. The row sums, a_i, are regions' total export supply, while the column sums, a_j, are the total import demanded. But at the outset, the matrix is blank as there is no information of the trade flows. There is no seed to start the calculation. However, the assumptions underlying the two ways of considering home-bias from above actually gives information about the seed.

The no-home-bias is seeded as matrix of ones, and can be interpreted as the composition of a demand basket with equal *weights* to region of origin. With the seed having equal weights, the RAS procedure yields a trade pattern exactly as described for the no-home-bias assumption.

The home-bias version can be described in varying degrees of the bias. I choose the straightforward way of saying that the 'weight' of goods is linear and depending on distance, i.e. goods from home is weighted higher than goods from the farthest region. If all production of a good

[12]The RAS procedure is an algorithm that is used for re-balancing a matrix so that row sums are equal to column sums, which is required in a bilateral trade matrix. The procedure is usually applied to balancing input-output tables.

Table 4.3: Seed Tables for Imputating Regional Trade Flows

	No-home bias seed				
From/to	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Copenhagen	1	1	1	1	1
Zeeland	1	1	1	1	1
Southern Denmark	1	1	1	1	1
Mid-Jutland	1	1	1	1	1
Northern Denmark	1	1	1	1	1

	Home bias seed				
From/to	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Copenhagen	5	4	3	2	1
Zeeland	4	5	4	3	2
S. Denmark	3	4	5	4	3
M. Jutland	2	3	4	5	4
N. Denmark	1	2	3	4	5

Source: Own calculations

is spread evenly, then the home-bias matrix will have 1/3 of the total consumption originating in the home region, while the balanced matrix will have 1/5 of consumption from the home region. Thus, the matrix is seeded with numbers 5 to 1, with 5 for home and 1 for the most distant neighbour. Other numbers could have been chosen for the seed, but refraining from extreme weights and staying with some sort of distance-reduced weights, the yielded trade pattern are very similar. The seed matrices are expressed in table 4.3.

The vector of row sums is the regionalised supply while the vector of column sums is the regionalised demand. Plugging the seed and vectors into the RAS procedure, regions' bilateral trade flows are calculated for each good. As the assumptions of bias regarding region of origin refrains from seeding the matrix with any zeros, the RAS procedure will always yield feasible solutions, see Möhr et al. (1987).

Thus, the interregional trade flows are approximated, and now all the data required for the calibration of the model is obtained.

4.5 Changes in the Equalisation Grant Scheme

In the wake of the reform of the Danish municipal structure, a recasting of the equalisation scheme was also needed. The new municipalities had different economic capabilities and a different composition of citizens than the previous system was designed for. In addition, some poor municipalities were merged with rich municipalities, so the new public local authorities were better able to handle the financing of public procurement. The new structure of local governments and a new financial foundation warranted an overhaul of the old equalisation scheme. This reform was adopted in February 2006, where it was also decided to change the calculation of the municipalities' tax base. The new equalisation grant scheme meant an increase in the flow of money from Copenhagen and Zealand to the other regions of Denmark.

The impact of these changes in interregional transfers are analysed using the CGE model presented in this chapter. As the previous equalisation scheme is embedded in the observed baseline to which the model is calibrated, the impact of the reform is analysed using the *changes* in interregional transfers, so the counterfactual imposed on the model is the difference in flows between the old and the new equalisation scheme.

As the model is built using the five new administrative regions, the changes in transfer flows are also aggregated to the regional level. This means that changes to interregional transfers within a region are not taken into account, e.g. changes to the special *Capital Equalisation* element where urban municipalities of Copenhagen are treated specially. In the model, the reform is implemented through a lump sum transfer targeted at the local governments' budgets. The local governments in each region have a net change in their available budgets. Overall, the governments in the Copenhagen region and Zealand region have their budget reduced, while other regions have a net gain in their budget. Again, it has to be stressed that it is only the change in interregional transfers that is analysed – not the total transfer flows between regions of Denmark.

The net changes to the equalisation scheme is given in first row in table 4.4. The table reports the overall results from the model simulations in *Equivalent Variations*. When calculating equivalent variation, the changes in consumer welfare are translated into how much the consumer's disposable income should change to be able to buy a consumption bundle that yield just as much utility, given the baseline price and income level. The reported effects are based on simulations using the most general version of the presented model, with elasticities of substitution for varieties are set at $\sigma = 4$ for all cluster sectors, and with a level of transport costs at 10% on interregional trade flows, and using the no-home-bias seed for approximating the interregional trade matrix.

Table 4.4: Overall Results in Equivalent Variations

	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Changes in grants (mill. DKK)	-790	-83	363	184	325
Changes in grants relative to disposable income	-0.43%	-0.11%	0.33%	0.16%	0.60%
Equivalent Variations for region's agent	-0.87%	-0.12%	0.62%	0.33%	1.38%
Equivalent Variations, National Level	0.03%				

Note: Transport costs at 10% and elasticity of subst. of varieties in cluster sectors of $\sigma = 4$
Source: Indenrigs- og Sundhedsministeriet (2005) and own calculations based on simulations.

Overall, the consumers in the Danish economy experience a welfare gain of 0.03%. This is an aggregated number based on an income weighted sum of the gains and losses of the regions' representative agents.[13] Although overall gains consist of losses in the net paying regions, these are countered by larger welfare gains in the net recieving regions. Thus, the transfers of just under 900 million Danish kroner from the Eastern part of Denmark to the Western part yields a small overall gain in welfare.

[13]The weights used in the sum are the agents' share of disposable income in the baseline.

For Copenhagen, the change in grants is a payment of 790 million kroner, equivalent to 0.43% of disposable income in the region. However, as the grants are taken from the municipalities' budgets, the immediate impact is a reduction in public goods provision to the consumers in Copenhagen. The welfare loss of the change is equivalent to a reduction in baseline income of twice the amount, i.e. a loss of 0.87%. Thus, the impact is doubled as the transfers are targeted at municipality budgets instead of a being a lump sum transfer on consumers' budgets. For the Zealand region, the impact is 0.12%, about the same as the grant change relative to disposable income. The largest welfare gain is in the Northern Jutland region where the transfers amount to 0.60% of income, but where the impact is more than double, yielding a welfare gain of 1.38%. In the Southern Denmark and Mid-Jutland regions the welfare gains are 0.62% and 0.33% respectively.

The differences in the immediate change measured relative to income and the welfare impact is due to the general equilibrium effects. The local governments are directly affected, and they have to adjust the production of local public goods according to their new budgets. In the net paying regions this contracts the local public sector, laying off workers and selling off capital, and vice versa in the net receiving regions. Decreased public demand for labour and capital lowers wages and rents in Copenhagen and Zealand regions, and higher demand for factors increase wages and rents in the net receiving regions until labour and capital is absorbed elsewhere in the economy, cf. table 4.5 and table 4.6.

Table 4.5: Changes in Prices across Regions

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%

Note: Transport costs at 10% of trade flows and elasticity of subst. of varieties in cluster sectors of $\sigma = 4$.

Table 4.6: Changes Production across Sectors and Regions

Changes in output by cluster or sector	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.06%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.03%	-0.03%	-0.01%	-0.05%	0.01%
Financial Services	0.08%	0.04%	-0.03%	-0.01%	-0.12%	0.05%
IT and Telecommunication	0.09%	0.05%	-0.03%	0.01%	-0.08%	0.05%
Tourism	0.09%	0.03%	-0.07%	-0.03%	-0.14%	0.01%
Manufacturing clusters						
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.08%	0.06%	0.02%	0.04%	0.00%	0.06%
Foodstuff	0.00%	-0.02%	-0.07%	-0.05%	-0.12%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
Non-cluster sectors						
Transport and Logistics	0.06%	0.03%	-0.03%	0.00%	-0.06%	0.01%
Local Production	0.08%	0.04%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.02%
Public Production**	–	–	–	–	–	–
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	-0.11%

Note: ***National public sector kept exogeneous.*
Transport costs at 10% of trade flows and elasticity of subst. of varieties in cluster sectors of $\sigma = 4$.

The wage level in Copenhagen drops by 0.24% and rents fall by 0.07%, so in addition to the lower level of local public goods, consumers in Copenhagen also earn less on their factor endowments. The biggest increase in factor income is in Northern Jutland where wages and rents increase by 0.42% and 0.07% respectively. The higher impact on wages compared to other rents is tied to the fact that local public production is labour intensive, so expanding production requires relatively more labour. Similarly, the prices for the consumption bundle in each region is close to unaffected, with a small fall of 0.01%. For citizens in the net paying regions of Copenhagen and Zealand, the combination of unchanged consumer prices, lower wages and fewer local public goods, inflates the negative impact of the change in grants. Equivalently for the other regions, the combination of these factors increase the positive impact of the equalisation reform.

Impact across Regions

The immediate effect of transferring money away from the local governments' budgets is a direct reduction in the government agents' demand for local public production. As the governments are the producers of local public production, and as the goods are non-traded across regions, the impact is a one-to-one reduction in output.

The reduction in regional public production implies a release of inputs otherwise used, especially the release of the production factors, labour and capital. The increased supply on the factor markets combined with the factors being immobile leads to a fall in the nominal wages and capital rents in the Copenhagen and Zealand regions. In contrast, the released intermediate inputs do not have a constraint to location, so they can be relocated to other regions.

As the local public production is labour intensive the impact on the wage is stronger compared to rents, so the reduction in public production lowers the relative price of labour in the region. The released resources are now free to be absorbed by the private sectors in the region, making them able to expand production. This reverse crowding out effect thus supports the private sectors in the region, and as they expand, they can supply more to other regions through interregional exports.

To the consumer there is an immediate drop in welfare since the local government cannot supply the public good in the same amount. The second round effect materialises as a drop in income from the fall nominal factor payments, and also reduces the budget for the private agent to buy consumer goods. The overall result for the consumers in the Copenhagen region is a sharp drop in welfare of around 0.9%, reported in table 4.4.

4.5.1 Impact across Sectors

Concerning the production in the different sectors, the contraction of the local public sector is apparent. In Copenhagen it is reduced by 1.16% as the largest fall, while Nothern Jutland expands by 1.73%. In the regions where the local public sector contracts, the increase in supply of labour and capital enables private firms to expand output.

In Copenhagen, the biggest expansion is in the knowledge intensive clusters in the range of 0.07% to 0.09%. While the Zealand region also experience expansion in these sectors, the sectors drop in the other regions. The largest impact is in Northern Jutland with Financial Services and Tourism falling by more than 0.12%. Though, aggregated to the national level the knowledge intensive sectors show an expansion, with both Financial Services and IT and Telecommunication expanding production by 0.05%. This effect is tied to three things.

First, almost half the knowledge intensive production is located in the Copenhagen region. Second, the expansion in production utilises the scale effects in clusters, embodied through varieties. And third, the relative price of labour falls. The availability of more and cheaper factors enables the sector to expand further in Copenhagen, and take advantage of the increasing returns to scale. In addition, the labour intensive sectors 'win' compared to the capital intensive sectors, i.e. Knowledge intensive gain relative to Manufacturing. Again, this effect is the reverse in other regions where the expansion of the local public sector constricts the knowledge intensive sectors.

