New Economic Geography, Empirics, and Regional Policy

Steven Brakman, Harry Garretsen, Joeri Gorter[1], Albert van der Horst[2], Marc Schramm
June 8, 2005

There are doubts about the effectiveness of regional policy. Well known are the fruitless attempts of Italy to bridge the gap between the Mezzogiorno and the North, of Germany to bridge the gap between the Neue Länder and the West, and of the European Commission to reduce regional disparities in general. We validate one explanation: agglomeration advantages lock business activity in relatively prosperous core regions, even though wages – and thus production costs – tend to be higher there. We set off from the 'New Economic Geography', a set of general equilibrium models that focus on location choice. Theory, descriptive statistics, and econometric analysis support the conclusion that the European economic geography is characterized by a network of *local* and *stable* core periphery systems. This implies that disparities between core regions and their peripheries at a (sub) provincial level of regional aggregation are with us to stay, as regional policy targeted on peripheries tends to be insufficient to counter centripetal market forces. Moreover, *even if* such policy has an impact, it may be adverse, as core regions may benefit disproportionately in the long run. A focus of regional policy on local agglomerations, which have a realistic chance to hold on to economic activity, is therefore desirable.

[1] Email: j.gorter@cpb.nl; Phone: ++31 70 3383382;
Homepage: http://www.cpb.nl/nl/general/org/homepages/jgt/

[2] Email: a.van.der.horst@cpb.nl; Phone: ++31 70 3383402;
Homepage: http://www.cpb.nl/nl/general/org/homepages/avdh/

1   Introduction

The failure of regional policy to substantially reduce regional disparities qualifies as a stylised fact. Italy and Germany have pushed hard to develop the Mezzogiorno respectively the Neue Länder. The efforts have been, however, of little avail. The peripheral regions continue to lag behind in employment, productivity, and wages. The cohesion policy of the European Commission, which annually allocates tens of billions of euro's to lagging regions all across the EU, has been equally ineffective.[3] Why?

A somewhat cynical explanation is that the available funds are wasted on nonsensical projects such as highways from nowhere to nowhere. Of course, 'cathedrals in the desert' have been built. But it is only fair to admit that most funds are spent on projects that, at least on paper, seem to be economically viable. There must be more to it.

One explanation is that peripheral regions lack the critical mass to hold on to economic activity. Regional policy may be temporarily successful in luring economic activity towards the periphery. But in the long run it will end up in the core. Even worse, reducing the interregional freeness of trade by large infrastructure projects, by product harmonisation, or by any other act that fosters economic integration may have a perverse impact on the periphery: it may become profitable for firms to relocate to the core and serve the peripheral market from there.

Until recently, the scientific underpinning of this explanation was scattered across the economic literature in an eclectic set of regional science papers. Fujita et al. (1999) integrated the prime insights from this literature in a consistent general equilibrium framework, and dubbed it the New Economic Geography (NEG). Brakman and Garretsen (2003, p.638) predicate that it is "to date the only theory within mainstream economics that takes the economics of location seriously".

A major insight from Baldwin et al. (2003), Midelfart (2004) and other studies within the NEG framework is that regions do not stand alone, but pertain to core periphery *systems*. Disregarding the interaction between the individual regions may lead to an unexpected and adverse impact of regional policy.

However powerful the insight may be, a problem of the NEG remains its lack of empirical grounding. As with most innovations within economic science, initial contributions show a strong bias towards theory. Consequently, many empirical questions – such as the geographical scale on which agglomeration advantages operate – remain to be answered. Therefore, we do not attempt to perfect theory, but confront existing tenets with European regional data. With the help

---

[3] For surveys of the academic literature on the effectiveness of regional policy, see Bijvoet and Koopmans (2004), Rodriguez-Pose and Fratesi (2004) and Ederveen et al. (2002).

of descriptive statistics and the econometric estimation of the key parameters of the NEG, we fill in some of the empirical blind spots.

A prime contribution of this study is the identification of the economic scale at which agglomeration advantages shape the economic geography. We find that the European economic geography comprises local and stable core periphery systems. This is backed up by strong and localised agglomeration advantages. It implies that regional policy at the (sub) provincial scale is likely to be ineffective, as it has to overcome centripetal market forces that induce a preference for location in the local core. The flip side of the coin is that at larger geographical scales regional policy retains its potential to reduce disparities. The conclusion is, not incidentally, consistent with an income convergence at national level, but a lack of it at the regional level.[4]

More agglomeration is not necessarily bad. The rationale of the Single Market Program rests primarily on exploitation of comparative advantages, which involves a shift of economic activity between Member States such that the location of production is in concordance with the location of production factors. Moreover, pleas for more agglomeration reveals an awareness of agglomeration externalities, i.e. of positive spillover-effects between co-locating economic agents.

The incoherence of the simultaneous promotion of clustering and dispersion is conspicuous. It exemplifies that choosing an optimal point on the efficiency-equity tradeoff is no mean feat. We do not, however, intend to determine which of the two strands of regional policy is superior. We ask instead a more fundamental question: how malleable is the European economic geography, and what does its (limited) malleability imply for the design of regional policy?

We must put forward a caveat. The empirical validation of the NEG is a relatively novel enterprise, and this study is by no means the last word on the issue. In addition, data limitations preclude a thorough sectoral decomposition. Finally, there are many (unobserved) reasons why an instance of regional policy has had, or has not had the desired effect for a particular subset of regions.

Since parts of this study are quite technical, we suggest readers primarily interested in policy implications to focus on chapter 2, and then jump to chapter 5. Readers interested in the empirics of the European economic geography should also have a look at chapters 3 and 4.

---

[4] See Martin (2001).

2 Theory

2.1 Introduction

Peripheral regions may lack the critical mass to hold on to economic activity. Consequently, regional policy may be only temporarily successful in luring economic activity toward the periphery. Even worse, reducing the interregional freeness of trade by large infrastructure projects, by product harmonisation, or by any other act that fosters economic integration may have a perverse impact on the periphery since it may become profitable for firms to relocate to the core and serve the peripheral market from there. The NEG combines insights from regional science within a consistent general equilibrium framework. It stands as the only theory within mainstream economics that takes the economics of location seriously. In this chapter we present an intuitive and non-technical introduction to the NEG.[5]

2.2 First and Second Nature

There are two basic causes of agglomeration. *First nature* causes are land, climate, navigable waterways, immobile labour, etc. These are regional endowments that cannot easily be changed. *Second nature* causes refer to a circularity in location choice. Firms want to be where large market are, and large markets are where many firms are located. Note that there is no a priori reason for a region to host a large market. An initial minor advantage of one region over another can evolve into a stable core- periphery pattern.

Heckscher-Ohlin theories of international trade are about first nature causes. On the basis of endowments we are able to understand why firms in one region tend to produce labour intensive, and in another capital intensive goods. Within the confines of these theories the absence of location choice is not a major drawback. International factor prize equalisation makes international factor movements redundant.

This is, however, not good enough for our purpose. Dixit and Norman (1980) point out that factor equalisation does not hold for non-standard instances of the Heckscher-Ohlin model, where the number of production factors is not equal to the number of goods. More important, Heckscher-Ohlin theories only explain specialisation patterns and not agglomeration of economic activity per se.

The NEG is about second nature causes. It explicitly incorporates location. This is important since there are ample indications that second nature causes are indispensable for understanding

---

[5] We discuss the details of the NEG in chapter 4.

the economic geography of Europe.[6] Moreover, it gives more clues for regional policy. Endowments are given by definition, but location can in principle be influenced.

But endowments also matter, if only as 'nuclei of condensation' that give one region an initial advantage over another. Forslid et al. (2002) and Ricci (1999) combine first and second nature causes along this line of reasoning.

2.3   Agglomeration and Trade

Agglomeration and trade are linked. Trade costs and increasing returns to scale induce a preference for regions with a large market access. Since regions that host a large number of plants also have a large market access, location choice is a circular process: if one firm prefers a region, the next does so a fortiori.

Agglomeration of economic activity is, however, not an equilibrium for high trade costs. Supplying distant markets from a single plant is too expensive. Neither is agglomeration an equilibrium for low trade costs. The pecuniary advantages of co-location dwindle as imports are hardly more expensive than locally produced goods. Thus, in many NEG models agglomeration is a bell shaped function of the freeness of trade, ϕ, which is the reciprocal of trade costs.

Building blocks of the NEG

|	
Mobility of production factors	This assumption distinguishes the NEG from trade theory. It makes location choice possible.
Increasing returns to scale	Production with a single plant is cheaper than with multiple plants. It makes location choice expedient.
Trade costs	Trade over physical distance is costly. It induces a preference for location in regions with a large market access.

Figure 2.1 displays the bell. It is the equilibrium distribution of economic activity over two initially similar regions (vertical axis) as a function of the freeness of trade (horizontal axis). For a wide range of freeness of trade the distribution remains fifty-fifty for ex ante similar regions. If, however, ongoing economic integration pushes the freeness of trade beyond threshold ϕ_B, then an uneven distribution, in which one region hosts a disproportionate amount of activity, prevails.

The core-periphery structure is stable for a range of intermediate trade costs. Within this range the balance tips in favour of centripetal market forces, and the circular causality of location choice comes into play. Beyond a threshold ϕ^B, the economic geography returns to a dispersion equilibrium, as the advantages of co-location dwindle, and direct costs of agglomeration become more prominent.

---

[6] See chapters 3 and 4.

The break points constitute the border between the dispersion and agglomeration equilibria. There is not necessarily catastrophic shift in economic activity, because congestion and other trade cost independent market forces choke off the agglomeration advantages. For now we are satisfied with reiterating that in between break points ϕ_B and ϕ^B centripetal *market* forces dominate centrifugal *market* forces. Whether or not an NEG-model includes the second break point ϕ^B depends on assumptions about urban costs and labour mobility. In chapter 4 we discuss two classes of NEG-models in more detail.

Figure 2.1   Integration and agglomeration[a]
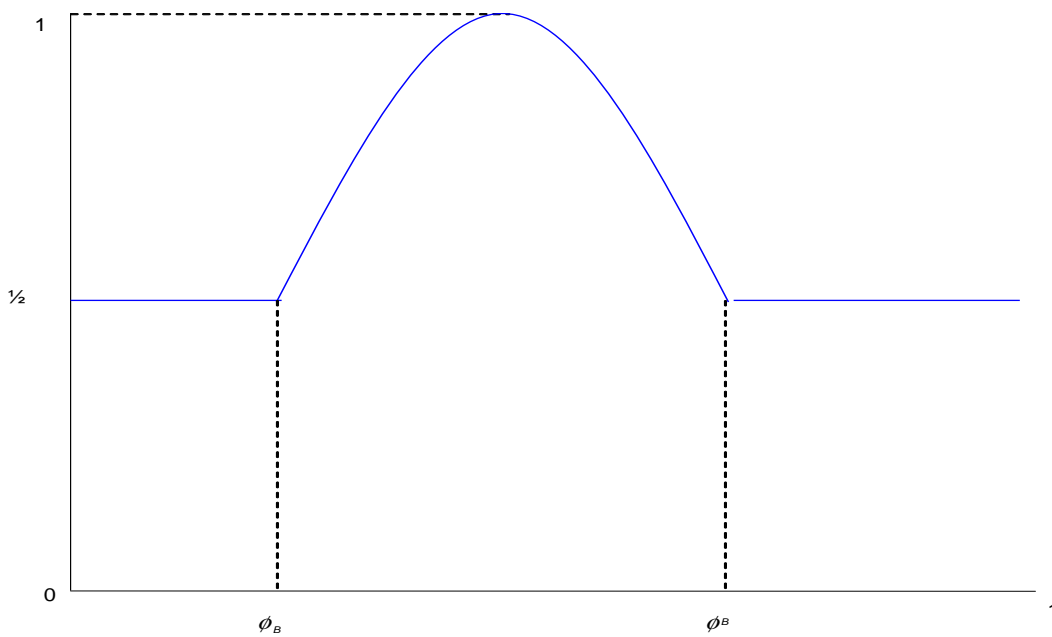
[a] The x-axis displays the freeness of trade, ranging from autarky (infinite trade costs) to free trade (zero trade costs). The y-axis displays the proportion of mobile economic activity located in one of the two regions. ϕ_B and ϕ^B are the break points at which the equilibrium regime shifts from dispersion to agglomeration and vice versa.

How does the circular causality of location choice work? Migrant workers spend their income locally. Their demand in the newly emerging core region benefits indigenous firms. This increases the incentive for extraneous firms to follow the migrants. Their demand for labour pushes up the wage rate. This attracts even more migrants, etc. More precise, the centripetal and centrifugal forces that work on firms are:

1. An increase of the number of local firms reduces the demand for a firm's good through an increase of cheap substitutes.
2. An increase of the number of local competitors reduces a firm's production costs through access to more locally produced intermediate inputs.

3. An increase of the number of local firms raises demand for a firm's variety insofar it is used as an intermediate input.

4. An increase of the number of local firms increases production costs though a higher local wage rate.

And the forces on workers are:

1. An increase of the number of firms reduces prices of consumption goods.

2. An increase of the number of firms raises demand for labour.

3. An increase of the number of workers raises competition for vacancies.

Recall that first nature advantages often give one region an initial advantage over another, and thus serve as nuclei of condensation. Moreover, direct agglomeration advantages such as knowledge spillovers between co-located firms, enforce the circular causality.

Without a backstop, the circular causality would drive the economic geography towards extreme agglomeration. The drift to the core of workers and firms stalls, however, because urban costs such as pollution, congestion, high housing prices, as well as high nominal wages due to labour immobility, choke off the centripetal forces.

Table 2.1 lists the centripetal and centrifugal forces for both firms and workers. The list is not comprehensive nor precise, since the details of the forces depend on the exact model one has in mind. The table is best interpreted as a common denominator of the forces that one encounters in a wide range of models.

Note that most forces depend on market interactions. Migration of workers and relocation of firms affect prices and through them the balance between benefits and costs of location in the core. Thus, agglomeration advantages may be substantial *even* in the absence of first nature causes or direct agglomeration advantages such as knowledge spillovers. Note also that centripetal as well as centrifugal forces increase in trade costs. The reason is that they hinge on price differences between locally produced and imported goods, and that these price differences in their turn increase in trade costs.

Whether or not the circular causality of location choice underpins the stability of an agglomeration equilibrium depends on the interplay between these forces. What matters is their *balance*. As long as it tips in favour of centrifugal forces, dispersion is the rule. But when falling trade costs push the freeness of trade beyond threshold ϕ_B, the centripetal forces dominate, and the circular causality comes into play. Beyond threshold ϕ^B the system returns to dispersion in the face of trade cost independent centrifugal forces. These are related to intermediate inputs (Venables, 1996), fixed factors (Helpman, 1998), or the labour market (Tabuchi and Thisse, 2002; Crozet, 2004).