The manufacturing cluster sectors also expand in Copenhagen and Zealand regions, although not to the same extent. These sectors are more capital intensive in production, so they do not benefit that much of the contraction of the labour intensive local public production. However, the Copenhagen Chemical and Pharmaceutical cluster expands by 0.08%.

Table 4.7: Changes in Regional Exports, Total Exports from Region

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.19%	0.05%	-0.09%	-0.03%	-0.15%
Entertainment	0.18%	0.04%	-0.07%	-0.02%	-0.07%
Financial Services	0.21%	0.06%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.18%	0.07%	-0.04%	0.00%	-0.09%
Tourism	0.25%	0.06%	-0.11%	-0.05%	-0.18%
Manufacturing clusters					
Building Materials	0.05%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.15%	0.08%	0.01%	0.04%	-0.01%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.04%	-0.19%
Local Production	0.04%	0.00%	-0.07%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector exogeneous and regional public goods are non-traded. Transport costs at 10% and elast. of subst. of varieties of* $\sigma = 4$

These changes in production is also reflected in the interregional trade pattern, cf. table 4.7. As consumers in all regions demand goods from all other regions, the increase in output from firms in the Copenhagen and Zealand regions are accompanied by increase in export volumes to other regions. Opposite for the regions where the clusters sectors contract. Here the total interregional exports falls. However, the increases in export volume is much higher than the immediate increase in output warrants. This is because consumers in Southern Denmark and the Jutland regions also experience higher income, and demand more varieties from the two Eastern regions, and conversely the consumers in Copenhagen and Zealand experience a drop in income and reduce their consumption.

4.5.2 Sensitivity to Parameters

The above presented results are based on simulations with the CGE model for the specific parameters of 10% transport costs and an elasticity of substitution of varieties of $\sigma = 4$ across all clustering sectors, and using the no-home-bias seed for the calculation of the interregional trade matrix. As the transport costs are important for the market access and supply access effects in agglomeration forces, as well as the variety effects expres the market power of firms, the simulation of the counterfactual is carried out using *grid search*, that is for a wide range of parameters. Table 4.8 reports the equivalent variations for different elasticities, while keeping the level of transport costs constant.[14]

Table 4.8: Sensitivity – Equivalent Variations

Elasticities of subst. Knowledge	Manufacturing	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.88%	-0.12%	0.61%	0.32%	1.37%	0.02%
$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.88%	-0.12%	0.62%	0.32%	1.37%	0.02%
$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.84%	-0.09%	0.65%	0.35%	1.41%	0.05%
$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.87%	-0.12%	0.62%	0.32%	1.38%	0.02%
$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.87%	-0.12%	0.62%	0.33%	1.38%	0.03%
$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.84%	-0.08%	0.66%	0.36%	1.41%	0.06%
$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.86%	-0.11%	0.63%	0.34%	1.39%	0.04%
$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.85%	-0.11%	0.63%	0.34%	1.39%	0.04%
$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.82%	-0.08%	0.67%	0.38%	1.43%	0.07%

Note: National values are weighted, cf. table 4.4. Transport costs at 10% of trade flows.

The variation of results for different elasticities is very small, except for the cases where the elasticity of substitution of manufacturing varieties are low, $\sigma_m = 2.3$, i.e. the more differentiated the varieties are. For these cases there are somewhat higher positive impacts in the net receiving regions. Especially in Northern Jutland, where the equivalent variation is above

[14]Results for varying transport costs are reported in appendix D.

1.4%, but just as importantly, the overall aggregated levels of equivalent variations are highest for these cases, almost double the effect compared the aggregated effect in other combinations of elasticities. However, effects stay within reasonable bounds, and the overall results of the local public sector crowding out private production, as well as positive gains from more varieties, both remain in spite of differences in magnitude of the variety effects and in turn the market power.

More detailed reports of simulations with varying parameters are shown in appendices B through D. These include simulations on models calibrated to interregional trade matrices based on the home-bias assumption. In general, the positive aggregate welfare gains remain, regardless of the level of transport costs and the varieties' elasticity of substitution. Although, the choice of parameters is not innocuous – there are differences in the scale of effects.

Looking strictly on the welfare gains, table D.1 and table D.2, it is apparent that the lower the elasticity of substitution of the manufacturing varieties, σ_m, the higher the welfare gains. This is the case for all regions, and it carries into the overall measure of welfare, i.e. the net paying regions have a smaller drop in welfare and the net receiving regions have a larger increase, the lower the elasticity of substitution. The same pattern is observed for the elasticity governing the knowledge intensive clusters. Although, the differences in welfare gains are markedly smaller, lowering the knowledge cluster elasticity, σ_k, increases the welfare effect.

Replacing the no-home-bias calculation of the interregional trade by the home-bias assumption, amplifies the welfare effects, and again the lower the elasticities, the higher the gains. One set of results stand out. For the specific combination of high transport costs and low elasticity for the manufacturing clusters, and low transport costs for the knowledge intensive clusters, the model yields very large welfare effects. For these parameter configurations, the model becomes volatile. This is most likely because special parameter combinations with low elasticities of substitution begin to approach the so-called 'Black Hole'-parameter combination. Black Hole combinations might cause the model to spin out of control, and utility and production tend towards corner solutions. Fujita et al. (1999), chapter 2, have a discussion of this phenomenon.

Except for these special cases, the model's results are overall robust to changes in parameters. However, the exact parameters for the Danish economy remain to be estimated, which is referred to future research.

4.6 Conclusion

The reform of the Danish equalisation grant scheme yields aggregated welfare gains. However, these gains are unevenly distributed as consumers in Copenhagen and Zealand regions loose while consumers in Southern Denmark, Mid-Jutland and Northern Jutland stand to gain in welfare. The results are based on an general equilibrium analysis that take concentration effects, scale effects from clusters and spatial effects into account.

The change in equalisation grants transfers money from Eastern part of Denmark to the Western part, but as the transfers are targeted at the local governments' budgets, they impact the local public production directly. For the case of the major economic centre, which the Copenhagen region is, the changes in equalisation grants mean a large outflow of finances from the public sector. The smaller public sector, and in turn lower public production, makes room for the private sectors to expand. Conversely, the private production in the Western regions is hurt by the local public sector's increased demand for factors, yielding the overall effect of a further concentration of private production in Copenhagen and a reduction of concentration in Western Denmark. Especially, the initial clustering of knowledge intensive sectors in Copenhagen means that the inherent scale effects give those sectors an advantage. Therefore, the knowledge intensive sectors grow more relative to the manufacturing clusters and other non-clustering sectors. The modelling setup does not take skill level into account, the labour is homogeneous, so the effect is stronger since the labour released from the public sector can be easily employed in the expanding private firms.

In addition to the crowding out (and crowding *in*) of the public sector vis-à-vis the private sector, there are significant changes to the relative prices of primary factors. As the public sector is labour intensive, the impact of the changes in public production is relatively stronger regarding wages, and this in turn impacts the output of labour intensive sectors more than the capital intensive sectors. This leads to an even stronger bias in the Copenhagen and Zealand regions towards knowledge intensive production.

Further, the expansion of knowledge sectors in these regions also means that the production is concentrated more. Meanwhile, the manufacturing sectors are diminished in the strongholds in the Western regions. The equalisation reform, thus, reinforces the agglomeration of knowledge intensive production in Copenhagen, and disperses the manufacturing sectors from the Western part to the rest of the country. The driver being the agglomeration forces at play for the different sectors.

Overall, the transfer of money from the rich regions to the poor regions, although reducing welfare in the net-paying regions, will benefit the private sector, to the overall benefit of the whole country. But it has to be stressed, that this does not mean that a further reform should transfer so much money that the public sector disappears. There are still issues of minimum required public provision from the local municipalities, and the consideration that a key assumption for this result is that factors are highly mobile across sectors, whereas labour and capital are immobile between regions.

Since this model is constructed to be able to be used in policy decisions, there are several issues that perhaps also need to be addressed through further development. The dependence on labour being mobile across sectors highlights the need for introducing a heterogeneous labour force, e.g. a split into high and low skilled labour. Since the public sector, especially the regional public sector, is labour intensive in low-skilled compared to for example the knowledge intensive sectors, the crowding out effects reported could be less. However, the immobility of labour across regions is another assumption that also could be addressed in more detail. These are all topics for future research.

4.7 References

Andersson, Fredrik and Rikard Forslid (2003), ‘Tax competition and economic geography’, *Journal of Public Economic Theory* **5**(2), 279–303.

Baldwin, Richard and Paul Krugman (2004), ‘Agglomeration, integration and tax harmonization’, *European Economic Review* **48**(1), 1–23.

Baldwin, Richard, Rikard Forslid, Philippe Martin, Gianmarco Ottaviano and Frédéric Robert-Nicoud (2003), *Economic Geography and Public Policy*, Princeton University Press, Princeton, New Jersey.

Behrens, Kristian, Carl Gaigné, Gianmarco I. P. Ottaviano and Jacques-François Thisse (2005), Countries, regions and trade: on the welfare impacts of economic integration, Discussion Papers in Economics 05-01, Department of Economics, University of Strathclyde, Glasgow, Scotland, UK.

Boadway, Robin (2003), The theory and practice of equalization. mimeo.

Bureau van Dijk (2006), ‘Amadeus database’.

Charlot, Sylvie, Carl Caigné, Frédéric Robert-Nicoud and Jacques-François Thisse (2004), Agglomeration and welfare: The Core-Periphery model in the light of Bentham, Kaldor and Rawls, CEPR Discussion Papers 4715, Centre for Economic Policy Research.

Charlot, Sylvie and Carl Gaigné (2001), Regional integration, inequalities and public policy, Working Paper 3, INRA-ENESAD.

Combes, P. and G. Duranton (2001), Labour pooling, labour poaching and spatial clustering, CEPR Discussion Papers 2975, Centre for Economic Policy Research.

Copenhagen Economics (2006), Den danske klyngedatabase. Unpublished.

Dahl, M. S. (2002), Embedded knowledge flows through labor mobility in regional clusters in denmark, Technical report, Eindhoven Centre for Innovation Studies (ECIS). Paper presented at the DRUID Summer Conference on "Industrial Dynamics of the New and Old Economy - who is embracing whom?".

Dixit, Avinash and Joseph E. Stiglitz (1977), 'Monopolistic Competition and Optimum Product Diversity', *American Economic Review* **67**(3), 297–308.

DREAM-group (2008), Danish Rational Economic Agents Model, Technical report, DREAM, Copenhagen, Denmark. http://www.dreammodel.dk.

Economic Modelling, Statistics Denmark (2008), Annual Danish Aggregated Model, Technical report, Statistics Denmark, Copenhagen, Denmark.

Forslid, Rikard (2004), Regional policy, integration and the location of industry, Technical report, Stockholm University, Department of Economics.

Forslid, Rikard and Gianmarco I.P. Ottaviano (2003), 'An analytically solvable core-periphery model', *Journal of Economic Geography* **3**(3), 229–240.

Fujita, Masahisa and Paul Krugman (2003), 'The new economic geography: Past, present and the future', *Papers in Regional Science* **83**(1), 139 –164.

Fujita, Masahisa, Paul R. Krugman and Anthony J. Venables (1999), *The Spatial Economy: Cities, Regions, and International Trade*, The MIT Press, Cambridge, Massachusetts.