Table 2.1   Centripetal and centrifugal forces

	Centripetal	Centrifugal
Firms		
Proximity to firms	High demand from firms	Strong competition from cheap substitutes
	Access to cheap intermediate inputs	Strong competition for labour
Proximity to workers	High demand from consumers	
	Weak competition for labour	
Workers		
Proximity to firms	High demand for labour	
	Access to cheap consumption goods	
Proximity to workers		Strong competition for vacancies
Miscellaneous	Direct agglomeration advantages[a]	Urban costs[b]
	Endowments[c]	Tax gap[d]

[a] Knowledge spillovers

[b] Pollution, congestion, high prices of houses and other non tradables

[c] Availability of a natural harbour, primary inputs

[d] (Positive) difference between tax burden in the core and the periphery

The thresholds ϕ_B and ϕ^B should be the focal point of the analysis. The reason is that attempts to lure economic activity to the periphery is marginally successful under a dispersion regime, and is likely to fail under an agglomeration regime. It is only in the neighbourhood of the thresholds that regional policy has a large potential.

This is illustrated by Figure 2.2. It represents the gap between real wages in two regions under the assumption of extreme agglomeration. In NEG-terms, it represents the sustainability of a core-periphery equilibrium. The crux is that one can only expect large effects of regional policy if the freeness of trade is in the neighbourhood of break point ϕ_B or ϕ^B. These borderline cases are, however, the exception. In general, once core-periphery systems have evolved it is hard to upset them. This is what Baldwin et al. (2003) call the *hysteresis* property of economic geography.

2.4   Agglomeration and Growth

The equilibrium distribution of economic activity over two regions has been central to the previous discussion. Agglomeration may, however, not only impact on the distribution, but also on the growth of economic activity.

Marshall (1920) states that local innovation depends on local stocks of knowledge. Baldwin et al. (2001) and Baldwin and Martin (2003) join his position by explaining this home-bias by

Figure 2.2   Real wages are higher in the core[a]
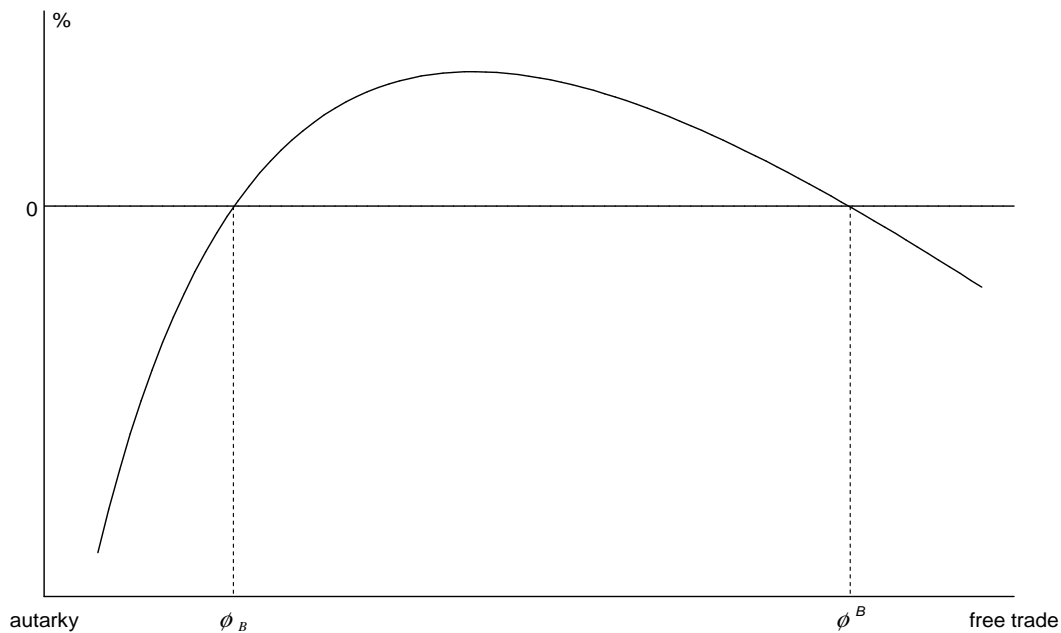
pointing to the importance of face-to-face contacts for knowledge transmission. Thus, agglomeration and growth are positively related if knowledge and production are co-located. In other words, "growth, through innovation, spurs spatial agglomeration of economic activities which in turn leads to a lower cost of innovation and higher growth so that a circular causation between growth and the geographic concentration of economic activities sets in" (Martin and Ottaviano, 2001, p. 948). Regional divergence results.

This is in line with the spatial variants of endogenous growth models developed by Romer (1990) and Grossman and Helpman (1991). Baldwin et al. (2001) derives a picture that is similar to Figure 2.1, where economic growth emerges as an additional centripetal force.

2.5   Agglomeration and Equity

Migrant firms and workers gain, otherwise they would not migrate. But what about the welfare of firms and workers that stay behind? And what about social welfare? Figure 2.3 illustrates the impact of positive and negative spillovers on the welfare of mobile and immobile workers in the core and the periphery. It displays the time paths of the real wages of each of the four groups against a background constituted by the Krugman (1991) model and an assumption of a steady

drift of workers from the periphery to the core.[7] The nonlinear nature of the graphs is due to the assumption that the annual migration depends on:

1. the gap between real wages in the core and the periphery,
2. the number of mobile workers in the periphery.

The gap is small initially, implying a small rate of migration, and a small change in real wages. In the long-run, migration is curbed by the small number of mobile workers left in the periphery.

Figure 2.3 Evolution of real wages during agglomeration in the core and periphery[a]
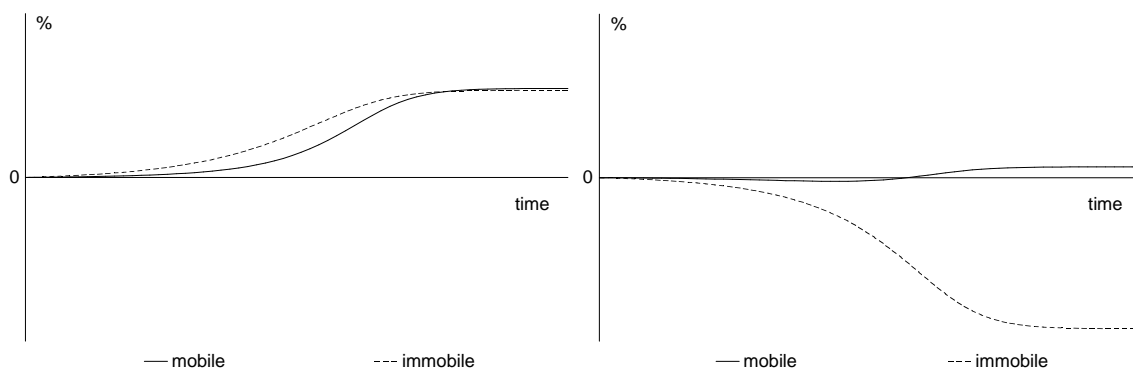
[a] The graphs show the impact of agglomeration on the real wages of two types of employees (mobile or immobile) in two regions, the core in the left graph and the periphery in the right graph.

Agglomeration reduces prices in the core, and increases prices in the periphery. Workers in the agglomeration gain, and workers in the periphery lose. Thus, agglomeration increases interregional inequity.

Mobile workers are able to respond to the variation in real wages. Their drift to the core increases their scarcity in the periphery and decreases it in the core. This tempers the welfare gain for mobile workers in the core, but boosts the welfare of those that for the time being stay behind in the periphery. Immobile workers are unable to respond to variation in real wages. If they live in the periphery their real wages decrease through a worse access to cheap locally produced varieties. Thus, agglomeration increases intra regional inequity in the periphery, but reduces it in the core.

In short, it is unclear whether agglomeration increases or reduces overall equity, let alone overall social welfare. In Ottaviano et al. (2002, p.432) the ambiguity "finds its origin in the

[7] The simulation is based upon the equations for wages, prices and expenditures as given in equations (B2.2) and (B2.13-15) in Baldwin et al. (2003, ch. 2). We assume: the elasticity of substitution $\varepsilon = 5$; the share of the mobile sector $\delta = 0.2$; no intermediates $\mu = 0$. See appendix B.1 for more details of the Krugman-model. Crozet (2004) and Baldwin et al. (2003, p.49) adopt similar assumptions.

10

simultaneous working of many potential sources of distortions". In Helpman (1998) the winners are capable of compensating the losers, but in Baldwin et al. (2003) they are not. More robust conclusions are, however, possible if one drops the assumption that agglomeration is neutral to growth. Fujita and Thisse (2002) show that agglomeration benefits everybody if technologically progressive firms cluster.

2.6   Empirical Validity

NEG models do not easily divulge testable predictions. The data requirements are substantial and it is difficult to discriminate between NEG and competing explanations based on first nature advantages or direct agglomeration externalities. This, in conjunction with the newness of the theory, lies at the root of the still somewhat meager empirical validation. Nevertheless, Head and Mayer (2003a) list five testable predictions that have served as the basis of a small but growing literature. They are:

1. *Factor prices tend to be high in regions with good access to the market.* Niebuhr (2004) shows that market access explains about half of the spatial variation of wages in Europe.
2. *Mobile production factors flow towards regions with a high market access.* Crozet (2004) verifies this prediction for Europe.
3. *Mobile sectors tend to be disproportionately clustered in regions with an idiosyncratically strong demand for their goods.* Davis and Weinstein (1999, 2003) demonstrate that the elasticity of output with respect to home demand exceeds unity for OECD industries; Trionfetti (2001) and Brülhart and Trionfetti (2002) estimate that between a quarter and a half of total European manufacturing output is subject to these home market effects.
4. *Reductions in trade costs induce agglomeration.* This prediction holds for the Krugman (1991) model but has to be dropped for the more recent models that yield the bell curve as the locus of equilibria.
5. *The location of economic activity is insensitive to shocks.* Davis and Weinstein (2002) and Brakman et al. (2004a) demonstrate that the bombing of Japanese and German cities had little or no long run impact on the distribution of economic activity.

Let us add several other observations in support of the NEG. First, the bell-curve typically emerges from time series data of agglomerations such as Madrid and Dublin and their surrounding peripheries, as displayed in Figure 2.4, where we assume that the freeness of trade increases over time. Second, Cornet and Rensman (2001) find evidence for co-location of R&D activities. Third, Bottazzi and Peri (2003) establish the locality of the corresponding spillovers. Fourth, Black and Henderson (1999) verify the implied positive relation between agglomeration

Figure 2.4   Population in Madrid[a] and Dublin[b]

and growth as well as the negative relation between agglomeration and equity. Finally, Yamamoto (2003) finds a link between agglomeration and the use of intermediate inputs.

2.7   Conclusion

The economic geography is shaped by endowments *and* location choice. Through market interactions location choice depends on itself. This circular causality gives core-periphery structures a putty-clay character. The freeness of trade of trade is pivotal: at intermediate levels agglomeration tends to be stable. The scope of regional policy in shaping the economic geography is therefore limited. The empirical support for the NEG is growing. In the next chapters we add our own pieces of evidence.

3 Descriptive Statistics

3.1 Introduction

The new economic geography (NEG) has done much to increase academic interest in the location of economic activity. Progress has been largely confined to theoretical contributions. The body of empirical work is, however, growing rapidly. This chapter establishes several stylised facts, and is the upbeat for the econometric analysis of the next chapter.

Spatial clustering of economic activity is ubiquitous. In a recent paper for the Dutch Royal Economic Society, Van Hinloopen and Van Marrewijk (2003) report an uneven distribution worldwide, irrespective of the kind of activity or the level of economic and regional aggregation. Satellite pictures of light pollution is illustrative for the clustering of activity. Figure 3.1 reveals a banana-shaped curve of intense light that cuts through an otherwise darker continent, from the English Midlands down to Northern Italy. One may also discern Madrid, Paris, and a large number of other autonomous agglomerations.

Figure 3.1   Light pollution of Europe[a]


[a] Source: http://www.inquinamentoluminoso.it/
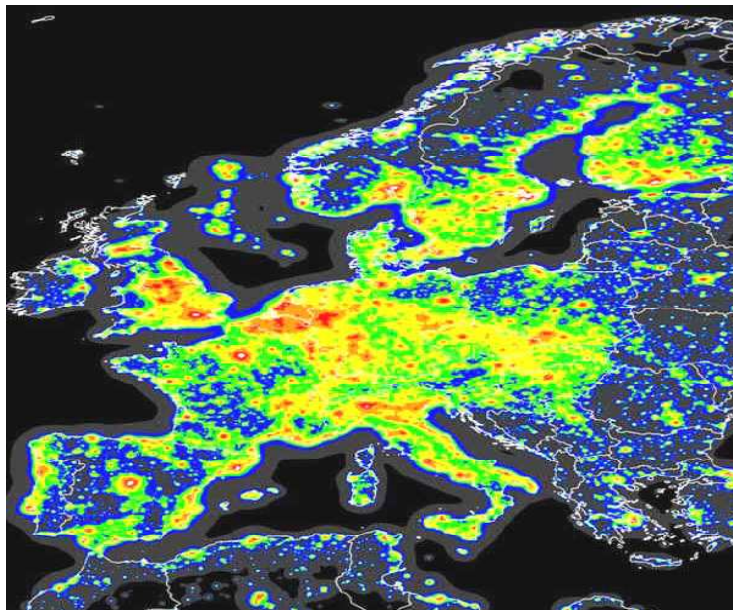
Zooming in on Italy unveils a similar picture: there is a clear core periphery pattern, with a remarkable density of firms and people producing the bulk of value added on relatively few square kilometres. The statistics of this chapter indicate that the core-periphery patterns at the

sub provincial level are, even more than the 'banana', characteristic of the European economic geography. They are, moreover, stable.