Gaigné, Carl and Stéphane Riou (2004), Regional integration and tax competition under upward revenue sharing, Working paper, Universite Jean Monnet Saint-Etienne.

Gaigné, Carl and Stéphane Riou (2007), 'Globalization, tax competition and fiscal equalization', *Journal of Public Economic Theory* **9**(5), 901–925.

Hertel, Thomas W. and Marinos E. Tsigas (1999), Structure of GTAP, *in* T. W.Hertel, ed., ‘Global Trade Analysis: Modeling and Applications’, Cambridge University Press, Cambridge, NY, chapter 2, pp. 13–74.

Indenrigs- og Sundhedsministeriet (2005), Finansieringsudvalgets rapport om et nyt tilskuds- og udligningssystem, Rapport, Indenrigs- og Sundhedsministeriet, København.

Krugman, Paul (1991), ‘Increasing returns and economic geography’, *Journal of Political Economy* **99**(3), 483–499.

Krugman, Paul R. (1980), ‘Scale Economies, Product Diffrentiation, and the Pattern of Trade’, *American Economic Review* **70**(5), 950–959.

Ludema, Rodney D. and Ian Wooton (2000), ‘Economic geography and the fiscal effects of regional integration’, *Journal of International Economics* **52**(2), 331–357.

Martin, P. and C.A. Rogers (1995), ‘Industrial location and public infrastructure’, *Journal of International Economics* **39**, 335–351.

Möhr, Malte, William H. Crown and Karen R. Polenske (1987), ‘A linear programming approach to solving infeasible RAS problems’, *Journal of Regional Science* **27**(4), 587–603.

Murata, Yasusada and Jacques-François Thisse (2005), ‘A simple model of economic geography à la Helpman-Tabuchi’, *Journal of Urban Economics* **58**(1), 137–155.

National Accounts, Statistics Denmark (2006), *Danish Input-Output Tables and Analyses 2004*, Statistics Denmark.

Ottaviano, Gianmarco I.P. (2002), Regional policy in the global economy: Insights from new economic geography, HWWA Discussion Paper 211, Hamburg Institute of International Economics, Hamburg, Germany.

Pedersen, Niels Jørgen Mau (1995), *Decentralisering og kommunaløkonomi*, Jurist- og Økonomforbundet.

Porter, Michael E. (2003), 'The economic performance of regions', *Regional Studies* **37**(6–7), 549–578.

Robert-Nicoud, Frédéric (2005), 'The structure of simple 'new economic geography' models (or, on identical twins)', *Journal of Economic Geography* **5**(2), 201–234.

Rutherford, Thomas F. and David G. Tarr (2008), 'Poverty effects of russia's wto accession: Modeling "real" households with endogenous productivity effects', *Journal of International Economics* **75**(1), 131–150.

Samuelson, P. A. (1952), 'The transfer problem and transport costs: The terms of trade when impediments are absent', *The Economic Journal* **62**(246), 278–304.

Spence, Michael A. (1976), 'Product Selection, Fixed Costs, and Monopolistic Competition', *Review of Economic Studies* **43**(2), 217–235.

Statistics Denmark (2007), 'Ida-database'.

The Economic Council (2003), Erhvervsstruktur og produktivitet, *in* 'Dansk Økonomi', Det Økonomiske Råd, chapter 5, pp. 193–218.

The Global Trade Analysis Project (2000), 'The global trade analysis project, center for global trade analysis'.

Tirole, Jean (1994), *The Theory of Industrial Organisation*, The MIT Press, Cambridge, Massachusetts, London, England.

Venables, Anthony J. (1996), 'Equilibrium Locations of Vertically Linked Industries', *International Economic Review* **37**(2), 341–360.

Chapter 5

Concluding Remarks

On the preceding pages CGE models within the economic geography framework have been presented. The first chapters analysed conceptual versions of the models in order to yield insights to how extra features change the models' agglomeration properties. These features covered interregional transfers between local authorities as well as supply of local public provision.

Introducing interregional transfers to take equalisation grants between regions into account, chapter 2 analysed the standard Core-Periphery model, and revealed that such transfers will alter the concentration patterns in the model; in particular the range of stable equilibria where the economy exhibits agglomeration in one region, the Core-Periphery outcomes, as these outcome requires still greater integration, i.e. lower costs associated with trade between regions. The analysis showed that a core can be taxed and some of the revenue transferred to a periphery. But at the expense of the agglomeration becoming unsustainable for medium transport costs. Introducing an equalisation scheme through interregional transfers of tax revenue thus has significant effects on the agglomeration pattern in the standard Core-Periphery model.

The issue of policies that intervene with agglomeration forces was further stressed in chapter 3. The chapter took the analysis further by introducing local public goods, congestion costs in addition to equalisation grants. When all these factors were taken into account, several factors governing the agglomeration pattern of the economy emerged. First, congestion costs are an extra *indirect* dispersion force. Congestion has the effect that symmetric outcomes emerge for high levels of integration. The domination of the concentrating forces when there is full integration between regions, disappears and the dispersion forces take over. The economy only exhibits agglomeration for an intermediate range of transport costs. Second, transfers between regions taps resources from economic centres for the benefit of consumers in poorer regions. This also increases the dispersion forces in the model. Third, provision of public goods increase the utility of agents. More immigration increase the tax base to finance public provision. However, local public production draws resources from the private sectors. Besides reducing the full agglomeration to partial agglomeration, the concentration patterns of the economy is only changed when introducing transfers in addition to public production. And this changes the concentration patterns dramatically, creating much more path dependency expressed through the increased area of the hysteresis zone.

Chapter 4 built on the experiences from the previous chapter. An applied regional computable general equilibrium model was set up of the Danish economy. The model was used for analysis of the changes in the equalisation grants which were introduced in 2007. The reform transferred money from the Eastern part of Denmark to the Western part. The simulations showed that, as the transfers were targeted at the local governments' public production, major economic centres reduced the size of the public sector freeing resources for the private sectors to expand. Conversely, the private production in the Western regions was hurt by the local public sector's higher demand for factors. The equalisation reform thus reinforced the agglomeration of knowledge intensive production in Copenhagen and dispersed manufacturing sectors across the country. The driver being the agglomeration forces at play for the different sectors, a direct consequence of the cluster effects built into the agglomeration models through the assumption of monopolistic competition. Thus, overall the increased agglomeration lead to an overall welfare increase in the economy, but still consumers in the Eastern part of Denmark lost compared to the consumers in the Western part.

The work presented in this dissertation is a first step in building applied regional economic geography CGE models. These models can account for clustering of economic activity, and can be used for regional policy analysis with special emphasis on regional production and welfare effects. Thus, the presented papers lay a much needed foundation for developing new tools for regional applied computable general equilibrium. Tools needed for policy-makers enabling them to make informed decisions.

Appendix A

Input Output Table

Table A.1: Input Output Coefficients, National Aggregation – 2003

From Sector / To Sector	Business Services	Entertainment	Financial Services	IT and Telecom-munication	Tourism	Building Materials	Chemical and Pharmaceutical	Foodstuff	Machinery and Engineering	Textiles, Wood and Furniture	Transport and Logistics	Local Production	Natural Resource Based	Public Production	Reg. Pub. Prod.
Business Services	0.031	0.026	0.014	0.025	0.025	0.007	0.016	0.018	0.005	0.012	0.013	0.019	0.015	0.012	0.010
Entertainment	0.063	0.094	0.004	0.008	0.006	0.007	0.008	0.014	0.004	0.009	0.002	0.008	0.001	0.005	0.008
Financial Services	0.008	0.003	0.162	0.003	0.005	0.002	0.002	0.003	0.002	0.003	0.051	0.010	0.015	0.004	0.002
IT and Telecommunication	0.036	0.021	0.025	0.097	0.020	0.043	0.018	0.011	0.021	0.014	0.027	0.027	0.009	0.038	0.018
Tourism	0.010	0.006	0.003	0.007	0.006	0.002	0.004	0.004	0.002	0.004	0.008	0.006	0.002	0.004	0.008
Building Materials	0.003	0.011	0.002	0.023	0.004	0.084	0.014	0.010	0.048	0.016	0.029	0.021	0.008	0.004	0.003
Chemical and Pharmaceutical	0.005	0.016	0.002	0.016	0.008	0.046	0.087	0.025	0.016	0.029	0.117	0.017	0.053	0.019	0.009
Foodstuff	0.003	0.009	0.002	0.005	0.059	0.012	0.022	0.106	0.010	0.015	0.005	0.013	0.090	0.004	0.008
Machinery and Engineering	0.002	0.025	0.002	0.018	0.005	0.072	0.011	0.014	0.100	0.023	0.084	0.015	0.014	0.004	0.002
Textiles, Wood and Furniture	0.001	0.010	0.001	0.004	0.003	0.011	0.004	0.004	0.009	0.113	0.009	0.012	0.004	0.003	0.004
Transport and Logistics	0.006	0.013	0.001	0.015	0.057	0.014	0.012	0.020	0.013	0.014	0.071	0.019	0.004	0.017	0.005
Local Production	0.223	0.179	0.132	0.165	0.216	0.118	0.121	0.105	0.095	0.118	0.136	0.215	0.177	0.127	0.119
Natural Resource Based	0.000	0.001	0.000	0.000	0.007	0.006	0.047	0.237	0.001	0.007	0.000	0.008	0.046	0.001	0.002
Public Production	0.007	0.001	0.003	0.008	0.005	0.001	0.007	0.001	0.001	0.001	0.001	0.004	0.002	0.032	0.009
Regional Public Production	0.013	0.009	0.002	0.003	0.009	0.000	0.001	0.001	0.000	0.001	0.002	0.003	0.001	0.009	0.010
Taxes	0.023	-0.003	0.045	0.008	0.025	0.005	-0.001	-0.004	0.004	0.005	0.006	0.027	-0.003	0.044	0.032
Wages	0.248	0.212	0.241	0.247	0.304	0.192	0.133	0.168	0.176	0.186	0.122	0.268	0.079	0.607	0.665
Capital Rents	0.229	0.104	0.140	0.090	0.205	0.060	0.094	0.075	0.053	0.078	0.102	0.244	0.322	0.064	0.084
Imports	0.089	0.264	0.220	0.258	0.030	0.317	0.401	0.189	0.442	0.354	0.214	0.065	0.161	0.003	0.003
Total Supply	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Note: *Coloured numbers indicate intermediate input coefficients larger than 0.01.*
Source: Own calculations based on Copenhagen Economics (2006) and National Accounts (2006).

Appendix B

Other Results - Prices and Production

Table B.1: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 9$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.25%	-0.09%	0.20%	0.09%	0.41%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.01%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.07%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.02%	-0.04%	-0.01%	-0.06%	0.01%
Financial Services	0.08%	0.03%	-0.04%	-0.02%	-0.12%	0.05%
IT and Telecommunication	0.08%	0.04%	-0.04%	0.00%	-0.09%	0.04%
Tourism	0.08%	0.03%	-0.07%	-0.03%	-0.15%	0.01%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.07%	-0.04%	-0.10%	-0.04%
Chemical and Pharmaceutical	0.07%	0.04%	0.00%	0.02%	-0.02%	0.04%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.11%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.10%	-0.05%
*Non-cluster sectors***						
Transport and Logistics	0.05%	0.02%	-0.04%	-0.01%	-0.07%	0.00%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.02%
Regional Public Production	-1.16%	-0.27%	0.91%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.2: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 9$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.25%	-0.08%	0.21%	0.10%	0.41%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.01%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.06%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.03%	-0.04%	-0.01%	-0.06%	0.01%
Financial Services	0.08%	0.04%	-0.04%	-0.01%	-0.12%	0.05%
IT and Telecommunication	0.08%	0.04%	-0.04%	0.00%	-0.09%	0.04%
Tourism	0.09%	0.03%	-0.07%	-0.03%	-0.14%	0.01%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.04%	-0.10%	-0.04%
Chemical and Pharmaceutical	0.08%	0.05%	0.02%	0.03%	-0.01%	0.06%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.12%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.10%	-0.05%
*Non-cluster sectors***						
Transport and Logistics	0.05%	0.02%	-0.03%	-0.01%	-0.06%	0.01%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.02%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.3: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 9$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.02%	0.02%	0.02%	0.02%	0.02%	–*
Wages	-0.21%	-0.04%	0.25%	0.14%	0.46%	–*
Capital rents	-0.03%	0.03%	0.10%	0.05%	0.12%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.09%	0.03%	-0.06%	-0.01%	-0.13%	0.03%
Entertainment	0.08%	0.03%	-0.03%	-0.01%	-0.05%	0.01%
Financial Services	0.09%	0.05%	-0.03%	0.00%	-0.11%	0.06%
IT and Telecommunication	0.06%	0.02%	-0.06%	-0.03%	-0.11%	0.02%
Tourism	0.10%	0.05%	-0.06%	-0.02%	-0.13%	0.02%
Manufacturing clusters						
Building Materials	0.00%	-0.02%	-0.09%	-0.06%	-0.12%	-0.06%
Chemical and Pharmaceutical	0.07%	0.05%	0.02%	0.03%	0.00%	0.05%
Foodstuff	0.18%	0.16%	0.12%	0.14%	0.08%	0.14%
Machinery and Engineering	0.02%	-0.01%	-0.06%	-0.04%	-0.10%	-0.04%
Textiles, Wood and Furniture	0.00%	-0.03%	-0.09%	-0.07%	-0.12%	-0.07%
*Non-cluster sectors***						
Transport and Logistics	0.05%	0.02%	-0.04%	-0.01%	-0.06%	0.01%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.11%	0.09%	0.03%	0.06%	-0.01%	0.07%
Regional Public Production	-1.16%	-0.28%	0.90%	0.43%	1.72%	-0.01%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.4: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 4$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.25%	-0.08%	0.21%	0.10%	0.41%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.01%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.06%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.03%	-0.03%	-0.01%	-0.05%	0.01%
Financial Services	0.08%	0.04%	-0.03%	-0.01%	-0.12%	0.05%
IT and Telecommunication	0.09%	0.05%	-0.03%	0.01%	-0.08%	0.05%
Tourism	0.09%	0.03%	-0.07%	-0.03%	-0.14%	0.01%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.04%	-0.10%	-0.04%
Chemical and Pharmaceutical	0.07%	0.04%	0.00%	0.02%	-0.02%	0.05%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.11%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	-0.01%	-0.06%	-0.04%	-0.10%	-0.05%
*Non-cluster sectors***						
Transport and Logistics	0.05%	0.02%	-0.03%	-0.01%	-0.06%	0.01%
Local Production	0.08%	0.04%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.02%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.5: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 4$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.06%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.03%	-0.03%	-0.01%	-0.05%	0.01%
Financial Services	0.08%	0.04%	-0.03%	-0.01%	-0.12%	0.05%
IT and Telecommunication	0.09%	0.05%	-0.03%	0.01%	-0.08%	0.05%
Tourism	0.09%	0.03%	-0.07%	-0.03%	-0.14%	0.01%
Manufacturing clusters						
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.08%	0.06%	0.02%	0.04%	0.00%	0.06%
Foodstuff	0.00%	-0.02%	-0.07%	-0.05%	-0.12%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.06%	0.03%	-0.03%	0.00%	-0.06%	0.01%
Local Production	0.08%	0.04%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.02%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.6: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 4$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.02%	0.02%	0.02%	0.02%	0.02%	–*
Wages	-0.21%	-0.04%	0.25%	0.14%	0.46%	–*
Capital rents	-0.03%	0.03%	0.10%	0.06%	0.12%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.09%	0.03%	-0.06%	-0.01%	-0.13%	0.03%
Entertainment	0.08%	0.03%	-0.03%	0.00%	-0.05%	0.02%
Financial Services	0.09%	0.05%	-0.02%	0.00%	-0.11%	0.06%
IT and Telecommunication	0.07%	0.03%	-0.05%	-0.02%	-0.10%	0.02%
Tourism	0.10%	0.05%	-0.05%	-0.01%	-0.13%	0.02%
Manufacturing clusters						
Building Materials	0.01%	-0.02%	-0.09%	-0.06%	-0.12%	-0.06%
Chemical and Pharmaceutical	0.08%	0.05%	0.02%	0.04%	0.00%	0.05%
Foodstuff	0.18%	0.16%	0.12%	0.14%	0.08%	0.14%
Machinery and Engineering	0.02%	-0.01%	-0.06%	-0.04%	-0.10%	-0.04%
Textiles, Wood and Furniture	0.00%	-0.03%	-0.09%	-0.07%	-0.12%	-0.07%
*Non-cluster sectors***						
Transport and Logistics	0.06%	0.03%	-0.03%	0.00%	-0.06%	0.01%
Local Production	0.08%	0.03%	-0.08%	-0.02%	-0.16%	0.01%
Natural Resource Based	0.11%	0.09%	0.03%	0.06%	-0.01%	0.07%
Regional Public Production	-1.16%	-0.28%	0.90%	0.43%	1.72%	-0.01%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.7: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.06%	-0.03%	0.06%	0.02%	0.08%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.09%	0.04%	-0.05%	-0.01%	-0.12%	0.03%
Entertainment	0.08%	0.03%	-0.02%	0.00%	-0.04%	0.02%
Financial Services	0.09%	0.05%	-0.01%	0.01%	-0.10%	0.06%
IT and Telecommunication	0.10%	0.06%	0.00%	0.03%	-0.05%	0.06%
Tourism	0.09%	0.04%	-0.06%	-0.02%	-0.13%	0.02%
Manufacturing clusters						
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.08%	0.05%	0.01%	0.02%	-0.02%	0.05%
Foodstuff	0.00%	-0.02%	-0.07%	-0.05%	-0.12%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	0.00%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.07%	0.03%	-0.02%	0.00%	-0.05%	0.02%
Local Production	0.09%	0.04%	-0.07%	-0.02%	-0.15%	0.01%
Natural Resource Based	0.01%	0.00%	-0.07%	-0.04%	-0.10%	-0.02%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.8: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.24%	-0.07%	0.22%	0.11%	0.42%	–*
Capital rents	-0.06%	-0.02%	0.06%	0.02%	0.08%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.09%	0.04%	-0.05%	-0.01%	-0.12%	0.03%
Entertainment	0.08%	0.04%	-0.02%	0.01%	-0.04%	0.02%
Financial Services	0.09%	0.05%	-0.01%	0.01%	-0.10%	0.06%
IT and Telecommunication	0.10%	0.06%	0.00%	0.03%	-0.05%	0.06%
Tourism	0.09%	0.04%	-0.06%	-0.02%	-0.13%	0.02%
Manufacturing clusters						
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.09%	0.06%	0.02%	0.04%	0.00%	0.06%
Foodstuff	0.00%	-0.02%	-0.07%	-0.05%	-0.12%	-0.05%
Machinery and Engineering	0.03%	0.01%	-0.05%	-0.02%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	0.00%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.07%	0.04%	-0.02%	0.01%	-0.05%	0.02%
Local Production	0.09%	0.04%	-0.07%	-0.02%	-0.15%	0.01%
Natural Resource Based	0.01%	0.00%	-0.07%	-0.04%	-0.10%	-0.02%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.9: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.02%	0.02%	0.02%	0.02%	0.02%	–*
Wages	-0.20%	-0.03%	0.26%	0.15%	0.47%	–*
Capital rents	-0.02%	0.04%	0.11%	0.06%	0.13%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.09%	0.04%	-0.05%	0.00%	-0.12%	0.04%
Entertainment	0.08%	0.04%	-0.02%	0.01%	-0.03%	0.03%
Financial Services	0.10%	0.06%	0.00%	0.02%	-0.09%	0.07%
IT and Telecommunication	0.07%	0.04%	-0.04%	0.00%	-0.09%	0.03%
Tourism	0.11%	0.06%	-0.04%	0.00%	-0.12%	0.03%
Manufacturing clusters						
Building Materials	0.01%	-0.02%	-0.08%	-0.05%	-0.11%	-0.06%
Chemical and Pharmaceutical	0.08%	0.06%	0.03%	0.04%	0.01%	0.06%
Foodstuff	0.18%	0.16%	0.12%	0.14%	0.08%	0.14%
Machinery and Engineering	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.04%
Textiles, Wood and Furniture	0.00%	-0.02%	-0.09%	-0.07%	-0.12%	-0.07%
*Non-cluster sectors***						
Transport and Logistics	0.07%	0.04%	-0.02%	0.00%	-0.05%	0.02%
Local Production	0.09%	0.04%	-0.07%	-0.02%	-0.16%	0.01%
Natural Resource Based	0.10%	0.09%	0.03%	0.06%	-0.01%	0.07%
Regional Public Production	-1.17%	-0.28%	0.90%	0.43%	1.72%	-0.01%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.10: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 9$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.06%	0.02%	0.08%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.07%	-0.02%	-0.14%	0.02%
Entertainment	0.07%	0.02%	-0.04%	-0.02%	-0.06%	0.00%
Financial Services	0.09%	0.05%	-0.03%	-0.01%	-0.11%	0.06%
IT and Telecommunication	0.08%	0.04%	-0.04%	-0.01%	-0.09%	0.04%
Tourism	0.09%	0.03%	-0.07%	-0.03%	-0.14%	0.01%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.03%	0.00%	0.01%	-0.03%	0.03%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.04%	0.01%	-0.04%	-0.02%	-0.08%	-0.02%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.08%	0.02%	0.05%	-0.01%	0.06%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.00%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.11: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 9$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.22%	0.11%	0.42%	–*
Capital rents	-0.06%	-0.03%	0.06%	0.02%	0.08%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.07%	-0.02%	-0.14%	0.02%
Entertainment	0.07%	0.02%	-0.04%	-0.02%	-0.06%	0.01%
Financial Services	0.09%	0.05%	-0.03%	0.00%	-0.11%	0.06%
IT and Telecommunication	0.08%	0.04%	-0.04%	-0.01%	-0.09%	0.04%
Tourism	0.09%	0.03%	-0.07%	-0.03%	-0.14%	0.01%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.04%	0.00%	0.02%	-0.02%	0.04%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.03%	0.01%	-0.04%	-0.02%	-0.07%	-0.02%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.08%	0.03%	0.05%	0.00%	0.07%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.00%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