Figure 3.2   Light pollution of Italy[a]

[a] Source: http://www.inquinamentoluminoso.it/
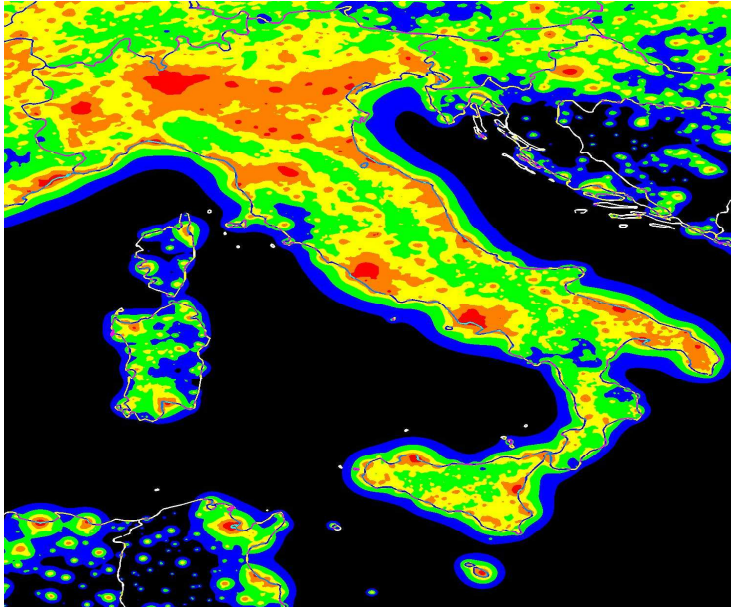
3.2   Concentration and Specialisation

In essence, we set out to describe the economic reality corresponding to Figures and 3.1 and 3.2. This is "a far less trivial exercise than might seem at first sight", as Head and Mayer (2003a, p.31) aptly put it. The spatial clustering of economic activity is a multidimensional phenomenon that can be measured in different ways.

The canonical way is to break total economic activity down to industries and regions. Subsequently, the observed distribution of economic activity of a particular industry over the regions is compared with a benchmark distribution in which clustering is absent. If it is biased towards a subset regions, the industry is by definition 'concentrated'. Similarly, if the economic activity of a particular region is biased towards a subset of industries, the region is by definition 'specialised'.

This raises a number of questions:

1. What is the appropriate measure of economic activity?

2. What is the appropriate economic and geographical breakdown?

3. What is the appropriate 'no-clustering' benchmark?

4. What is the appropriate statistic?

Since the NEG gives little guidance it is unsurprising that the literature comprises a wide array of different answers. If one is to distill stylised facts, a careful review is imperative.

Most researchers choose value added as the measure of economic activity. It has the advantage of incorporating the contribution of both capital and labour, as well as variation in productivity. Unfortunately, there is no information on price levels between regions within Member States which distorts the value added data. For this reason some prefer employment when working with disaggregate regional data.

Geographical economists repeatedly run into the problem of choosing the relevant industrial and geographical scale (Audretsch and Feldman, 1996). Ideally, real world industries and regions correspond to their theoretical counterparts. In practice, there is a tradeoff between industrial and regional detail. Some researchers choose a fine grid of 36 manufacturing industries which are available at the NUTS0 level.[8] Others choose the coarser grid of seventeen industries which are available at the NUTS2 level. The geographical scope of the NEG is, as we will argue, by and large restricted to sets of NUTS2 and NUTS3 regions. This suggests that there is something to gain from sacrificing even more industrial detail for the sake of regional detail. We will substantiate this in section 3.3.

The simplest no-clustering benchmark is the uniform distribution. The corresponding types of concentration and specialisation are dubbed 'absolute' since they do not incorporate variation of industry respectively variation of region size. Absolute specialisation is about whether a few regions tend to account for a large share of economic activity of an industry. Absolute concentration is about whether a few industries tend to account for a large share of economic activity of a region.

A more complex no-clustering benchmark is the distribution of total economic activity. The corresponding types of concentration and specialisation are dubbed 'relative'. Relative concentration is about whether regions tend to account for a large share of economic activity of an industry *relative* to their average share in all other industries. Relative specialisation is about whether industries tend to account for a large share in the economic activity of a region *relative* to their average share in all other regions.

The difference between absolute and relative clustering can best be explained by means of an

---

[8] NUTS stands for Nomenclature of Statistical Territorial Units, running from NUTS0 (Member States) to NUTS3 (sub provincial regions). For example, NUTS0 corresponds to Germany, NUTS1 to Länder, NUTS2 to Regierungsbezirke, and NUTS3 to Kreise (European Commission, 2003).

example. The employment shares of agriculture, manufacturing and services or any other comprehensive set of industries defines the industrial structure of a region. For Paris these shares amounted in 1998 to 0.05%, 10.24%, respectively 89.70%, and for Chelmsko-Zamojski (Poland) to 53.31%, 14.74%, respectively 31.96%.

The importance of services makes Paris the most specialised region in *absolute* terms. Nevertheless, as services are important in all European regions it does *not* make Paris the most specialised region in *relative* terms.[9] In contrast, Chelmsko-Zamojski qualifies as the most specialised region in *relative* terms. Nevertheless, as the uniform distribution prescribes a employment share of agriculture of 33.33%, Chelmsko-Zamojski ranks low in *absolute* terms.

Figure 3.3 visualises the point. Compare the economic structure of Paris, displayed in the left panel, to the relative benchmark, displayed in the right panel, and it is clear that they are different. Then compare the economic structure of Paris to the absolute benchmark and it is clear that they are even more different. The same exercise can be repeated for Chelmsko-Zamojski, and this leads to the reverse conclusion.

Figure 3.3   The two most specialised regions[a]
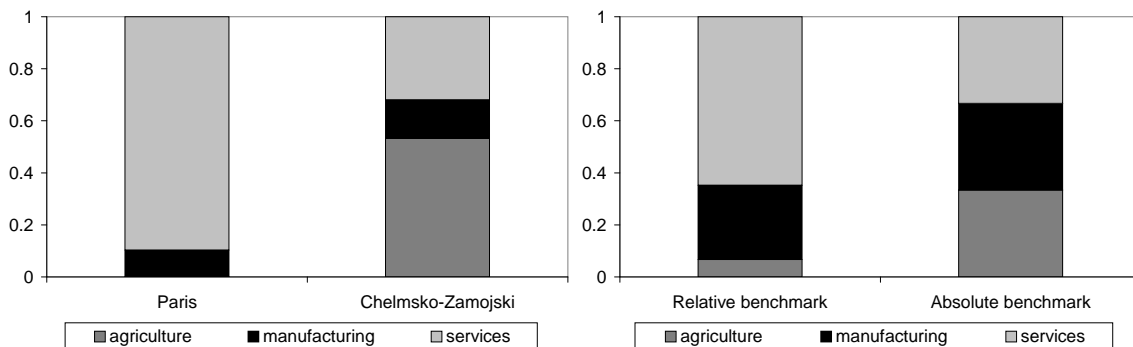
[a] Variable: employment (in thousands of employees).
Source: EUROSTAT REGIO-database; CPB Regional Economics and Spatial Analysis Unit; Nationale Instituut voor Statistiek van België. Aggregation: NUTS3 and NUTS2 (Berlin, Greek NUTS2 regions, Ceuta and Melilla, Austrian, and Portuguese NUTS2 regions, and Latvia).

Concentration is assessed in a similar manner. The sole difference with specialisation is that instead of a comparison of industrial structures of regions, it involves a comparison of regional structures of industries.

There are two additions to concentration indices. First, Ellison and Glaeser (1997) take the number of firms per industry into account. The reason is that if individual firms make their location choice at random, the resulting distribution of industrial economic activity over the

---

[9] For a formal exposition of how specialisation indices map the distribution of industry value added to a scalar see appendix A.

regions (or over units of total economic activity of regions) will not be uniform for industries comprising only a few firms. Second, Brülhart and Traeger (2003) coined topographic concentration, where region size is not controlled for by total economic activity but by land mass.

Combes and Overman (2003) note that there has been no systematic attempt to outline the criteria by which we should assess the statistic measuring the variation in the spatial distribution of economic activity. Hence they propose a baseline. The statistic should

1. be comparable across economic activities
2. be comparable across spatial scales
3. take a unique known value under the no-clustering benchmark
4. be amenable to the calculation of confidence intervals
5. be insensitive to change in industrial or regional classification
6. respond to the clustering brought about by the agglomeration forces stressed by the theoretical literature.

For practical purposes, these criteria are too stringent. There is no single statistic that satisfies all criteria. The 'best game in town' appears, however, to be the Theil index, primarily because it can be decomposed into within and between group variation.[10] A viable alternative is Moran's I. It lacks the decomposability of the Theil index, but takes the spatial configuration of regions explicitly into account by means of a distance matrix.[11]

In our review of the existing literature, we confine ourselves to recent studies that consider European data for (sets of regions of) more than one Member State. Table 3.1 lists the main results of these studies. They consistently report substantial levels of concentration and specialisation. Furthermore, they reveal that changes – indicated by a plus and a minus – tend to be slow. It is conceivable that only a few of the changes are statistically significant as the papers do not report confidence intervals. The exception is Brülhart and Traeger (2003).

It seems that there is no consensus on the stylised facts. Three out of four columns of table 3.1 contain both plus and minus signs. The characteristics of the studies explain, however, part of the variation of the results. In particular, country studies tend to find increasing concentration and specialisation, whereas regional studies tend to find the opposite. Furthermore, concentration and specialisation diverge, even though they conceptually are each other's mirror image.

The contrary motion of specialisation and concentration is easily resolved. Aiginger and Davies (2001) demonstrate that specialisation and concentration do not necessarily move in the

---

[10] For a state of the art example of the application of the Theil index in spatial analysis see Brülhart and Traeger (2003).

[11] For a theoretical discussion of Moran's I, see Cliff and Ord (1981) and Tiefelsdorf and Boots (1995).

Table 3.1   Concentration and specialisation

	Concentration		Specialisation		Data			Period
	Abs[a]	Rel[b]	Abs[a]	Rel[b]	Industries[c]	Regions[d]		
Aiginger and Davies (2001)	–		+		99 M	14	N0	1985-1998
Aiginger et al. (1999)	–		+		95 M	14	N0	1988-1998
Aiginger and Leitner (2002)	–	–			10 M	70	N1	1987-1995
Aiginger and Rossi-Hansberg (2003)	–		+		23 M	14	N0	1987-1996
Amiti (1998)		+		+	27 M	10	N0	1968-1990
Amiti (1999)				+	65 M	5	N0	1976-1989
Barrios and Strobl (2002)		+			36 M	15	N0	1972-1995
Brülhart (1998)				+	18 M	11	N0	1980-1990
Brülhart (2001)		+			32 M	13	N0	1972-1996
Brülhart and Torstensson (1998)		+			18 M	11	N0	1980-1990
Brülhart and Traeger (2003)		0			8 T	236	N2/3	1970-2000
De Nardis et al. (1996)	0				9 M	56	N1	1980-1989
Gorter (2001)		–		–	17 T	119	N1/2	1980-1995
Greenaway and Hine (1991)				+	28 M	15	N0	1980-1985
Haaland et al. (1999)	+	+			35 M	13	N0	1985-1992
Hallet (2000)		–		–	17 T	119	N1/2	1980-1995
Helg et al. (1995)	+				8 T	11	N0	1975-1995
Midelfart-Knarvik and Overman (2002)				+	9 M	119	N1/2	1980-1995
Midelfart-Knarvik et al. (2000)		+		–	36 M	13	N0	1970-1997
Midelfart-Knarvik et al. (2002)		+		–	36 M	14	N0	1970-1999
Molle (1997)		–		–	17 T	96	N0-2	1950-1990

[a] Abs = Absolute

[b] Rel = Relative

[c] Industries: number and type of industries (M = manufacturing, T = agriculture, manufacturing, and services)

[d] Regions: number and type of regions (Ni: NUTSi, i=0,1,2,3)

same direction in the presence of variation of industry and region size.

The empirical paradox regarding the orthogonal results of country and region studies is a harder nut to crack. Country studies tend to use a relatively fine grid of industries excluding services. In contrast, region studies tend to use a coarser grid including services. Given the increasing share of services in European value added, and given the dispersion of services relative to manufacturing industries, it is therefore possible to see diverging trends in the two types of studies. Moreover, Gorter (2001) points out that economic integration may have allowed the forces behind concentration and specialisation to operate at the country level where they previously had been confined to regions within countries.

Our own calculations point at stability. The solid lines in Figure 3.4 display the evolution of concentration in Europe. Absolute concentration is more or less constant, and relative concentration has decreased. This indicates that, on average, the number of regions in which an industry produces its value added did not change much over the sample period, and that the

variation in this number has decreased. The dotted lines in Figure 3.4 display concentration where industry shares are fixed at their 1980 levels. Thus, the difference between both lines corresponds to the impact of changes in the size distribution of industries – i.e. the increasing importance of services – on the concentration index. Clearly, the decline in relative concentration evaporates when one statistically removes this impact.

Figure 3.4 Absolute and relative concentration are stable[a]
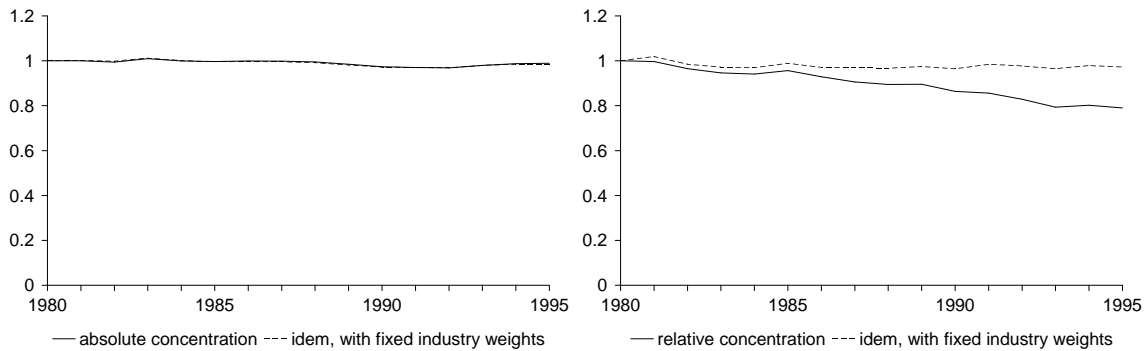
[a] Concentration of industries with the absolute benchmark of all N regions containing a similar share $(= 1/N)$ of all industries and the relative benchmark of all regions containing industry-shares equal to their aggregate production shares.
Source: own calculations based on Gross Value Added data from Hallet (2000), including 17 industries (agriculture, 10 manufacturing sectors and 6 service sectors) in 119 NUTS1 and NUTS2 regions.
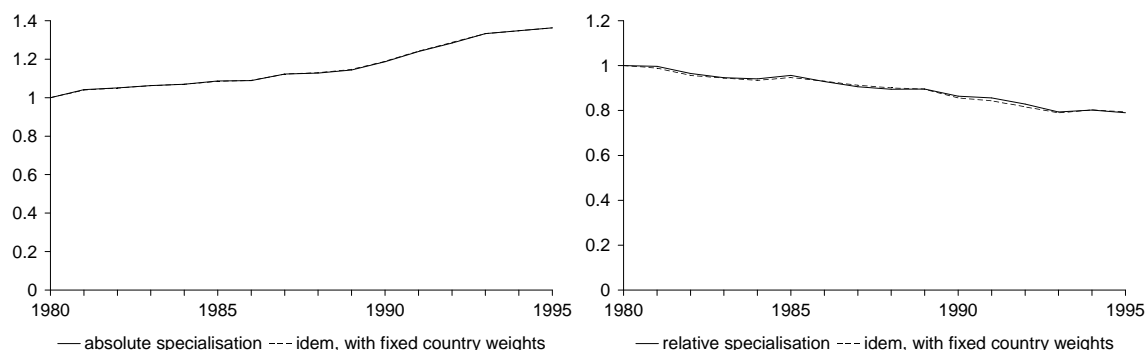
Figure 3.5 displays the evolution of relative and absolute specialisation in Europe. The solid and dotted lines correspond to variable respectively fixed region weights. Since they move in unison, we do not have to worry about impact of changes in the size distribution of regions on the specialisation index. Absolute specialisation has increased. This is again due to an increase of the importance of services, which drives regions away from the absolute specialisation benchmark. Relative specialisation has decreased. This is due to convergence of regions with an old fashioned structure, such as Chelmsko-Zamojski, where the importance of services has increased more rapidly than in regions with a more mature economic structure, such as Paris.