Note: **Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.12: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 9$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.02%	-0.07%	-0.02%	-0.14%	0.02%
Entertainment	0.07%	0.02%	-0.05%	-0.02%	-0.07%	0.00%
Financial Services	0.09%	0.04%	-0.03%	-0.01%	-0.12%	0.06%
IT and Telecommunication	0.08%	0.03%	-0.05%	-0.01%	-0.10%	0.03%
Tourism	0.08%	0.03%	-0.07%	-0.04%	-0.15%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.03%	-0.01%	0.01%	-0.03%	0.03%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.04%	0.01%	-0.04%	-0.02%	-0.08%	-0.02%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.07%	0.02%	0.05%	-0.01%	0.06%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.00%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

Note: **Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.13: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 4$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.22%	0.11%	0.42%	–*
Capital rents	-0.06%	-0.03%	0.06%	0.02%	0.08%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.06%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.02%	-0.04%	-0.01%	-0.06%	0.01%
Financial Services	0.09%	0.05%	-0.02%	0.00%	-0.11%	0.06%
IT and Telecommunication	0.08%	0.04%	-0.04%	0.00%	-0.08%	0.04%
Tourism	0.09%	0.03%	-0.07%	-0.03%	-0.14%	0.01%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.03%	0.00%	0.01%	-0.03%	0.03%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.04%	0.01%	-0.04%	-0.02%	-0.08%	-0.02%
Textiles, Wood and Furniture	0.02%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.08%	0.03%	0.05%	0.00%	0.07%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.14: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 4$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.02%	-0.07%	-0.02%	-0.14%	0.02%
Entertainment	0.07%	0.02%	-0.05%	-0.02%	-0.07%	0.00%
Financial Services	0.09%	0.04%	-0.03%	-0.01%	-0.12%	0.06%
IT and Telecommunication	0.08%	0.03%	-0.05%	-0.01%	-0.10%	0.03%
Tourism	0.08%	0.03%	-0.07%	-0.04%	-0.15%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.03%	-0.01%	0.01%	-0.03%	0.03%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.04%	0.01%	-0.04%	-0.02%	-0.08%	-0.02%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.07%	0.02%	0.05%	-0.01%	0.06%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.00%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.15: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 4$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.02%	-0.07%	-0.02%	-0.14%	0.02%
Entertainment	0.07%	0.02%	-0.05%	-0.02%	-0.07%	0.00%
Financial Services	0.09%	0.04%	-0.03%	-0.01%	-0.12%	0.06%
IT and Telecommunication	0.08%	0.03%	-0.05%	-0.01%	-0.10%	0.03%
Tourism	0.08%	0.03%	-0.07%	-0.04%	-0.15%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.03%	-0.01%	0.01%	-0.03%	0.03%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.04%	0.01%	-0.04%	-0.02%	-0.08%	-0.02%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.07%	0.02%	0.05%	-0.01%	0.06%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.00%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.16: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 2.3$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.02%	-0.07%	-0.02%	-0.14%	0.02%
Entertainment	0.07%	0.02%	-0.05%	-0.02%	-0.07%	0.00%
Financial Services	0.09%	0.04%	-0.03%	-0.01%	-0.12%	0.06%
IT and Telecommunication	0.08%	0.03%	-0.05%	-0.01%	-0.10%	0.03%
Tourism	0.08%	0.03%	-0.07%	-0.04%	-0.15%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.03%	-0.01%	0.01%	-0.03%	0.03%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.04%	0.01%	-0.04%	-0.02%	-0.08%	-0.02%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.07%	0.02%	0.05%	-0.01%	0.06%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.00%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.17: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 2.3$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.02%	-0.07%	-0.02%	-0.14%	0.02%
Entertainment	0.07%	0.02%	-0.05%	-0.02%	-0.07%	0.00%
Financial Services	0.09%	0.04%	-0.03%	-0.01%	-0.12%	0.06%
IT and Telecommunication	0.08%	0.03%	-0.05%	-0.01%	-0.10%	0.03%
Tourism	0.08%	0.03%	-0.07%	-0.04%	-0.15%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.03%	-0.01%	0.01%	-0.03%	0.03%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.04%	0.01%	-0.04%	-0.02%	-0.08%	-0.02%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.07%	0.02%	0.05%	-0.01%	0.06%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.00%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.18: Changes in Prices and Production

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 2.3$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.00%	0.00%	0.00%	0.00%	0.00%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.02%	-0.07%	-0.02%	-0.14%	0.02%
Entertainment	0.07%	0.02%	-0.05%	-0.02%	-0.07%	0.00%
Financial Services	0.09%	0.04%	-0.03%	-0.01%	-0.12%	0.06%
IT and Telecommunication	0.08%	0.03%	-0.05%	-0.01%	-0.10%	0.03%
Tourism	0.08%	0.03%	-0.07%	-0.04%	-0.15%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.06%	0.03%	-0.01%	0.01%	-0.03%	0.03%
Foodstuff	-0.01%	-0.03%	-0.08%	-0.06%	-0.12%	-0.06%
Machinery and Engineering	0.04%	0.01%	-0.04%	-0.02%	-0.08%	-0.02%
Textiles, Wood and Furniture	0.01%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.11%	0.07%	0.02%	0.05%	-0.01%	0.06%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.00%
Natural Resource Based	0.00%	-0.01%	-0.08%	-0.05%	-0.11%	-0.03%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.19: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 9$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.25%	-0.09%	0.20%	0.09%	0.41%	–*
Capital rents	-0.08%	-0.04%	0.05%	0.01%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.07%	0.02%	-0.07%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.02%	-0.04%	-0.01%	-0.06%	0.01%
Financial Services	0.07%	0.02%	-0.04%	-0.02%	-0.12%	0.04%
IT and Telecommunication	0.08%	0.03%	-0.04%	-0.01%	-0.08%	0.04%
Tourism	0.08%	0.02%	-0.07%	-0.03%	-0.14%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.07%	-0.04%	-0.10%	-0.04%
Chemical and Pharmaceutical	0.07%	0.04%	0.00%	0.02%	-0.02%	0.05%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.11%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	-0.01%	-0.06%	-0.04%	-0.10%	-0.05%
*Non-cluster sectors***						
Transport and Logistics	0.05%	0.01%	-0.04%	-0.01%	-0.07%	0.00%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.01%
Regional Public Production	-1.16%	-0.27%	0.91%	0.44%	1.73%	0.00%

Note: **Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.20: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 9$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.25%	-0.08%	0.20%	0.09%	0.41%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.01%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.07%	0.02%	-0.06%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.02%	-0.04%	-0.01%	-0.05%	0.01%
Financial Services	0.07%	0.03%	-0.04%	-0.02%	-0.12%	0.04%
IT and Telecommunication	0.08%	0.03%	-0.04%	-0.01%	-0.08%	0.04%
Tourism	0.08%	0.03%	-0.07%	-0.03%	-0.14%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.06%	-0.04%	-0.10%	-0.04%
Chemical and Pharmaceutical	0.08%	0.06%	0.02%	0.04%	-0.01%	0.06%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.11%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	-0.01%	-0.06%	-0.04%	-0.10%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.05%	0.02%	-0.04%	-0.01%	-0.07%	0.01%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.01%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

Note: **Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.21: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 9$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.02%	0.02%	0.02%	0.02%	0.02%	–*
Wages	-0.21%	-0.04%	0.25%	0.14%	0.47%	–*
Capital rents	-0.03%	0.03%	0.10%	0.06%	0.12%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.02%	-0.06%	-0.02%	-0.12%	0.02%
Entertainment	0.07%	0.03%	-0.03%	-0.01%	-0.05%	0.01%
Financial Services	0.08%	0.04%	-0.03%	-0.01%	-0.11%	0.05%
IT and Telecommunication	0.06%	0.01%	-0.06%	-0.03%	-0.11%	0.02%
Tourism	0.09%	0.05%	-0.05%	-0.01%	-0.12%	0.02%
Manufacturing clusters						
Building Materials	0.00%	-0.02%	-0.09%	-0.06%	-0.12%	-0.06%
Chemical and Pharmaceutical	0.08%	0.05%	0.02%	0.04%	0.01%	0.06%
Foodstuff	0.18%	0.17%	0.12%	0.14%	0.09%	0.14%
Machinery and Engineering	0.02%	-0.01%	-0.06%	-0.04%	-0.10%	-0.04%
Textiles, Wood and Furniture	0.00%	-0.03%	-0.09%	-0.07%	-0.12%	-0.07%
*Non-cluster sectors***						
Transport and Logistics	0.07%	0.04%	-0.02%	0.01%	-0.05%	0.02%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.11%	0.09%	0.03%	0.06%	0.00%	0.08%
Regional Public Production	-1.16%	-0.28%	0.90%	0.43%	1.72%	-0.01%

Note: **Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.22: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 4$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.25%	-0.09%	0.20%	0.09%	0.41%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.01%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.07%	0.02%	-0.06%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.02%	-0.03%	-0.01%	-0.05%	0.01%
Financial Services	0.07%	0.03%	-0.04%	-0.02%	-0.12%	0.04%
IT and Telecommunication	0.08%	0.03%	-0.03%	0.00%	-0.08%	0.04%
Tourism	0.08%	0.03%	-0.07%	-0.03%	-0.14%	0.00%
Manufacturing clusters						
Building Materials	0.02%	0.00%	-0.07%	-0.04%	-0.10%	-0.04%
Chemical and Pharmaceutical	0.07%	0.04%	0.01%	0.02%	-0.02%	0.05%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.11%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.05%	0.02%	-0.03%	-0.01%	-0.06%	0.01%
Local Production	0.08%	0.04%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.01%
Regional Public Production	-1.16%	-0.27%	0.91%	0.44%	1.73%	0.00%