In short, there is significant concentration and specialisation. Absolute and relative concentration are constant; the changes of absolute and relative specialisation boil down to an increasing importance of services, most notably in regions with an old fashioned economic structure where agriculture and manufacturing are still important.

3.3 Agglomeration

Concentration and specialisation give information about the regional structure of industries and the industrial structure of regions. They are, however, silent about the agglomeration of

Figure 3.5   The increasing importance of services drives the change of absolute and relative specialisation[a]

——— absolute specialisation   - - - idem, with fixed country weights   ——— relative specialisation   - - - idem, with fixed country weights

[a] Specialisation of regions with the absolute benchmark of all industries equally large *and* evenly spread over all regions and the relative benchmark of all industries as large as the European average, but evenly spread over all regions. The dotted lines represent the special case where the relative size of the regions has been held fixed at the 1980-levels.

Source: see Figure 3.4.

economic activity per se, i.e. the sum of the value added of all industries. The evidence for this phenomenon is relatively scarce: none of the studies listed in Table 3.1 pays due attention to agglomeration.

This is remarkable, given that the NEG stresses agglomeration, while the more traditional trade literature is more concerned with concentration and specialisation (Brakman and Garretsen, 2003). In this section we attempt to fill this gap in the empirical literature. Our calculations reveal that agglomeration is significant, that it is, just as concentration and specialisation, stable over time, and that it prevails predominantly at the NUTS3 level of regional disaggregation.

Figure 3.6 displays the Theil agglomeration index. It is a measure of the variation in the distribution of economic activity over the set of regions.[12] Clearly, agglomeration is significant and stable. Equally important is, however, that agglomeration is most saliently manifest at the NUTS3 level of disaggregation. This can be inferred from the decomposition of the Theil index into four parts, indicated by the four coloured surfaces in Figure 3.6. They correspond to a core-periphery pattern between NUTS3 regions within NUTS2 region, between NUTS2 regions within NUTS1 regions, between NUTS1 regions within NUTS0 regions, and between NUTS0 regions.

The core-periphery pattern of NUTS3 regions within NUTS2 regions accounts for almost half of the total value of the Theil index, while there is virtually no variation between NUTS2 regions within NUTS1 regions. This, in conjunction with the locality of agglomeration spillovers, lies at the root of our claim that the NEG is relevant at a disaggregated geographical scale.

[12] For details, see appendix A.

20

Figure 3.6   Agglomeration is stable[a]
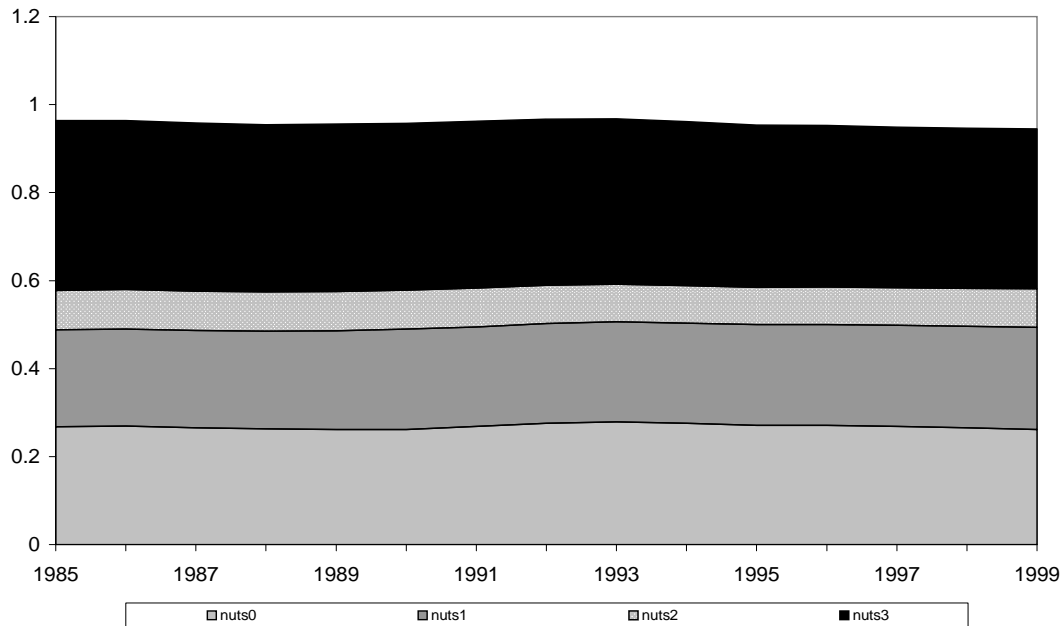
The Theil index does not take the spatial ordering of regions into account. It is, for example, blind to the contiguity of the regions that constitute the 'banana'. Imagine that these regions are scattered over Europe. The Theil index would have yielded the same value, even though there is less clustering. For this reason we alternatively measure agglomeration with Moran's I, defined here as spatial auto correlation of regional employment per square kilometre.[13] It yields a positive value if regions with an above average density of economic activity tend to be spatially clustered, and a negative value if the economic geography displays a chessboard pattern.

Figure 3.7 displays Moran's I. The vertical axis corresponds to the value of the statistic itself, and the horizontal axis to different assumptions regarding spatial contiguity. In particular, the bars give the value of Moran's I for NUTS3 regions within half an hour travel time, between half an hour and one hour travel time, between one hour and one and a half hours travel time, etc., while the grey area gives the 95% confidence interval.

A glance at Figure 3.7 reveals that spatial auto correlation between nearby regions is statistically significant, but that it disappears once one considers regions that lie somewhat further apart. Curious is the reappearance of a significant positive spatial auto correlation for

[13] For details, see appendix A.

Figure 3.7   Agglomeration is local[a]
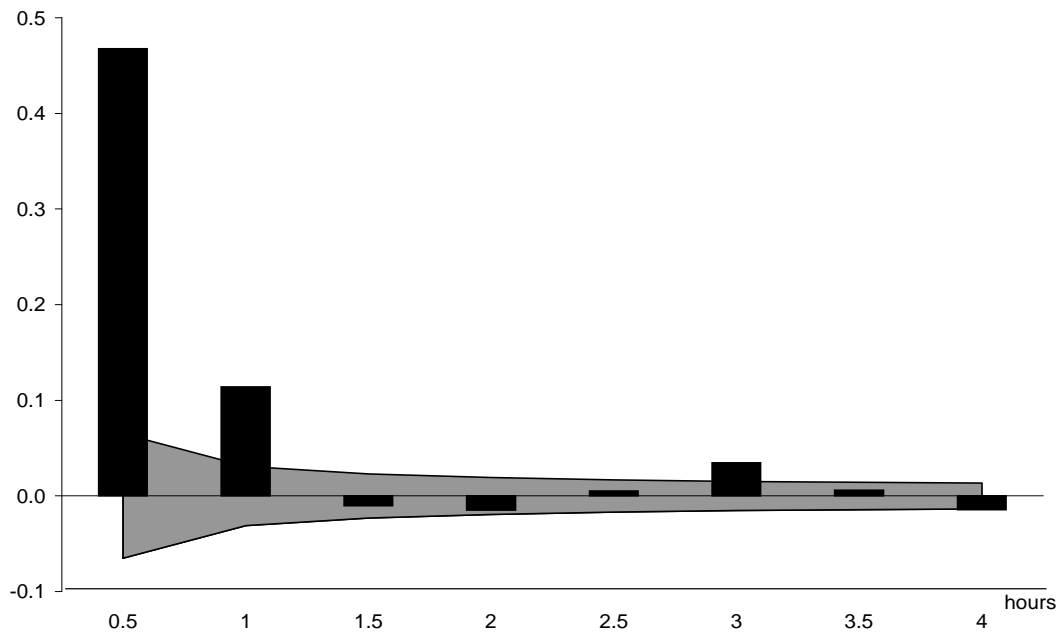
[a] The x-axis depicts the distance between regions within half an hour travel time, between half an hour and one hour travel time, etc. The bars depict Moran's I, and the grey area the 95% confidence interval.

Source: own calculations for Gross Value Added in 2177 NUTS3 regions in 2000 with data from Cambridge Econometrics.

regions that lie between two and a half and three hours travel time. It echoes the fractal nature of clustering observed by Van Hinloopen and Van Marrewijk (2003). The prime conclusion remains, however, that positive spatial auto correlation can most clearly be found for genuinely contiguous regions. It lends support to the importance of the NEG when considering the economic geography at a disaggregated scale.

3.4   Conclusion

The measurement of economic geography is fraught with difficulties. Yet we can draw a number of rough conclusions on the basis of descriptive statistics. First, concentration of industries is constant. Over the past decades industries have remained where they are, both in absolute and in relative terms. Second, specialisation of regions has changed. This is paradoxal since concentration of industries and specialisation of regions are theoretically each other's mirror image. Close examination of the data reveals that the change in specialisation is almost entirely due to the increasing importance of services. Third, agglomeration is stable. The balance between core regions and their periphery has not tipped in favour of either category. Finally, agglomeration is local. It is most pronounced at a sub provincial scale.

4 Dispersion and Agglomeration

4.1 Introduction

The descriptive statistics of chapter 3 establish that stable and local agglomeration is the essence of the European economic geography. As Combes and Overman (2003) point out, the statistics only describe, but do not explain or predict the spatial distribution of economic activity. The present chapter fits more tightly with theory. We give empirical support to the NEG by verifying a spatial wage structure, and identify the prevailing equilibrium regime of a typical pair of contiguous European regions. It turns out that agglomeration tends to be the rule at a (sub) provincial level of regional aggregation. In this light the poor record of regional policy in reducing regional disparities should not come as a surprise.

4.2 The Tomahawk and the Bell

The traditional Heckscher-Ohlin theory of international trade is based on perfect competition and constant returns to scale. As we point out in chapter 2, this theory explains specialisation and concentration, but has little to say about agglomeration. The NEG stresses the importance of economies of scale and trade costs. In their presence the location decisions of economic agents become important.

Krugman (1991) adds increasing returns to scale, location choice, and trade costs to the trade theory. He thus builds the proto NEG model that puts geography at the heart of the analysis. The predictions are strong: a system of regions leaps from dispersion into agglomeration once the freeness of trade surpasses a break point. The proto NEG model is therefore best interpreted as a theoretical framework to be extended by auxiliary assumptions for practical purposes.

Puga (1999) does exactly this. He develops a model that is more in line with the European reality. It yields a smoother transition from dispersion to agglomeration, and allows for dispersion at high degrees of market integration.

He puts the NEG models in two classes.[14] The first class comprises models that, against a background of gradually increasing freeness of trade, move from dispersion to agglomeration. The second class comprises models that do the same, but return to dispersion once the wage gap drives firms to the periphery. We call the first class of models the 'tomahawk', and the second class the 'bell', after the resemblance of the locus of long run equilibria to a tomahawk hatchet

---

[14] For an extensive discussion of the details of the proto NEG model, see Brakman et al. (2001, ch.3&4) and Fujita et al. (1999, ch.4&5).

respectively a church bell.[15]

The tomahawk

Figure 4.1 displays the tomahawk-shaped locus of long run equilibria. The underlying model contains two regions which initially host a similar amount of firms and workers. Workers employed by mobile firms producing varieties of a good that can be exported to the other regions at a certain cost, can move between regions. The distribution of mobile economic activity is related to the freeness of trade.

Figure 4.1   The tomahawk[a]
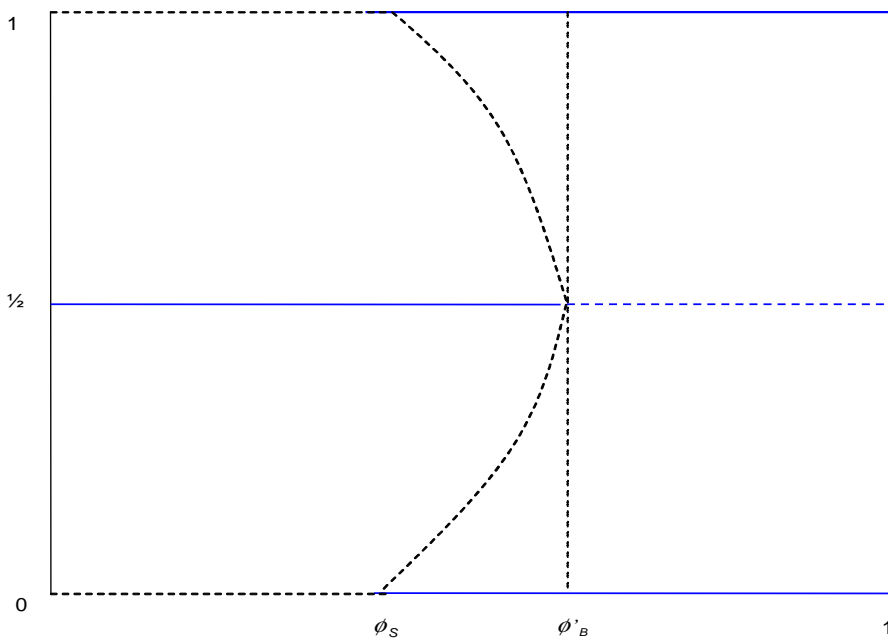
[a] The x-axis depicts the freeness of trade ϕ. The y-axis shows the share of mobile production in the core region $\lambda \in [0, 1]$.

For low values of ϕ, the regions are subject to a dispersion regime: centrifugal forces outweigh centripetal forces. From ϕ'_B onwards, agglomeration becomes profitable, and the regions are subject to the agglomeration regime: centripetal forces outweigh centrifugal forces. Here the circular causality of location choice comes into play which drives the economic geography from the uniform distribution ($\lambda = 0.5$) to extreme agglomeration ($\lambda = 1$). Note that the economic geography never returns to dispersion. The single centrifugal force of price competition is too weak to destabilise the agglomeration.

The tomahawk has an idiosyncrasy. If ϕ decreases instead of increases, then agglomeration is

---

[15] For a discussion of other determinants of the tomahawk and the bell, see the textbox on page 25.

sustained up to $\phi_S < \phi_B'$. Since the freeness of trade tends to increase in practice, we let the complications related to this inequality rest.[16]

Choosing between the tomahawk and the bell

Which model is most relevant for the economic geography of Europe? Three ingredients matter: wage flexibility, labour mobility and urban costs. Krugman (1991) assumes mobile labour and flexible wages, and abstracts from urban costs. This yields the tomahawk. Puga (1999) assumes labour immobility. This yields the bell. If wages are rigid the tomahawk reappears, however only in the absence of urban costs.

Picking the relevant NEG model[a]

	Tomahawk	Bell	Tomahawk	Bell
Wage flexibility	yes	yes	no	yes
Labour mobility	yes	no	no	yes
Urban costs[a]	no			yes
Key reference	Krugman (1991)	Puga (1999)	Puga (2002)	Helpman (1998)

[a] Other than the wage gap between core and peripheral regions due to interregional labour immobility.

In our view, the relevant model depends on the size of regions: the empirical relevance of wage flexibility increases in the level of aggregation (e.g. wages vary more between countries than within countries), while labour mobility and urban costs decrease in it (workers are reluctant to move to distant locations; urban costs such as congestion play a relatively large role in cities). In our view, the bell curve is the safest bet for analyses using European data. At the sub provincial level, labour may be mobile, but then urban costs come into play.

The Bell

If labour is immobile then agglomeration of firms pushes up wages in the core. This chokes off the circular causality of location choice, and makes the economic geography return to a uniform distribution once the freeness of trade surpasses a second break point.

Supplier access and the elasticity of labour supply now take centre stage. Access to cheap intermediate inputs induces a preference of firms for location in the core region beyond the first break point. However, as they need to persuade labour employed by immobile firms to work for them, they have to offer higher wages. This reduces the incentive for location in the core and ultimately brings the economic geography back to the dispersion regime.

Figure 4.2 displays the bell shaped locus of long run equilibria. The underlying model has two similar regions, with an initial uniform distribution of labour. Labour employed by firms

---

[16] For a discussion of the difference between the break point and the sustain point, see Neary (2001), Robert-Nicoud (2004) and Ottaviano and Robert-Nicoud (2004).

Figure 4.2 The bell[a]
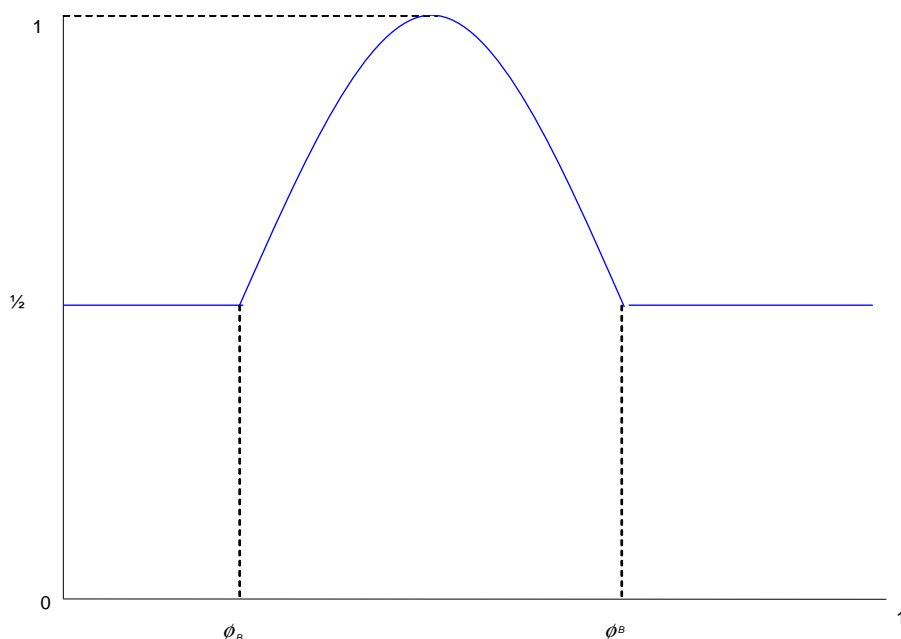
[a] The x-axis shows the freeness of trade ϕ, the y-axis shows the share λ of mobile production in the core region.

producing varieties of the manufacturing good can move between sectors, but not between regions.

For low freeness of trade ($\phi < \phi_B$) and high freeness of trade ($\phi > \phi^B$), the regions are subject to dispersion; for intermediate freeness of trade ($\phi_B < \phi < \phi^B$) the circular causality sustains an uneven distribution of economic activity. Agglomeration is, however, never as extreme as in the tomahawk due to the addition of centrifugal forces independent of trade cost.

For either model, we need to identify the actual freeness of trade as well as the break point(s) if we want to know whether or not regional policy has to swim against the tide of the market forces that foster agglomeration. This matter is the subject of the next sections.

4.3   The Wage Equation

A key prediction of both classes of NEG models is that wages are higher in agglomerations. This holds in the short run, i.e. for a given distribution of firms and workers.

The *wage equation* 'closes' the model, by equating demand to supply on all regional product markets. Each firm of the mobile sector produces one variety of a good. It is demanded in all regions, some nearby, some further away. Demand comes from final consumption and intermediate input by other firms. Equating demand to supply on each regional market gives the

equilibrium price for each firm. It is standard practice to rewrite this equilibrium condition to a wage equation that maps the market access of a region to the zero profit wage in a given region. It reflects the agglomeration advantages of core regions that materialise as higher wages, and can be written as:[17]

$$W_r = c I_r^{\frac{-\mu}{1-\mu}} \left[\sum_s Y_s I_s^{(\varepsilon-1)} \phi_{rs} \right]^{\frac{1}{\varepsilon(1-\mu)}} \quad \text{with} \quad \phi_{rs} = T_{rs}^{1-\varepsilon} \tag{4.1}$$

where:

W_r is the nominal wage rate in region r

Y_s is the market size of region s, defined as the demand for final consumption and intermediate inputs

I_s is the price index for manufactured goods

ε is the elasticity of substitution for manufactured goods (a high value of ε means that firms are close competitors)

T_{rs} are the transport costs between regions r and s, defined as the number of goods to be transported over one unit of distance for one unit to arrive

D_{rs} is distance between regions r and s

μ is the share of intermediates in the inputs for a firm's production process.

Scaling yields the freeness of trade parameter $\phi_{rs} \in [0, 1]$, where $\phi_{rs} = 0$ corresponds to infinite trade costs, and $\phi_{rs} = 1$ to zero trade costs.

W_r increases in the market size Y_s and in the freeness of trade ϕ_{rs}. We dub the term between brackets on the right hand side of equation (4.1) *market access*. Note the resemblance to the well known gravity or market potential equation. W_r also decreases in the competition a firm located in r faces. This is the *competition effect* captured by I_s. Prices are fixed mark ups over marginal costs and there is no strategic interaction between firms. A low I_s reflects the number of varieties produced by competitors in nearby regions: the higher is this number, the lower is I_s, the lower is the demand for a given variety, hence the lower is W_r at which a firm breaks even. A low price index implies, moreover, that suppliers of intermediate inputs are located in nearby regions. Hence Redding and Venables (2000) dubbed the term $I_r^{-\mu/(1-\mu)}$ *supplier access*. The lower are prices of intermediary inputs, the better is supplier access, hence the higher is W_r. If one abstracts from intermediate inputs by setting $\mu = 0$, supplier access drops out, and the wage equation comprises only market access.

The wage equation defines a system of equations in W, Y, and I. It is a short run equilibrium, i.e. equilibrium on all markets for a given spatial distribution of firms and workers. Nevertheless,

---

[17] For a formal derivation, see appendix B.1.

the wage equation suffices for the estimation of the key parameters T and ε. Armed with these estimates we can tackle the long run process of agglomeration by plugging them into a model and derive their implications in a 'theory with numbers' fashion. The short run nature is an advantage, since the differences between NEG models only come to the fore if one considers the long run. Therefore, the estimates apply to a wide range of NEG models.

4.4   A Spatial Wage Structure

Are wages in core regions relatively high, as the NEG wage equation suggests? To answer this question, we estimate a simplified version of equation (4.1). We exploit the market potential function:

$$\log W_r = \kappa_0 + \kappa_1 \log \left[\sum_{s \in EU+} Y_s e^{-\kappa_2 D_{rs}} \right] \quad \text{with} \quad r \in EU14+ \tag{4.2}$$

where:

W_r is the average remuneration per employee in region r

$EU+$ is an index set containing all NUTS2 regions (NUTS1 for Germany) of the EU14 (Luxembourg excluded), Norway, the Czech Republic, Poland, Hungary and Switzerland

Y_s is total gross value added of region s as given by the Cambridge Econometrics regional database, supplemented with the AMECO price deflator of national gross domestic product to control for differences in purchasing power.

The function, well known from the gravity approach to international trade and investment (Harrigan, 2001), says that wages are lower the further a region is away from regions with high production.

The parameters of interest are κ_1, that measures the strength of agglomeration advantages, and κ_2, that measures how quickly agglomeration advantages decay over distance. In other words, κ_1 measures how much market potential matters in terms of wages, and κ_2 how advantageous it is to be located in an agglomeration relative to its immediate surroundings. The combination of κ_1 and κ_2 defines a spatial wage structure. Table 4.1 displays the results of the OLS first-difference estimation including a constant:

$$\log W_{r,t} - \log W_{r,t-1} = \kappa_0' + \kappa_1 \left(\log \left[\sum_s Y_{s,t} e^{-\kappa_2 D_{rs}} \right] - \log \left[\sum_s Y_{s,t-1} e^{-\kappa_2 D_{rs}} \right] \right) \tag{4.3}$$

In spite of wage rigidity and national wage bargaining, the signs of the estimates confirm the spatial wage structure predicted by the NEG. This is in line Niebuhr (2004), one of the few alternative estimations using European data.

Table 4.1   A spatial wage structure on the basis the market potential function[a]

		Coefficient	Standard Error
κ_1	Strength of agglomeration advantages	0.8984	0.020
κ_2	Distance decay of agglomeration advantages	0.0133	0.001
R^2		0.61	

[a] OLS estimation of equation (4.3).
Sample: 1992–2000, with 1647 observations.

The values of κ_1 and κ_2 are difficult to interpret. In order to get a feel for them, we conduct a thought experiment: how much higher would wages in Nordrhein-Westfalen be if the size of its market would be ten percent larger, and how much higher would wages be in nearby regions such as Gelderland?

From equation (4.2) follows:

$$\frac{\mathrm{d}w_r}{w_r} = \kappa_1 \frac{e^{-\kappa_2 D_{rs}} dY_s}{\sum_s Y_s e^{-\kappa_2 D_{rs}}}. \tag{4.4}$$

The ten percent larger market in Nordrhein-Westfalen translates into $dY_s = 0.10Y_s$. This, combined with the estimates $\kappa_1 = 0.898$ and $\kappa_2 = 0.013$ gives a wage increase of 0.7% in the epicentre of the shock. The advantage of the larger production quickly decays over distance. At one hundred kilometres away only a quarter of this agglomeration advantage remains. This concords with the locality of core-periphery structures established in chapter 3. And the distance decay is found by other estimations of this kind. Figure 4.3 visualises the thought experiment. A dark green colour indicates a high wage response to the income shock. Clearly, only nearby regions benefit.

4.5   The Freeness of Trade

The freeness of trade can be inferred from the estimation of the wage equation (4.1). It depends on the transport costs T and the elasticity of substitution ε. Estimation of these parameters is somewhat problematic due to the absence of data on regional price indices I_s. We bypass I_s by imposing additional structure on the underlying NEG model. In particular, we eliminate I_r from equation (4.1) by relating it to W_r and by assuming $\mu = 0$.[18] In addition, to control for exogenous differences in technology we include regional labour productivity PL_r relative to the

---

[18] For details, see Brakman et al. (2004a) and appendix B.3. The assumption $\mu = 0$ yields a convenient specification as supplier access drops out of the wage equation. This is, as Robert-Nicoud (2004) and Ottaviano (2003) claim, the best empirical strategy given the isomorphic quality of NEG models. The qualitative results hold, however, also for alternative specifications with $\mu > 0$.

Figure 4.3   Impact on wages of an income shock in Nordrhein-Westfalen[a]

[a] Calculations are based on equation (4.4) with the parameters of Table 4.1.

mean of the $EU+$ sample.[19] Since first nature causes also matter we include a vector FN containing hours of sunshine, altitude above sea level, and access to the open sea that is available at the NUTS2 level. In addition, we include a vector Z of country dummies. We thus arrive at:

$$\log W_r = \frac{1}{\varepsilon} \log \left[\sum_s Y_s \left(T^{D_{rs}} \right)^{1-\varepsilon} I_s^{\varepsilon-1} \right] + \frac{1-\varepsilon}{\varepsilon} \log \left(\frac{PL_{EU+}}{PL_r} \right) + \beta FN + \gamma Z. \tag{4.5}$$

The Glesjer test rejects the null hypothesis of homoskedasticity. Hence the preferred estimation method is weighted least squares. Table 4.2 displays the results. The estimates of the key parameters are in line with the findings of Head and Ries (2001) and Head and Mayer (2003a).

Table 4.2   A spatial wage structure on the basis of the wage equation[a]

		Coefficient	Standard Error
ε	Elasticity of substitution	8.0524	0.8637
$\log(T)$	Transport cost	0.0004	0.00005
R^2		0.9996	

[a] WLS estimation of equation (4.5).

Sample: 1991–2000, with 1670 observations.

Parameters of first nature variables and country dummies are not reported.

[19] For details, see appendix B.2.

The signs of the parameters again verify a spatial wage structure. Wages in core regions, defined as regions with high production per squared kilometre, exceed those of peripheral ones.