Note: **Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.23: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 4$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.25%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.01%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.07%	0.02%	-0.06%	-0.02%	-0.13%	0.02%
Entertainment	0.07%	0.02%	-0.03%	-0.01%	-0.05%	0.01%
Financial Services	0.07%	0.03%	-0.04%	-0.02%	-0.12%	0.04%
IT and Telecommunication	0.08%	0.04%	-0.03%	0.00%	-0.08%	0.04%
Tourism	0.08%	0.03%	-0.07%	-0.03%	-0.13%	0.01%
Manufacturing clusters						
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.08%	0.06%	0.02%	0.04%	0.00%	0.06%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.11%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	-0.01%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.06%	0.02%	-0.03%	-0.01%	-0.06%	0.01%
Local Production	0.08%	0.04%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.01%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.24: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 4$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.02%	0.02%	0.02%	0.02%	0.02%	–*
Wages	-0.21%	-0.04%	0.26%	0.14%	0.47%	–*
Capital rents	-0.02%	0.03%	0.11%	0.06%	0.12%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.06%	-0.01%	-0.12%	0.02%
Entertainment	0.07%	0.03%	-0.03%	0.00%	-0.05%	0.01%
Financial Services	0.08%	0.04%	-0.02%	0.00%	-0.10%	0.05%
IT and Telecommunication	0.06%	0.02%	-0.06%	-0.02%	-0.10%	0.02%
Tourism	0.09%	0.05%	-0.05%	-0.01%	-0.12%	0.02%
Manufacturing clusters						
Building Materials	0.01%	-0.02%	-0.09%	-0.06%	-0.12%	-0.06%
Chemical and Pharmaceutical	0.08%	0.06%	0.03%	0.04%	0.01%	0.06%
Foodstuff	0.18%	0.17%	0.12%	0.14%	0.09%	0.14%
Machinery and Engineering	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.04%
Textiles, Wood and Furniture	0.00%	-0.03%	-0.09%	-0.07%	-0.12%	-0.07%
*Non-cluster sectors***						
Transport and Logistics	0.07%	0.05%	-0.02%	0.01%	-0.05%	0.03%
Local Production	0.08%	0.03%	-0.08%	-0.03%	-0.16%	0.01%
Natural Resource Based	0.11%	0.09%	0.03%	0.06%	-0.01%	0.07%
Regional Public Production	-1.17%	-0.28%	0.90%	0.43%	1.72%	-0.01%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.25: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 9$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.25%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.05%	0.02%	0.07%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.07%	0.02%	-0.06%	-0.02%	-0.12%	0.02%
Entertainment	0.06%	0.03%	-0.03%	0.00%	-0.05%	0.01%
Financial Services	0.07%	0.03%	-0.03%	-0.01%	-0.11%	0.05%
IT and Telecommunication	0.08%	0.04%	-0.02%	0.01%	-0.06%	0.05%
Tourism	0.08%	0.03%	-0.06%	-0.03%	-0.13%	0.01%
Manufacturing clusters						
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.08%	0.05%	0.01%	0.03%	-0.02%	0.05%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.11%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.03%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	0.00%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.06%	0.03%	-0.03%	0.00%	-0.06%	0.01%
Local Production	0.09%	0.04%	-0.08%	-0.02%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.02%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.26: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 4$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	–*
Wages	-0.24%	-0.08%	0.21%	0.10%	0.42%	–*
Capital rents	-0.07%	-0.03%	0.06%	0.02%	0.08%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.07%	0.03%	-0.06%	-0.01%	-0.12%	0.02%
Entertainment	0.07%	0.03%	-0.03%	0.00%	-0.04%	0.01%
Financial Services	0.07%	0.03%	-0.03%	-0.01%	-0.11%	0.05%
IT and Telecommunication	0.08%	0.04%	-0.02%	0.01%	-0.06%	0.05%
Tourism	0.08%	0.03%	-0.06%	-0.02%	-0.13%	0.01%
Manufacturing clusters						
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%	-0.04%
Chemical and Pharmaceutical	0.09%	0.06%	0.02%	0.04%	0.00%	0.06%
Foodstuff	0.01%	-0.02%	-0.07%	-0.05%	-0.11%	-0.05%
Machinery and Engineering	0.03%	0.00%	-0.05%	-0.02%	-0.09%	-0.03%
Textiles, Wood and Furniture	0.02%	0.00%	-0.06%	-0.04%	-0.09%	-0.04%
*Non-cluster sectors***						
Transport and Logistics	0.07%	0.03%	-0.02%	0.00%	-0.05%	0.02%
Local Production	0.09%	0.04%	-0.07%	-0.02%	-0.16%	0.01%
Natural Resource Based	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.02%
Regional Public Production	-1.16%	-0.27%	0.90%	0.44%	1.73%	0.00%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Table B.27: Changes in Prices and Production

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 2.3$

Changes in prices	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
Price index. consumption bundle	0.02%	0.02%	0.02%	0.02%	0.02%	–*
Wages	-0.20%	-0.03%	0.26%	0.15%	0.47%	–*
Capital rents	-0.02%	0.04%	0.11%	0.07%	0.13%	–*
Changes in output by cluster or sector						
Knowledge intensive clusters						
Business Services	0.08%	0.03%	-0.05%	-0.01%	-0.11%	0.03%
Entertainment	0.07%	0.03%	-0.02%	0.00%	-0.04%	0.02%
Financial Services	0.09%	0.05%	-0.01%	0.01%	-0.09%	0.06%
IT and Telecommunication	0.06%	0.02%	-0.04%	-0.01%	-0.09%	0.02%
Tourism	0.09%	0.05%	-0.05%	-0.01%	-0.11%	0.02%
Manufacturing clusters						
Building Materials	0.01%	-0.02%	-0.08%	-0.05%	-0.11%	-0.06%
Chemical and Pharmaceutical	0.09%	0.07%	0.04%	0.05%	0.02%	0.07%
Foodstuff	0.19%	0.17%	0.12%	0.14%	0.09%	0.14%
Machinery and Engineering	0.02%	0.00%	-0.06%	-0.03%	-0.10%	-0.04%
Textiles, Wood and Furniture	0.00%	-0.02%	-0.09%	-0.07%	-0.12%	-0.07%
*Non-cluster sectors***						
Transport and Logistics	0.08%	0.05%	-0.01%	0.02%	-0.04%	0.04%
Local Production	0.09%	0.04%	-0.08%	-0.02%	-0.16%	0.01%
Natural Resource Based	0.11%	0.09%	0.03%	0.06%	-0.01%	0.07%
Regional Public Production	-1.17%	-0.28%	0.90%	0.43%	1.72%	-0.01%

*Note: *Aggregated price indices not available. **National public sector kept exogeneous.*

Appendix C

Other Results - Regional Exports

Table C.1: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.25%	0.07%	-0.08%	-0.02%	-0.14%
Entertainment	0.22%	0.07%	-0.05%	0.00%	-0.05%
Financial Services	0.27%	0.11%	-0.03%	0.02%	-0.11%
IT and Telecommunication	0.20%	0.06%	-0.05%	-0.01%	-0.10%
Tourism	0.31%	0.11%	-0.09%	-0.03%	-0.15%
Manufacturing clusters					
Building Materials	0.02%	-0.02%	-0.09%	-0.05%	-0.12%
Chemical and Pharmaceutical	0.19%	0.10%	0.04%	0.07%	0.01%
Foodstuff	0.40%	0.30%	0.17%	0.23%	0.12%
Machinery and Engineering	0.04%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.05%	-0.02%	-0.11%	-0.06%	-0.14%
*Non-cluster sectors**					
Transport and Logistics	0.20%	0.05%	-0.11%	-0.04%	-0.19%
Local Production	0.15%	0.09%	0.01%	0.05%	-0.02%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.2: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.23%	0.07%	-0.08%	-0.02%	-0.14%
Entertainment	0.21%	0.07%	-0.05%	-0.01%	-0.06%
Financial Services	0.25%	0.09%	-0.04%	0.00%	-0.12%
IT and Telecommunication	0.24%	0.11%	-0.02%	0.03%	-0.07%
Tourism	0.29%	0.08%	-0.11%	-0.04%	-0.17%
Manufacturing clusters					
Building Materials	0.05%	0.01%	-0.06%	-0.03%	-0.10%
Chemical and Pharmaceutical	0.16%	0.08%	0.01%	0.04%	-0.01%
Foodstuff	0.06%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.05%	-0.02%	-0.09%
Textiles, Wood and Furniture	0.08%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.05%	-0.11%	-0.04%	-0.18%
Local Production	0.04%	0.00%	-0.08%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.3: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.23%	0.07%	-0.08%	-0.02%	-0.14%
Entertainment	0.21%	0.07%	-0.05%	-0.01%	-0.06%
Financial Services	0.25%	0.09%	-0.04%	0.00%	-0.12%
IT and Telecommunication	0.24%	0.11%	-0.02%	0.03%	-0.07%
Tourism	0.29%	0.08%	-0.11%	-0.04%	-0.17%
Manufacturing clusters					
Building Materials	0.05%	0.01%	-0.07%	-0.03%	-0.10%
Chemical and Pharmaceutical	0.13%	0.05%	-0.01%	0.02%	-0.03%
Foodstuff	0.06%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.05%	-0.03%	-0.09%
Textiles, Wood and Furniture	0.07%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.05%	-0.11%	-0.04%	-0.18%
Local Production	0.04%	0.00%	-0.08%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.4: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 4.0$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.21%	0.05%	-0.08%	-0.03%	-0.15%
Entertainment	0.18%	0.05%	-0.06%	-0.02%	-0.07%
Financial Services	0.23%	0.07%	-0.05%	-0.01%	-0.13%
IT and Telecommunication	0.16%	0.04%	-0.07%	-0.03%	-0.12%
Tourism	0.27%	0.08%	-0.10%	-0.03%	-0.16%
Manufacturing clusters					
Building Materials	0.02%	-0.02%	-0.09%	-0.06%	-0.12%
Chemical and Pharmaceutical	0.18%	0.09%	0.03%	0.06%	0.00%
Foodstuff	0.39%	0.29%	0.17%	0.23%	0.11%
Machinery and Engineering	0.04%	-0.01%	-0.07%	-0.04%	-0.11%
Textiles, Wood and Furniture	0.04%	-0.02%	-0.11%	-0.07%	-0.14%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.04%	-0.19%
Local Production	0.15%	0.09%	0.01%	0.05%	-0.02%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.5: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 4.0$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.19%	0.05%	-0.09%	-0.03%	-0.15%
Entertainment	0.18%	0.04%	-0.07%	-0.02%	-0.07%
Financial Services	0.21%	0.06%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.18%	0.07%	-0.04%	0.00%	-0.09%
Tourism	0.25%	0.06%	-0.11%	-0.05%	-0.18%
Manufacturing clusters					
Building Materials	0.05%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.15%	0.08%	0.01%	0.04%	-0.01%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.04%	-0.19%
Local Production	0.04%	0.00%	-0.07%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.6: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 4.0$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.19%	0.04%	-0.09%	-0.03%	-0.15%
Entertainment	0.17%	0.04%	-0.07%	-0.02%	-0.07%
Financial Services	0.21%	0.06%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.18%	0.06%	-0.04%	0.00%	-0.09%
Tourism	0.25%	0.05%	-0.12%	-0.05%	-0.18%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.13%	0.05%	-0.01%	0.02%	-0.03%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.04%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.05%	-0.19%
Local Production	0.04%	0.00%	-0.07%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.7: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 9.0$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.19%	0.04%	-0.09%	-0.03%	-0.15%
Entertainment	0.17%	0.04%	-0.07%	-0.02%	-0.07%
Financial Services	0.21%	0.06%	-0.05%	-0.02%	-0.13%
IT and Telecommunication	0.15%	0.02%	-0.08%	-0.04%	-0.12%
Tourism	0.24%	0.07%	-0.10%	-0.04%	-0.17%
Manufacturing clusters					
Building Materials	0.01%	-0.02%	-0.09%	-0.06%	-0.12%
Chemical and Pharmaceutical	0.17%	0.09%	0.02%	0.05%	-0.01%
Foodstuff	0.39%	0.29%	0.17%	0.23%	0.11%
Machinery and Engineering	0.04%	-0.01%	-0.07%	-0.04%	-0.11%
Textiles, Wood and Furniture	0.04%	-0.02%	-0.11%	-0.07%	-0.14%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.15%	0.09%	0.01%	0.05%	-0.02%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.8: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 9.0$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.17%	0.04%	-0.09%	-0.04%	-0.16%
Entertainment	0.16%	0.03%	-0.07%	-0.03%	-0.08%
Financial Services	0.19%	0.05%	-0.06%	-0.03%	-0.14%
IT and Telecommunication	0.16%	0.05%	-0.05%	-0.01%	-0.10%
Tourism	0.23%	0.04%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.15%	0.07%	0.01%	0.04%	-0.02%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.05%	-0.19%
Local Production	0.04%	0.00%	-0.07%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.9: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 10\%$, $\sigma_k = 9.0$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.17%	0.03%	-0.09%	-0.04%	-0.16%
Entertainment	0.16%	0.03%	-0.07%	-0.03%	-0.08%
Financial Services	0.19%	0.04%	-0.06%	-0.03%	-0.14%
IT and Telecommunication	0.16%	0.05%	-0.05%	-0.01%	-0.10%
Tourism	0.23%	0.04%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.13%	0.05%	-0.01%	0.02%	-0.03%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.04%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.05%	-0.19%
Local Production	0.04%	0.00%	-0.07%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.10: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 2.3$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.16%	0.03%	-0.10%	-0.04%	-0.16%
Entertainment	0.14%	0.02%	-0.08%	-0.04%	-0.08%
Financial Services	0.18%	0.05%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.15%	0.04%	-0.06%	-0.02%	-0.11%
Tourism	0.21%	0.04%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.10%	0.03%	-0.02%	0.00%	-0.04%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.18%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.05%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.11: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 2.3$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.16%	0.03%	-0.10%	-0.04%	-0.16%
Entertainment	0.14%	0.02%	-0.08%	-0.04%	-0.08%
Financial Services	0.18%	0.05%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.15%	0.04%	-0.06%	-0.02%	-0.11%
Tourism	0.21%	0.04%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.10%	0.03%	-0.02%	0.00%	-0.04%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.18%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.05%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.12: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 2.3$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.16%	0.03%	-0.10%	-0.04%	-0.16%
Entertainment	0.14%	0.02%	-0.08%	-0.04%	-0.08%
Financial Services	0.18%	0.05%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.15%	0.04%	-0.06%	-0.02%	-0.11%
Tourism	0.21%	0.04%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.10%	0.03%	-0.02%	0.00%	-0.04%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.18%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.05%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.13: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 4.0$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.16%	0.03%	-0.10%	-0.04%	-0.16%
Entertainment	0.14%	0.02%	-0.08%	-0.04%	-0.08%
Financial Services	0.18%	0.05%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.15%	0.04%	-0.06%	-0.02%	-0.11%
Tourism	0.21%	0.04%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.10%	0.03%	-0.02%	0.00%	-0.04%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.18%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.05%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.14: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 4.0$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.16%	0.03%	-0.10%	-0.04%	-0.16%
Entertainment	0.14%	0.02%	-0.08%	-0.04%	-0.08%
Financial Services	0.18%	0.05%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.15%	0.04%	-0.06%	-0.02%	-0.11%
Tourism	0.21%	0.04%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.10%	0.03%	-0.02%	0.00%	-0.04%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.18%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.05%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.15: Changes in Regional Exports