Figure 4.4   The freeness of trade decreases in distance[a]
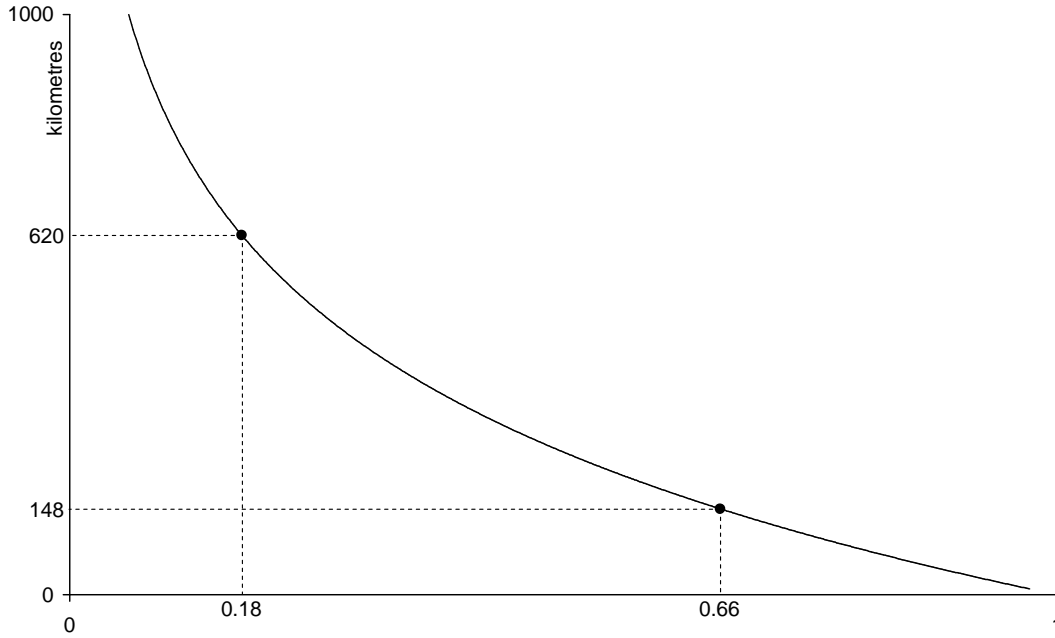
[a] The x-axis shows the freeness of trade between two regions, and the y-axis shows the distance between them in kilometres.

The estimates for the transport costs and the elasticity of substitution will prove to be crucial in assessing the spatial regime of European regions. They imply the function $\phi_{rs} = 1.0004^{-7.05 D_{rs}}$, which maps the distance D_{rs} between two regions r and s to the freeness of trade ϕ_{rs} between them, as shown in figure 4.4. Of course, the longer is the distance, the lower is the freeness of trade.[20] The average distance between a pair of NUTS2 regions is 620 km, which corresponds to $\phi = 0.18$. The average distance between a pair of *contiguous* NUTS2 regions is 148 km, which corresponds to $\phi = 0.66$. Both values are depicted on the vertical axis.[21] In the next section, we confront these values with the break points of the tomahawk and bell.

[20] Brakman et al. (2004b) show that the results are robust to alternative, non exponential functional forms.

[21] Brakman et al. (2004b) use an alternative specification. This yields a lower estimate of ε but an offsetting higher estimate of T. Consequently, the implied ϕ for pairs of (contiguous) NUTS2 regions remains virtually unchanged (0.22 and 0.70, instead of 0.18 and 0.66).

4.6   The Equilibrium Regime

Is a typical pair of contiguous NUTS2 regions subject to an agglomeration regime? In other words, do the inequalities $\phi > \phi_B'$ or $\phi_B < \phi < \phi^B$ hold? The break points play a key role in answering this question. They are, however, only instrumental, and do not serve to emphasise the instability of the economic geography. On the contrary, we will find that a typical pair of contiguous NUTS2 regions are subject to an agglomeration equilibrium, which implies stability of the economic geography.

The tomahawk can be solved for the breakpoint ϕ_B', and the bell for the breakpoints ϕ_B and ϕ^B. Unfortunately, this requires that the number of regions is restricted to two, or that all regions lie at an equal distance from each other.[22] We choose to consider a single pair of regions at a time as the assumption of equal distances flies in the face of reality. Computer simulations on the basis of a multi-region model with unequal distances remains possible. Our analysis in this section, where we use the empirical estimations of the key parameters with a *two* region theoretical model closely follows Crozet (2004) and is explained in more detail in Brakman et al. (2004b).

Let us first consider the tomahawk. Puga (1999) demonstrates that the break point is a function of four model parameters: $\phi_B' = f(\mu, \eta, \delta, \varepsilon)$, where μ is the share of intermediate inputs, η is the elasticity of intersectoral labour supply with respect to wages, δ the share of the mobile good in total expenditures, and ε is the substitution elasticity of varieties.[23] The bell, based on labour immobility, is somewhat more complicated. Puga (1999) demonstrates that, if certain conditions are met, ϕ_B and ϕ^B are the roots of the quadratic equation $a\phi^2 + b\phi + c = 0$, where a, b, c functions of μ, η, δ and ε. [24]

For both the tomahawk and the bell the range of ϕ that supports agglomeration increases in μ, η, and δ, and decreases in ε.[25] A larger share of intermediate inputs μ fosters agglomeration because it makes co-location of firms more profitable. A larger elasticity of intersectoral labour supply η fosters agglomeration because it makes it more easy to lure workers from the immobile to mobile sector. A larger share of the mobile good δ fosters agglomeration because it reduces the size of costly 'exports' to the periphery. A larger substitution elasticity ε, in contrast, restrains agglomeration because it increases the centrifugal competition effects.

Table 4.3 lists the break points for $\varepsilon = 8$, $\mu = 0.3$, $\eta = 200$, and $\delta = 0.1$. This is our

---

[22] Personal communication with Puga.

[23] Our calculations are based on equation (16) in Puga (1999), if $\mu = \eta = 0$ equation (16) gives the break point for Krugman (1991).

[24] Our calculations are based on equation (33) in Puga (1999), see also section 14.4 in Fujita et al. (1999).

[25] See appendix B.1 for a formal derivation. The intuition can most easily be grasped with Table 2.1 at hand.

Table 4.3   The Break Points

	μ	η	δ	ε	ϕ_B	ϕ^B	ϕ'_B
Benchmark configuration	0.30	200	0.10	8.00	0.29	0.91	0.09
Alternative configurations	0.20	200	0.10	8.00	0.51	0.82	0.18
	0.20	200	0.10	4.00	0.44	0.90	0.05
	0.20	250	0.10	8.00	0.48	0.87	0.14
	0.20	200	0.05	8.00	0.51	0.82	0.32

benchmark configuration, with ε taken from Table 4.2, and with μ, η, and δ probed on the basis of Puga (1999) and Head and Mayer (2003a). Table 4.3 also gives the break points for a number of other parameter configurations.
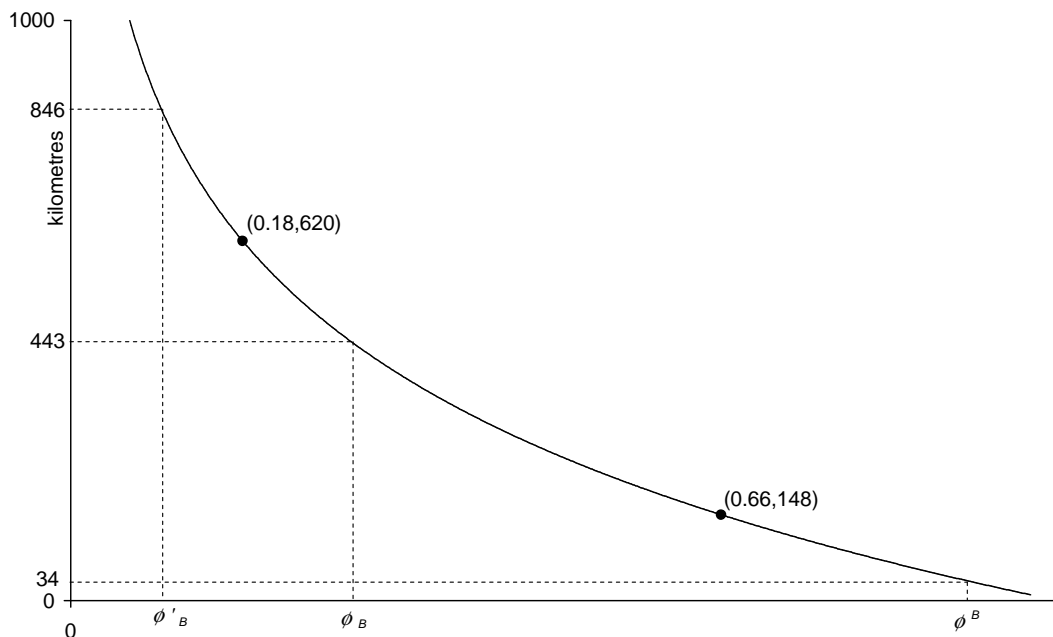
By and large, the range of ϕ supporting an agglomeration equilibrium is smaller in the bell than in the tomahawk. In addition, the dispersion equilibrium destabilises earlier in the tomahawk, as $\phi'_B < \phi_B$. This is unsurprising, as the bell comprises trade cost independent centrifugal forces that are absent in the tomahawk. Moreover, in either model the range is sensitive to the chosen configuration, however not to the extent that it endangers our main conclusion. We will come back to this point shortly. First we need to confront the estimated freeness of trade from Table 4.2 with the break points from Table 4.3.

Figure 4.5 depicts the freeness of trade function $\phi_{rs} = 1.0004^{-7.05D_{rs}}$, just as in figure 4.4. It adds the breakpoints $\phi'_B = 0.09$, $\phi_B = 0.29$ and $\phi^B = 0.91$, which corresponds to the distances 846, 443 and 34km. The dots on the curve correspond to $(620, 0.176)$ and $(148, 0.661)$, the points containing the distance and the freeness of trade between a typical pair of NUTS2 regions respectively a typical pair of contiguous NUTS2 regions.

The location of the dots reveals that, within the confines of the bell model, a typical pair of NUTS2 regions is subject to dispersion. They are in the pre-agglomeration range. If labour mobility would increase dramatically, which implies a shift towards to tomahawk model, or if the freeness of trade would increase dramatically due to economic integration, the agglomeration regime may become material. More relevant is, however, that a typical pair of contiguous NUTS2 regions is subject to agglomeration. They are right in the middle of the head of the bell where the relative strength of the centripetal forces is at its peak.

We conduct a thought experiment to clarify the result. Suppose Paris is the sole core region in Europe. Which peripheral regions are subject to an agglomeration, and which to a dispersion equilibrium? We confront the estimated freeness of trade with the break points for all pair wise combination of Paris and other (NUTS3) regions in Europe. It turns out that a small number of regions – which cover the Banlieu – lie close enough to Paris to be in the right skirt of the bell, and thus are subject to a dispersion equilibrium on account of a high freeness of trade. A large

**Figure 4.5 Contiguous regions are in a core-periphery regime[a]**

number of regions lie far enough from Paris to be in the left skirt of the bell, and thus are subject to a dispersion equilibrium on account of a low freeness of trade. These groups of regions are dark grey in figure 4.6. In between these two groups there is a number of regions that are subject to an agglomeration equilibrium on account of an intermediate freeness of trade. This group of regions is light grey in figure 4.6. They would struggle to retain economic activity since the centripetal forces pulls it towards Paris and the Banlieu.

The reality is more complex because Paris is not the sole core region. The European economic geography is a patchwork of overlapping core-periphery structures. It would be overstretching the results to conclude anything for a particular pair of regions. It would also be overstretching the results to conclude anything for the subset of regions with a freeness of trade close to the break points. The estimates are too imprecise for that purpose. And the probability of any given pair of regions being close to a break point is low.

In any event, figure 4.6 does capture the thrust of the geographical scope of the agglomeration advantages. It fits tightly with the descriptive statistics of chapter 3, which reveal that more than 50% of total agglomeration is at the NUTS2 and NUTS3 scale. Moreover, it is consistent with the findings of Crozet (2004), Forslid et al. (2002), Midelfart et al. (2003), and

Brülhart et al. (2004).

Figure 4.6 Agglomeration and dispersion around Paris[a]
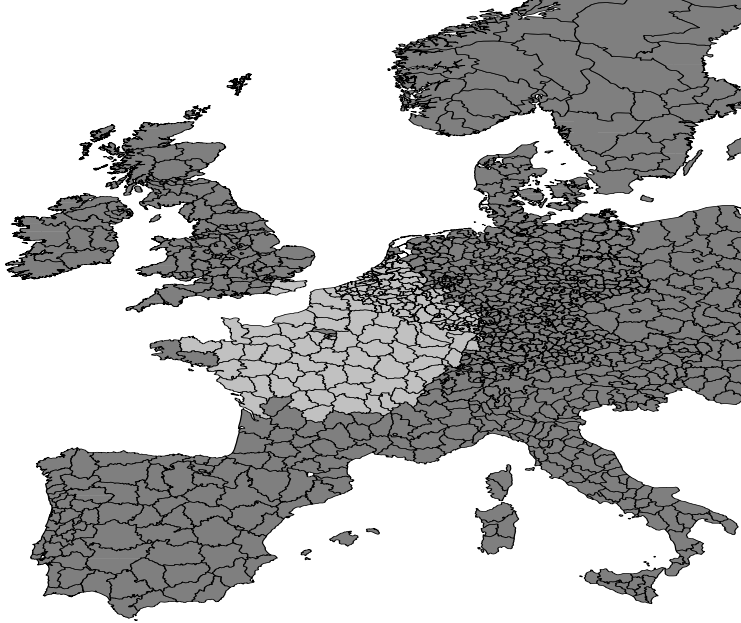
[a] The bell in shades of grey, where Paris is assumed to be the sole core.

4.7 A Sectoral Analysis

So far the analysis has been based on aggregate data, i.e. total value added per region. The freeness of trade and the break points may, however, vary between sectors. In this section we probe into this variation. The price for the sectoral disaggregation is, however, regional aggregation, since the necessary data are only available at the NUTS0 level.

Head and Mayer (2003b) explain that ϕ can be estimated on the basis of bilateral trade and production data.[26] They derive a simple estimator of ϕ for a given sector:

$$\phi = \sqrt{\frac{m_{ij}m_{ji}}{m_{ii}m_{jj}}}, \tag{4.6}$$

where:

m_{ij} are the imports of country i from country j
m_{ji} are the imports of j from i

[26] See also Head and Ries (2001) and Head and Mayer (2003a, p.7).

m_{ii} is the value of all shipments minus the value of shipments from i to all other countries

m_{jj} is the value of all shipments minus the value of shipments from j to all other countries.

If there is much bilateral trade relative to total turnover in the respective countries then the estimator takes a high value and vice versa. Note that the detour via T, used in the previous sections can be evaded.

Table 4.4   Sector specific values of ϕ for the EU15-accession countries [a]

IOcode	Sector	ϕ	ϕ'_B	ϕ_B
1	Agriculture	0.03	NA	NA
2	Energy	0.01	NA	NA
3	Food, Beverages and Tobacco	0.05	0.22	0.46
4	Clothing	0.14	0.18	0.21
5	Wood	0.05	0.36	0.39
6	Paper	0.03	0.16	0.17
8/10	Plastics and Drugs	0.13[*]	0.10	0.11[b]
9	Petro	0.02	0.71	DISP
11	Minerals	0.04	0.44	0.47
12	Ferrous metals	0.04[*]	AGGL	0.00[c]
13	Non-ferrous metals	0.03	0.06	0.09
14	Fab. Metals	0.05	0.69	DISP
15/16	Machinery and Computers	0.25	0.36	0.43
17	Electrical	0.09	0.39	0.67
19/20	Shipping/Railroad/Transport[d]	0.01	0.39	0.46
21	Vehicles	0.13[*]	0.08	0.10[e]
23	Instruments	0.02	0.45	0.57
18	Services	0.16	NA	NA

[a] Source: GTAP 1997.
 NA = Not Available, DISP = Dispersion equilibrium for all ϕ, AGGL = Agglomeration equilibrium for all ϕ.
[b] Top of the bell: $\phi = 0.55$.
[c] Top of the bell: $\phi = 0.50$.
[d] Based on Railroad.
[e] Top of the bell: $\phi = 0.49$.
[*] Freeness of trade is in agglomeration range, i.e. $\phi > \phi_B$.

Table 4.4 lists ϕ for eighteen industries, calculated on the basis of 1997 GTAP data. They are confronted with the break points ϕ'_B and ϕ_B taken from the appendix of Head and Mayer (2003a).

All sectors, except Plastics and Drugs, Ferrous Metals, and Shipping/Railroad/Transport, are in a dispersion equilibrium. This is unsurprising since ϕ is bound to be smaller at the NUTS0 level than at the NUTS2 level. The range of ϕ runs from 0.01 for Energy, to 0.25 for Machinery and Computers. The break points also vary due different sector specific values of the model parameters μ, η, δ, and ε. This variation between sectors qualifies the result from the previous sections. If there is sectoral variation at the NUTS0 level, then there is probably also variation at

the NUTS2 level. Thus, although contiguous pairs of NUTS2 regions tend to be in a agglomeration equilibrium, this conclusion may not hold for some sectors.

4.8   Conclusion

A spatial wage structure in line with the predictions of the NEG exists. Wages tend to be high in regions with a large market access. And the advantage of being in or close to an agglomeration quickly peters out over distance, as the wage premium quickly decays once one moves away from the core. Moreover, the expected freeness of trade between a pair of contiguous NUTS2 regions is such that agglomeration equilibria tend to be the rule. For regions that lie further apart, dispersion equilibria prevail. There is, however, a large variation of freeness of trade as well as break points between sectors.

5   Regional policy

5.1   Introduction

Regional policy often explicitly intends to lure economic activity to the periphery, and thus to reduce agglomeration. 'Objective 1' funding in Europe and the 'Kompas voor het Noorden' in the Netherlands are prime examples. Yet the descriptive statistics as well as the econometric estimations presented in this study suggest that agglomeration is difficult to counter, at least at a disaggregated level of regional aggregation.

In this light it is opportune that governments review their regional policy. Reports such as 'Pieken in de Delta' (Minsterie van Economische Zaken, 2004) and the 'Third Report' (European Commission, 2004) reveal a refocus from interregional equity to overall efficiency. The dogged effort to make lagging regions catch up is gradually replaced by a more flexible approach, in which regional policy is more in harmony with market forces.

The implications of this study are thus in line with the direction in which thinking about regional policy is moving. A long run impact of policy is only to be expected if it is targeted on regions that have a realistic chance of holding on to mobile economic activity. And if the policy remains focused on lagging regions, the durability of its impact is maximised if it is targeted on labour, since this is the production factor that is least likely to relocate to the core.

5.2   The Equity-Efficiency Trade-Off

The objectives of regional policy are sundry. Sometimes it is geared towards agglomeration, but more often towards dispersion. European Cohesion policy embodies the two track approach. On the one hand it places its bet on core regions by yearly spending billions of euros on projects such as the Madrid ring road or the bridge crossing the river Tago. On the other hand it attempts to achieve a "balanced spread" of economic activity by directing the bulk of the available funds towards Extremadura, Alentejo, and other lagging regions.

The incoherence of the two track approach is conspicuous. Simultaneously promoting agglomeration and dispersion is bound to be ineffective, irrespective of the validity of the NEG as compared with the neoclassical trade theory. We conjecture that the incoherence stems from the difficulty to strike a balance between boosting overall productivity and growth, which is associated with agglomeration, and reducing regional disparities of wealth and employment, which is associated with dispersion. In fact, the 'Third Report' describing the official position of the European Commission on Cohesion Policy, conveniently sweeps the equity-efficiency trade-off out of sight. It states: "Strengthening regional competitiveness throughout the Union

and helping people to fulfil their capacities will boost the growth potential of the EU economy as a whole to the common benefit of all" (European Commission, 2004, p. viii).

The equity-efficiency trade-off does not, of course, disappear by negation. In chapter 2 we point out that NEG models feature a positive relation between agglomeration and overall productivity. The reason is that co-locating firms save on trade costs, broadly defined as anything that impedes trade between distant regions. Introducing endogenous growth into the models amplifies the trade-off: agglomeration increases the growth rate of both the core and its periphery; the core settles, however, for the higher rate (Baldwin and Forslid, 1999). Finally, core regions tend to account for a disproportionate amount of innovation as measured by the number of registered patents (Bottazzi and Peri, 2003).

Policy makers should face up to the equity-efficiency trade-off. The evidence suggests, for example, that cohesion policy sits uneasily with Lisbon agenda. Playing the ostrich leads to unrealistic expectations regarding convergence, or the funding of projects that pull the economic geography in opposite directions. Regional policy should not be overburdened with a set of objectives that cannot possibly be achieved simultaneously.

5.3 Optimal Agglomeration

The optimal regional policy guides the development of the economic geography towards the desired degree of agglomeration, that is towards the degree that strikes a balance between interregional equity and overall productivity growth. The point that maximises social welfare is hard to pin down for any real world core-periphery system. Is too much or too little business activity agglomerated in Amsterdam, Den Haag, Rotterdam and Utrecht as compared with the rest of the Netherlands? We do not have a firm answer. Moreover, changes of the economic geography always involves winners and losers, see figure 2.3.

The difficulty lies in several externalities that work in different directions. Migrant workers and firms do not take into account that their location decisions affect profits and wages in the origin as well as the destination region. There is, therefore, no guarantee that their individual location decisions add up to the social optimum.

Even within the confines of theory there is no consensus. Baldwin et al. (2003) incline towards too much agglomeration on the basis of a specific NEG model. Lammers and Stiller (2000) are less determinate: they settle for a tie on the basis of a more comprehensive analysis. There are, moreover, important issues outside the scope of the NEG. One can think of preservation of historical land- or cityscapes, or the preservation of rural cultures.

The externalities present in the NEG justify regional policy. It remains, however, unclear whether the policy should promote agglomeration or dispersion. Policy makers will have to

continue to rely on heuristics in order to determine the direction that their initiatives should take. Besides, a one-size-fits-all regional policy does not exist. The European economic geography is an not a unity nor a set of unrelated regions. It is a patchwork of local core-periphery systems. Some systems may benefit from more agglomeration, others from more dispersion.

5.4   Hysteresis

The Third Report notes that a disproportionate amount of investment flows towards core regions, that is towards locations where capital is abundant and productivity is high. Lagging regions seem to lack competitiveness, to be interpreted as attractiveness as a place for business. The Third Report goes on to advocate public spending on development of "suitable levels of physical infrastructure [..], human capital, [..] and the capacity to innovate and use both existing know-how and new technologies" (European Commission, 2004, p.xi).

The experience with regional policy casts doubt on the cogency of this competitiveness paradigm. For example, the capacity of publicly funded seaports in Eemshaven and Delfzijl continues to outstrip demand by a factor three in even the most optimistic scenario (Centraal Planbureau, 1999). This negative experience is not exceptional. Virtually all independent econometric assessments of cohesion policy conclude that the collection of funded projects have had no significant growth impact on the target regions (Ederveen et al., 2002).

According to the NEG, agglomeration externalities lock the European economic geography into stable core-periphery systems that can only be upset if the freeness of trade is close to the break points. This is what Baldwin et al. (2003) call hysteresis. Firms and workers prefer to locate near markets, and markets are located where firms and workers reside. This circular causality of location decisions gives the economic geography a 'putty-clay' character: the location of a core-periphery system is indeterminate ex ante, but stable ex post (Ottaviano, 2002; Baldwin et al., 2003). It explains why efforts to increase the competitiveness of existing peripheral regions are often insufficient to entice business activity from the core.

A thought experiment clarifies the point. Figure 5.1, which is similar to figure 2.2, depicts the difference between the real wage in the core and the periphery under the assumption of extreme agglomeration. Note that this wage gap is positive for intermediate freeness of trade. In this domain a migrant would be worse off if he ventured out to the periphery. Hence, in this domain the agglomeration equilibrium is stable. A transfer equal from the core to the periphery equal to five percent of total gross value added perturbs the wage curve as indicated. The crux is that even this large transfer hardly changes the domain in which agglomeration is stable.

A sufficiently large transfer would, of course, tip the balance in favour of the periphery. The empirical evidence suggests, however, that the shock necessary to upset a typical agglomeration

Figure 5.1 Subsidies and the wage gap[a]

%

0

autarky ϕ_B ϕ^B free trade
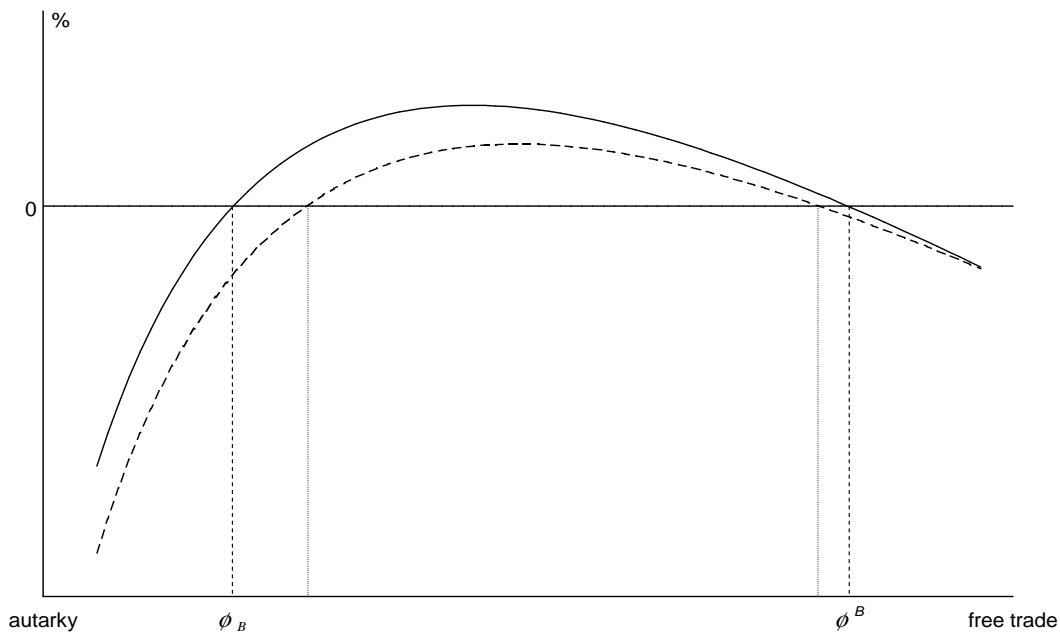
[a] The continuous curve depicts the difference between the real wage in the core and the periphery under the assumption that footloose business a activity agglomerates. The dotted curve depicts the wage gap for a transfer 5% of total income from the core to the periphery.

equilibrium lies beyond the scope of the available funds for regional policy. Brakman et al. (2004a) report that the bombing of German cities during World War II – which can be interpreted as a perverse regional policy experiment – had only a minor impact on the German economic geography: over 90% of all Western German cities had returned to their pre-war population level by the early 1960s.

In short, the European economic geography is less malleable than regional policy makers like to believe. Martin (1998) distinguishes two reasons why regional aid may have a positive impact on convergence: a direct income effect and an indirect industrial location effect. Hysteresis implies that the indirect industrial location effect fails to materialise.

5.5   Infrastructure

Regional policy is biased towards infrastructure. The European Commission (2004), for example, channels EUR 4.5 billion annually towards transport projects in objective 1 regions. This amounts to as much as 20% of the total available funds. In addition, it finances trans-European networks (TEN-T) of cross-border routes, as well as secondary networks and connections with the TEN-T.

The bias stems from a simple argument. Adequate infrastructure adds to competitiveness,

and competitiveness adds to regional growth. Hence, improving infrastructure helps lagging regions to catch up.

The estimates of chapter 4 appear to lend support to the argument: market access and wages are positively correlated. They concern, however, only the short run relation between market access and wages, that is the relation under the assumption of a given spatial distribution of business activity. The long run relation is more complex: persons make location decisions in response to real wage differences, location decisions impact upon market access, and market access impacts – in its turn – on real wage differences. It is this circular causality that may lock regions into an agglomeration equilibrium, and make regional policy ineffective.

The NEG stresses that stability of such an equilibrium depends critically on freeness of trade. This makes new infrastructure a hazardous policy instrument. If it pushes the freeness of trade beyond break point ϕ_B or ϕ_B', then it enforces a core-periphery structure with its corresponding spatial wage structure.

The intuition is that links between a periphery and a contiguous core increase everybody's market access. As a result, the periphery may become *relatively* less competitive. This induces a shift of business activity to the core. Puga (2002) notes that new infrastructure in Europe is of a hub-and-spoke nature which amplifies the shift. Moreover, Forslid (2004) shows that even intraregional infrastructure may induce agglomeration. The reason is that intraregional infrastructure is in fact veiled interregional infrastructure. Links between locations within peripheral regions are indirectly links between any one of these locations and the core.

5.6 Capital and Labour

Regional policy targets both capital and labour. The European Commission (2004) channels EUR 2.5 billion annually towards small, medium sized, and large firms in objective 1 regions. Simultaneously, it channels EUR 3.4 billion towards workers by funding labour market projects such as vocational training.

We suspect that labour market projects are most effective in promoting convergence. The reason is that subsidies for capital end up in the core if recipients decide to relocate. Worse still, Dupont and Martin (2003) demonstrate that even if capital stays in the periphery, the subsidy may harm convergence.