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 4.0$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.18%	0.04%	-0.09%	-0.04%	-0.15%
Entertainment	0.16%	0.04%	-0.07%	-0.03%	-0.08%
Financial Services	0.21%	0.07%	-0.05%	-0.01%	-0.13%
IT and Telecommunication	0.17%	0.05%	-0.05%	-0.01%	-0.10%
Tourism	0.24%	0.05%	-0.12%	-0.05%	-0.18%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.11%	0.04%	-0.02%	0.01%	-0.04%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.02%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.06%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

Note: **National public sector fixed and regional public goods are non-traded.*

Table C.16: Changes in Regional Exports

Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 9.0$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.16%	0.03%	-0.10%	-0.04%	-0.16%
Entertainment	0.14%	0.02%	-0.08%	-0.04%	-0.08%
Financial Services	0.18%	0.05%	-0.06%	-0.02%	-0.14%
IT and Telecommunication	0.15%	0.04%	-0.06%	-0.02%	-0.11%
Tourism	0.21%	0.04%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.03%	0.00%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.10%	0.03%	-0.02%	0.00%	-0.04%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.18%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.05%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

Note: **National public sector fixed and regional public goods are non-traded.*

Table C.17: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 9.0$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.17%	0.04%	-0.09%	-0.04%	-0.16%
Entertainment	0.15%	0.03%	-0.07%	-0.03%	-0.08%
Financial Services	0.20%	0.06%	-0.05%	-0.02%	-0.13%
IT and Telecommunication	0.16%	0.04%	-0.06%	-0.02%	-0.10%
Tourism	0.23%	0.05%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.04%	0.01%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.12%	0.05%	-0.01%	0.02%	-0.03%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.02%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.18%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.06%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.18: Changes in Regional Exports
Scenario $\tau_k = 10\%$, $\tau_m = 20\%$, $\sigma_k = 9.0$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.17%	0.04%	-0.09%	-0.04%	-0.16%
Entertainment	0.15%	0.03%	-0.08%	-0.03%	-0.08%
Financial Services	0.20%	0.06%	-0.05%	-0.02%	-0.13%
IT and Telecommunication	0.16%	0.04%	-0.06%	-0.02%	-0.10%
Tourism	0.23%	0.05%	-0.12%	-0.06%	-0.18%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.06%	-0.03%	-0.09%
Chemical and Pharmaceutical	0.11%	0.04%	-0.02%	0.01%	-0.04%
Foodstuff	0.05%	-0.02%	-0.10%	-0.07%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.04%	-0.02%	-0.08%
Textiles, Wood and Furniture	0.06%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.18%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.03%	-0.01%	-0.09%	-0.05%	-0.12%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.19: Changes in Regional Exports

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.22%	0.06%	-0.08%	-0.02%	-0.13%
Entertainment	0.19%	0.06%	-0.05%	-0.01%	-0.06%
Financial Services	0.24%	0.08%	-0.04%	0.00%	-0.11%
IT and Telecommunication	0.17%	0.04%	-0.06%	-0.02%	-0.10%
Tourism	0.28%	0.09%	-0.09%	-0.03%	-0.14%
Manufacturing clusters					
Building Materials	0.03%	-0.02%	-0.09%	-0.05%	-0.12%
Chemical and Pharmaceutical	0.20%	0.12%	0.05%	0.08%	0.02%
Foodstuff	0.40%	0.30%	0.18%	0.23%	0.12%
Machinery and Engineering	0.05%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.05%	-0.02%	-0.11%	-0.07%	-0.14%
*Non-cluster sectors**					
Transport and Logistics	0.20%	0.05%	-0.11%	-0.04%	-0.19%
Local Production	0.15%	0.09%	0.01%	0.05%	-0.02%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.20: Changes in Regional Exports

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.20%	0.05%	-0.08%	-0.03%	-0.14%
Entertainment	0.18%	0.05%	-0.06%	-0.02%	-0.06%
Financial Services	0.21%	0.06%	-0.05%	-0.02%	-0.12%
IT and Telecommunication	0.19%	0.08%	-0.03%	0.01%	-0.08%
Tourism	0.26%	0.06%	-0.10%	-0.05%	-0.16%
Manufacturing clusters					
Building Materials	0.05%	0.01%	-0.07%	-0.03%	-0.10%
Chemical and Pharmaceutical	0.16%	0.08%	0.02%	0.05%	-0.01%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.05%	-0.03%	-0.09%
Textiles, Wood and Furniture	0.08%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.05%	-0.11%	-0.04%	-0.18%
Local Production	0.04%	0.00%	-0.07%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.21: Changes in Regional Exports
Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 2.3$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.20%	0.05%	-0.08%	-0.03%	-0.14%
Entertainment	0.18%	0.05%	-0.06%	-0.02%	-0.06%
Financial Services	0.21%	0.06%	-0.05%	-0.02%	-0.13%
IT and Telecommunication	0.19%	0.08%	-0.03%	0.01%	-0.08%
Tourism	0.26%	0.06%	-0.11%	-0.05%	-0.16%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.07%	-0.03%	-0.10%
Chemical and Pharmaceutical	0.13%	0.06%	-0.01%	0.02%	-0.03%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.05%	-0.03%	-0.09%
Textiles, Wood and Furniture	0.07%	0.00%	-0.08%	-0.05%	-0.11%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.05%	-0.11%	-0.04%	-0.19%
Local Production	0.04%	0.00%	-0.07%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.22: Changes in Regional Exports
Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 4.0$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.19%	0.04%	-0.08%	-0.03%	-0.14%
Entertainment	0.17%	0.04%	-0.06%	-0.02%	-0.06%
Financial Services	0.20%	0.06%	-0.05%	-0.02%	-0.12%
IT and Telecommunication	0.14%	0.02%	-0.07%	-0.03%	-0.11%
Tourism	0.24%	0.07%	-0.09%	-0.03%	-0.15%
Manufacturing clusters					
Building Materials	0.02%	-0.02%	-0.09%	-0.06%	-0.12%
Chemical and Pharmaceutical	0.19%	0.10%	0.03%	0.07%	0.01%
Foodstuff	0.40%	0.30%	0.18%	0.23%	0.12%
Machinery and Engineering	0.04%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.04%	-0.02%	-0.11%	-0.07%	-0.14%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.12%	-0.04%	-0.19%
Local Production	0.15%	0.09%	0.02%	0.05%	-0.02%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.23: Changes in Regional Exports
Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 4.0$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.17%	0.03%	-0.09%	-0.03%	-0.14%
Entertainment	0.16%	0.04%	-0.06%	-0.02%	-0.07%
Financial Services	0.18%	0.04%	-0.06%	-0.03%	-0.14%
IT and Telecommunication	0.16%	0.05%	-0.05%	-0.01%	-0.09%
Tourism	0.23%	0.04%	-0.11%	-0.05%	-0.17%
Manufacturing clusters					
Building Materials	0.05%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.16%	0.08%	0.01%	0.04%	-0.01%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.01%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.05%	-0.19%
Local Production	0.05%	0.01%	-0.07%	-0.04%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.24: Changes in Regional Exports
Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 4.0$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.17%	0.03%	-0.09%	-0.04%	-0.15%
Entertainment	0.16%	0.04%	-0.06%	-0.02%	-0.07%
Financial Services	0.18%	0.04%	-0.06%	-0.03%	-0.14%
IT and Telecommunication	0.16%	0.05%	-0.05%	-0.01%	-0.09%
Tourism	0.22%	0.04%	-0.11%	-0.05%	-0.17%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.13%	0.05%	-0.01%	0.02%	-0.03%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.04%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.05%	-0.19%
Local Production	0.05%	0.01%	-0.07%	-0.03%	-0.11%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

*Note: *National public sector fixed and regional public goods are non-traded.*

Table C.25: Changes in Regional Exports
Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 9.0$ and $\sigma_m = 2.3$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.17%	0.03%	-0.08%	-0.03%	-0.14%
Entertainment	0.15%	0.03%	-0.06%	-0.02%	-0.07%
Financial Services	0.19%	0.05%	-0.05%	-0.02%	-0.13%
IT and Telecommunication	0.13%	0.02%	-0.07%	-0.04%	-0.12%
Tourism	0.23%	0.06%	-0.10%	-0.04%	-0.15%
Manufacturing clusters					
Building Materials	0.02%	-0.02%	-0.09%	-0.06%	-0.12%
Chemical and Pharmaceutical	0.18%	0.10%	0.03%	0.06%	0.00%
Foodstuff	0.40%	0.30%	0.18%	0.23%	0.12%
Machinery and Engineering	0.04%	0.00%	-0.06%	-0.04%	-0.11%
Textiles, Wood and Furniture	0.04%	-0.03%	-0.11%	-0.07%	-0.14%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.15%	0.09%	0.02%	0.05%	-0.02%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

Note: **National public sector fixed and regional public goods are non-traded.*

Table C.26: Changes in Regional Exports
Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 9.0$ and $\sigma_m = 4.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.16%	0.03%	-0.09%	-0.04%	-0.15%
Entertainment	0.15%	0.03%	-0.07%	-0.03%	-0.07%
Financial Services	0.17%	0.03%	-0.07%	-0.03%	-0.14%
IT and Telecommunication	0.14%	0.04%	-0.05%	-0.02%	-0.10%
Tourism	0.21%	0.04%	-0.11%	-0.05%	-0.17%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.15%	0.08%	0.01%	0.04%	-0.01%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.05%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.11%	-0.05%	-0.19%
Local Production	0.05%	0.01%	-0.07%	-0.03%	-0.10%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

Note: **National public sector fixed and regional public goods are non-traded.*

Table C.27: Changes in Regional Exports

Scenario $\tau_k = 20\%$, $\tau_m = 10\%$, $\sigma_k = 9.0$ and $\sigma_m = 9.0$

From region	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland
Knowledge intensive clusters					
Business Services	0.16%	0.03%	-0.09%	-0.04%	-0.15%
Entertainment	0.15%	0.03%	-0.07%	-0.03%	-0.07%
Financial Services	0.17%	0.03%	-0.07%	-0.04%	-0.14%
IT and Telecommunication	0.14%	0.04%	-0.05%	-0.02%	-0.10%
Tourism	0.21%	0.04%	-0.11%	-0.06%	-0.17%
Manufacturing clusters					
Building Materials	0.04%	0.00%	-0.07%	-0.04%	-0.10%
Chemical and Pharmaceutical	0.13%	0.05%	-0.01%	0.02%	-0.03%
Foodstuff	0.07%	-0.01%	-0.10%	-0.06%	-0.14%
Machinery and Engineering	0.04%	0.00%	-0.06%	-0.03%	-0.10%
Textiles, Wood and Furniture	0.07%	0.00%	-0.09%	-0.05%	-0.12%
*Non-cluster sectors**					
Transport and Logistics	0.19%	0.04%	-0.12%	-0.05%	-0.19%
Local Production	0.05%	0.01%	-0.07%	-0.03%	-0.10%
Natural Resource Based	0.01%	0.00%	0.00%	0.00%	0.00%

Note: *National public sector fixed and regional public goods are non-traded.

Appendix D

Other Results - Sensitivity

Table D.1: Equivalent Variations – across Scenarios

Transport costs Knowledge	Transport costs Manufacturing	Elasticities of substitution Knowledge	Elasticities of substitution Manufacturing	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.88%	-0.12%	0.61%	0.32%	1.37%	0.02%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.88%	-0.12%	0.62%	0.32%	1.37%	0.02%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.84%	-0.09%	0.65%	0.35%	1.41%	0.05%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.87%	-0.12%	0.62%	0.32%	1.38%	0.02%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.87%	-0.12%	0.62%	0.33%	1.38%	0.03%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.84%	-0.08%	0.66%	0.36%	1.41%	0.06%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.86%	-0.11%	0.63%	0.34%	1.39%	0.04%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.85%	-0.11%	0.63%	0.34%	1.39%	0.04%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.82%	-0.08%	0.67%	0.38%	1.43%	0.07%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.88%	-0.13%	0.62%	0.32%	1.37%	0.02%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.88%	-0.13%	0.62%	0.32%	1.37%	0.02%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.87%	-0.13%	0.62%	0.33%	1.37%	0.02%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.88%	-0.12%	0.62%	0.32%	1.37%	0.02%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.88%	-0.12%	0.62%	0.32%	1.38%	0.02%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.84%	-0.09%	0.65%	0.36%	1.41%	0.06%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.88%	-0.12%	0.62%	0.32%	1.38%	0.02%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.88%	-0.12%	0.62%	0.33%	1.38%	0.02%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.84%	-0.08%	0.66%	0.36%	1.42%	0.06%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.87%	-0.11%	0.63%	0.34%	1.39%	0.03%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.86%	-0.11%	0.63%	0.34%	1.39%	0.04%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.82%	-0.08%	0.67%	0.38%	1.43%	0.07%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.88%	-0.13%	0.62%	0.32%	1.37%	0.02%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.88%	-0.13%	0.62%	0.33%	1.37%	0.02%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.02%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.88%	-0.13%	0.61%	0.32%	1.36%	0.01%

Note: Interregional trade imputed with No Home Bias seed.

Table D.2: Equivalent Variations – across Scenarios

Transport costs: Knowledge	Transport costs: Manufacturing	Elasticities of substitution: Knowledge	Elasticities of substitution: Manufacturing	Copenhagen	Zealand	Southern Denmark	Mid-Jutland	Northern Jutland	Denmark
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.94%	-0.15%	0.63%	0.39%	1.44%	0.02%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.94%	-0.15%	0.64%	0.39%	1.45%	0.02%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.89%	-0.10%	0.69%	0.44%	1.51%	0.08%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.93%	-0.15%	0.64%	0.39%	1.45%	0.02%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.93%	-0.14%	0.64%	0.40%	1.45%	0.03%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.88%	-0.09%	0.70%	0.45%	1.51%	0.08%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.90%	-0.14%	0.65%	0.41%	1.46%	0.04%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.90%	-0.13%	0.66%	0.41%	1.46%	0.05%
$\tau_k = 10\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.85%	-0.08%	0.71%	0.47%	1.52%	0.10%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.94%	-0.16%	0.63%	0.39%	1.44%	0.02%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.68%	0.08%	0.93%	0.68%	1.77%	0.30%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.68%	0.07%	0.93%	0.68%	1.77%	0.29%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 10\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.68%	0.07%	0.92%	0.68%	1.76%	0.29%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.95%	-0.15%	0.63%	0.38%	1.44%	0.02%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.94%	-0.15%	0.64%	0.39%	1.45%	0.02%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.88%	-0.10%	0.69%	0.44%	1.51%	0.08%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.94%	-0.15%	0.64%	0.39%	1.45%	0.02%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.93%	-0.14%	0.64%	0.39%	1.45%	0.03%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.87%	-0.09%	0.70%	0.45%	1.51%	0.08%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.92%	-0.14%	0.65%	0.40%	1.46%	0.04%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.91%	-0.13%	0.65%	0.41%	1.46%	0.04%
$\tau_k = 20\%$	$\tau_m = 10\%$	$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.85%	-0.08%	0.71%	0.47%	1.52%	0.10%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 9.0$	-0.94%	-0.16%	0.64%	0.39%	1.44%	0.02%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 4.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 9.0$	$\sigma_m = 2.3$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 9.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 4.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 4.0$	$\sigma_m = 2.3$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 9.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 4.0$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%
$\tau_k = 20\%$	$\tau_m = 20\%$	$\sigma_k = 2.3$	$\sigma_m = 2.3$	-0.94%	-0.16%	0.63%	0.38%	1.42%	0.01%

Note: Interregional trade imputed with Home Bias seed.

Regional Computable General Equilibrium Models for Denmark

Lars Brømsøe Termansen

Resumé

Hvert år, når den danske regering fremlægger finanslovsforslaget, er forslaget vedlagt en økonomisk effektberegning og en fremskrivning af økonomien. Disse beregninger er baseret på økonomiske modeller, som ADAM og DREAM. Modellernes bidrag er deres evne til at holde styr på dynamiske sammenhænge, der er til stede i økonomien.

Danmarks erhvervsliv har en regional dimension, hvor næsten halvdelen af produktionen sker i Hovedstadsregionen, mens resten er nogenlunde jævnt fordelt på de resterende regioner. Vi kan desuden observere, at mange erhverv har en tendens til at klumpe sig sammen i erhvervsklynger. Men netop det regionale perspektiv og klyngeeffekter er *ikke* indarbejdet i de nationale modeller som ADAM og DREAM. De er ikke bygget med formålet at analysere regionale effekter, og kan derfor ikke give informationer på det detaljeringsniveau, som er nødvendigt for at evaluere politiske initiativer med regionale implikationer.

For at give et sådant værktøj til regionale effektmålinger, præsenterer nærværende afhandling tre papirer om *regionale* anvendte generelle ligevægtsmodeller. Modellerne tager højde for klyngeeffekter med agglomerationsegenskaber og er baseret på litteraturen om økonomisk geografi.

Ved at introducere finansiel udligning mellem regioner, afslører det første papir (kapitel 2), at en sådan udligning vil ændre koncentrationsmønstret i modellen. Analysen viser, at et økonomisk center, til en hvis grad, kan beskattes og en del af skatteprovenuet overføres til et udkantsområde. Omkostningen er dog, at det økonomiske center er vanskeligere at opretholde.

Det andet papir (kapitel 3) fører analysen videre og introducerer lokale offentlige ydelser og trængselsomkostninger. Nu har modellen endnu færre løsninger med centre og udkantsområder, idet koncentrationseffekterne modvirkes yderligere af effekterne af de nye

udvidelser. Transfereringer mellem regioner trækker således ressourcer ud af økonomiske centre til gavn for borgerne i fattigere udkantsområder. Offentlige serviceydelser hæver, ydermere, nytten for borgerne, dog lægger det beslag på ressourcer der kunne være brugt i den private sektor.

Resultaterne fra de stiliserede analyser tages videre i det sidste papir (kapitel 4), som præsenterer en regional anvendt generel ligevægtsmodel kalibreret til den danske økonomi. Modellen bruges til at analysere effekterne af udligningsreformen, der blev implementeret i 2007. Reformen betød at der blev flyttet penge fra det østlige til det vestlige Danmark. Simulationer viser at østdanmark reducerer den offentlige sektor, hvilket frigør ressourcer så den private sektor kan ekspandere. Modsat i vestdanmark, hvor det går ud over den private sektor, at den offentlige sektor udvider. Udligningsreformen betyder, at koncentrationen af videnstunge klynger i Hovedstadsregionen styrkes, mens klynger af fremstillingsvirksomheder svækkes i det vestlige Danmark. Overordnet betyder den stærkere koncentration, at der kommer en velfærdsgevinst nationalt set, dog vil borgere i østdanmark tabe sammenlignet med borgere i vestdanmark.

Arbejdet, der er præsenteret her i afhandlingen, er et første skridt på vejen til at konstruere anvendte regionale generelle ligevægtsmodeller. Disse modeller vil kunne medregne klyngeeffekter, og vil kunne bruges til at analysere regionalpolitiske initiativer, specielt med fokus på erhvervslivets lokalisering og regionale velfærdseffekter. Papirerne i afhandlingen lægger derfor et efterspurgt fundament til at udvikle nye værktøjer til analysere regionalpolitik. Værktøjer, der vil bidrage til at øge informationsgrundlaget for beslutningstagere, både generelt og mere specifikt i regionalpolitiske sammenhænge.

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