The paradox hinges on a subtle interplay between the freeness of trade and the return to capital with an interregionally integrated capital market. Capitalists in either region benefit. But since there are more capitalists in the core than in the periphery, the subsidy increases interregional income differences.

The mirror image of this negative result is that a subsidy to labour does have a lasting impact.

Labour is, by its immobility, less prone to agglomeration forces. Thus 'human resources' policy may even help the problem regions at intermediate distances from their local core. Moreover, figure 2.3 shows that the immobile production factor in the periphery loses out by agglomeration. A subsidy compensates for the decrease of its remuneration.

5.7   Conclusion

This study supports the direction in which thinking about regional policy is moving. More funds are channeled to local cores as compared to local peripheries. This makes sense given the prevalence of the agglomeration equilibrium. Core regions have a better chance to hold on to mobile economic activity.

The downside is that a focus on local cores enforces disparities between provinces and between regions within provinces. The equity-efficiency trade-off cannot be evaded. Local peripheries benefit absolutely, as agglomeration advantages emanate over distance, but not relatively, as they quickly peter out. Whether this is something to be afraid off is unclear: more agglomeration may or may not be beneficial for social welfare, depending on the weight of productivity and growth versus the weight of wage equality.

If the objective of regional policy remains reducing regional disparities, then large infrastructure projects are a hazardous instrument. If they push the freeness of trade beyond the second break point, then they trigger dominance of dispersion forces which benefit the periphery. But if they push the freeness of trade beyond the first break point then they trigger dominance of agglomeration forces which harm the periphery. Infrastructure may thus accelerate a drift to the core. Targeting peripheral labour is better from the perspective of regional convergence. It maximises the durability of the policy impact, since peripheral labour is the most immobile production factor. It dampens, moreover, the increase of intraregional inequality related to the agglomeration process.

A   Appendix: The Indices

Concentration and Specialisation

Concentration is the extent of over or under representation of an industry in each element of a set regions. It can be measured by the Theil index:

$$T^f = \sum_{r=1}^{R} \frac{x_r^f}{x^f} \left(\log \frac{x_r^f}{x^f} - \log \frac{n_r}{n} \right)$$

where:

f is an industry index

r is a region index

R is the total number of regions

x_r^f is the economic activity of industry f in region r

x^f is total economic activity of industry f, $\sum_r x_r^f$

n_r is the number of basic units of region r

n is the total number of basic units, $\sum_r n_r$.

T^f compares for each region r the relative economic activity of industry f, x_r^f/x^f, with what it should have been on the basis of the relative number of basic units n_r/n. If they match $(x_r^f/x^f = n_r/n)$ then the comparison yields the value 0; if the industry is over represented $(x_r^f/x^f > n_r/n)$ then the comparison yields a positive number; if the industry underrepresented $(x_r^f/x^f < n_r/n)$ then the comparison yields a negative number. The logarithmic transformation and the weights guarantee that T^f increases in the inequality of the distribution of x^f with respect to n, and that its minimum value equals 0.

Since the Theil index measures the inequality of the distribution of x^f with respect to n, the choice of n determines the kind of concentration. If regions are chosen as basic units then $n_r = 1 \, \forall r$, and $n = R$. The no-concentration benchmark, i.e. the distribution of x^f such that $T^f = 0$, is the uniform distribution of x^f over the regions. This kind of concentration is called *absolute concentration*. If square kilometres are chosen then $n_r = km_r^2$, en $n = \sum_r km_r^2$. The no-concentration benchmark is the uniform distribution of x^f over square kilometres, and thus over regions proportional to their land mass. This kind of concentration is called *topographic concentration*. If total economic activity is chosen then $n_r = \sum_f x_r^f$, and $n = x = \sum_r \sum_f x_r^f$. The no-concentration benchmark is the uniform distribution of x^f over units of x (gross value added or employment), and thus over regions proportional to their economic size. This kind of concentration is called *relative concentration*. Table A.1 gives a summary.

Table A.1 Concentration

	n_r	n	No-concentration benchmark
Absolute concentration	1	R	Uniform distribution of x^f over regions
Topographic concentration	km_r^2	$\sum_r km_r^2$	Distribution of x^f matches distribution of km^2
Relative concentration	$\sum_f x_r^f$	x	Distribution of x^f matches distribution of x

Specialisation is the extent of over- or under representation of a region in each element of a set industries. The corresponding Theil index is:

$$T_r = \sum_{f=1}^{F} \frac{x_r^f}{x_r} \left(\log \frac{x_r^f}{x_r} - \log \frac{n^f}{n} \right)$$

where:

x_r is total economic activity of region r, $\sum_{f=1}^{F} x_r^f$

n^f is the number of basic units of industry f

n is the total number of basic units, $\sum_{f=1}^{F} n^f$.

T_r compares for each industry f the relative economic activity of the region x_r^f / x^r with what it should have been on the basis of the relative number of basic units n^f / n. It equals T^f, except that the indices f and r trade places. This is logical: if industries concentrate then regions specialise. Nevertheless, the equalities $T^f = T_r$ en $dT^f = dT_r$ do not generally hold due to variation in region and industry size.

The choice of n determines the kind of specialisation. If industries are basic units then $n^f = 1 \, \forall f$, and $n = F$. The no-specialisation benchmark is the uniform distribution of x_r over the industries. This kind of specialisation is called *absolute specialisation*. The alternative is total economic activity, implying $n^f = \sum_r x_r^f$, and $n = x$. The no-specialisation benchmark is the uniform distribution of x_r over the units of x, and thus a distribution of x_r over the industries proportional to their economic size. This kind of specialisation is called *relative specialisation*. Table A.2 gives a summary.

Table A.2 Specialisation

	n^f	n	No-specialisation benchmark
Absolute specialisation	1	F	Uniform distribution of x_r over industries
Relative specialisation	$\sum_r x_r^f$	x	Distribution of x_r matches distribution of x

Agglomeration

Agglomeration of total economic activity can be measured by the Theil index:

$$T = \sum_{r=1}^{R} \frac{x_r}{x} \left(\log \frac{x_r}{x} - \log \frac{n_r}{n} \right)$$

where the distribution of total economic x is pitted against the distribution of n. Since comparing the distribution of x with itself is trivial, the only choice options for n are regions and square kilometres. The corresponding kinds of agglomeration could be called *absolute* and *topographic agglomeration*.

The prime advantage of the Theil index above other indices of inequality is its decomposability. In order to verify at which level of economic aggregation agglomeration is most saliently manifest we choose the following decomposition:

$$T_3 = (T_3 - T_2) + (T_2 - T_1) + (T_1 - T_0) + T_0$$

where:

T_i is the Theil index at NUTSi level $\sum_{ri} \frac{x_{ri}}{x} \left(\log \frac{x_{ri}}{x} - \log \frac{n_{ri}}{n} \right)$;
ri is a region index at NUTSi level.

Moran's I-statistic is a spatial covariance with the weights w_{rs} – measuring contiguity between regions r and s – as a crucial extra element. It is the standard way to control for spatial autocorrelation in regression analysis. It is defined as:

$$I = \frac{\sum_r \sum_s w_{rs} z_r z_s}{\sum_r \sum_s w_{rs} \sum_r z_r^2}$$

where:

r, s are region-indices;
w_{rs} is a measure of contiguity of regions r en s;
z_r is a measure of relative economic activity of region r.

Given data availability one can think of two measures for z_r: $x_r - \bar{x}_r$ and $x_r/km_r^2 - \left(\bar{x}_r/km_r^2 \right)$ which roughly correspond to absolute and relative agglomeration. For w_{rs} we can draw from a distance-matrix with travel times in hours D_{rs} between the capital cities of the regions r and s. There infinite possibilities to measure contiguity. Obvious possibilities are $w_{rs} = 1/D_{rs}$, or $w_{rs} = (1/D_{rs})^2$ if one wishes to stress direct contiguity. An elegant way to probe into the subsets of regions that are spatially correlated is to define w_{rs} by means of critical travel times: choose for example $w_{rs} = 1$ for $D_{rs} \leq 1$ and $w_{rs} = 0$ in all other cases, and choose subsequently $w_{rs} = 1$ for $1 < D_{rs} \leq 2$ and $w_{rs} = 0$ in all other cases, etc. In other words, calculate Moran's I for regions within a radius of one hour travel time, subsequently for regions within one and two hours travel time, etc. Table A.3 gives a summary.

Table A.3   Agglomeration and Spatial Autocorrelation

	n_r	n	No-agglomeration benchmark
Absolute agglomeration	1	R	Uniform distribution of x over regions
Topographic agglomeration	km_r^2	$\sum_r km_r^2$	Distribution of x matches distribution of km^2
Absolute spatial autocorrelation			Random distribution of x over regions
Topographic spatial autocorrelation			Random distribution of x over km^2

B   Appendix: The Econometric Analysis

B.1   Derivation of the Wage Equation

In this appendix we derive the wage equation. The underlying NEG model rests heavily on Dixit and Stiglitz (1977) and Puga (1999).

Demand

The economy comprises two sectors: an immobile numeraire sector (often called agriculture), and a mobile sector (often called manufacturing). The preferences of the representative consumer are represented by a Cobb-Douglas utility function:

$$U = M^{\delta} H^{1-\delta} \tag{B.1}$$

where:

U is utility

H is consumption of the good produced by the numeraire sector

M is consumption of the good produced by the mobile sector

δ is the share of income spent on the good produced by the mobile sector.

The term M is a CES sub-utility function aggregating the distinct varieties:

$$M = \left(\sum_{i=1}^{n} c_i^{\rho} \right)^{1/\rho} \quad \text{with} \quad c_j = p_j^{-\varepsilon} I^{\varepsilon-1} \delta Y \tag{B.2}$$

where:

c_j is consumption of variety j

p_j is the price of variety j

$\varepsilon = \frac{1}{1-\rho}$ is the substitution elasticity

$I = \left(\sum_i p_i^{1-\varepsilon} \right)^{1/(1-\varepsilon)}$ is a price index

Y is (wage) income.

Consumers maximise utility subject to their budget constraint. This yields the demand function of variety j:

$$c_j = p_j^{-\varepsilon} I^{\varepsilon-1} \delta Y \tag{B.3}$$

Firms also use varieties from the mobile sector as intermediate inputs. Assuming that all varieties are necessary in the production process and that the elasticity of substitution is the same

for firms as for consumers, we can use the same CES-aggregator function for producers as for consumers. This yields:

$$c_j = p_j^{-\varepsilon} I^{\varepsilon-1} E, \quad E = \delta Y + \mu X \qquad (B.4)$$

where:

X is the value of intermediate inputs

μ is the share of intermediate inputs in the production process.

Supply

The representative firm produces its variety i with the cost function:

$$C(x_i) = I^{\mu} W_i^{(1-\mu)} (\alpha + \beta x_i) \qquad (B.5)$$

where:

x_i is the quantity of variety i

$C(x_i)$ is the cost of production of x_i

W_i is the wage rate

α is the fixed input requirement

β is the marginal input requirement.

Firms maximise profits. This yields a mark-up pricing rule, common in Dixit-Stiglitz models:

$$p_i \left(1 - \frac{1}{\varepsilon}\right) = I^{\mu} W^{(1-\mu)} \beta, \qquad (B.6)$$

Free entry and exit drive profits to zero:

$$p_i x_i = I^{\mu} W_i^{(1-\mu)} (\alpha + \beta x_i) \qquad (B.7)$$

Solving equations B.6 and B.7 for x_i yields the break-even supply:

$$x_i = \frac{\alpha(\varepsilon - 1)}{\beta} \qquad (B.8)$$

Equilibrium with Trade Costs

Transport of varieties is not for free. The 'iceberg' transport costs between regions 1 and 2 are:

$$T^{D_{12}} > 1 \qquad (B.9)$$

where D_{12} is the distance between region 1 and 2.

Assume for the time being that there are no other regions. Total demand for a variety produced in region 1 comes from consumers and firms in region 1 as well as region 2. But

consumers and firms located in region 2 have to pay a higher price due to the transportation costs. This yields the demand function:

$$x_1 = E_1 p_1^{-\varepsilon} I_1^{\varepsilon-1} + E_2 p_1^{-\varepsilon} (T^{D_{12}})^{-\varepsilon} I_2^{\varepsilon-1} \tag{B.10}$$

Note that the demand from region 2 is multiplied by $T^{D_{12}}$ in order to compensate for the part that melts away during transportation. Equating supply to demand yields:

$$\frac{\alpha(\varepsilon-1)}{\beta} = E_1 p_1^{-\varepsilon} I_1^{\varepsilon-1} + E_2 p_1^{-\varepsilon} (T^{D_{12}})^{1-\varepsilon} I_2^{\varepsilon-1} \tag{B.11}$$

Incorporation of the mark-up pricing rule in this last equation and solving for the wage rate yields the two-region version of the wage equation:

$$W_1 = c I_1^{\frac{-\mu}{1-\mu}} \left(E_1 I_1^{\varepsilon-1} + E_2 \left(T^{D_{12}}\right)^{1-\varepsilon} I_2^{\varepsilon-1} \right)^{\frac{1}{\varepsilon(1-\mu)}} \tag{B.12}$$

where c is a function of model parameters.

Equation 4.1 that constitutes the basis of the estimations is the n regions version of equation B.12. Imposing $\mu = 0$ reveals that the proto Krugman (1991) model is a special case of this more general model.

B.2   Incorporating Regional Productivity Differences

The equilibrium output of firm i in region r is:

$$x_{ir} = \frac{\alpha(\varepsilon-1)}{\beta_{ir}} \tag{B.13}$$

where β_{ir} is the region specific marginal input requirement.

The regional factor productivity is approximated by the difference in marginal labour productivity in region r and the mean marginal labour productivity for the NUTS2 regions:

$$\beta_{ir} = PL_{EU+} / PL_{ir} \tag{B.14}$$

The equilibrium demand facing each firm i is then:

$$x_d = \frac{p^{-\varepsilon}}{I^{(1-\varepsilon)}} E \tag{B.15}$$

Summing over all firms, using the mark-up pricing rule, and taking iceberg transport costs into account yields:

$$p = \frac{\varepsilon}{\varepsilon-1} \beta_r W^{1-\mu} I^{\mu} \tag{B.16}$$

and

$$x_r = \sum_{s=1}^{R} \left[\left(\frac{\varepsilon}{\varepsilon-1} \frac{W_r^{1-\mu} I^{\mu} T^{D_{rs}} \beta_r}{I_s} \right)^{-\varepsilon} T^{D_{rs}} \frac{E_s}{I_s} \right] \tag{B.17}$$

Equating the break-even supply to this expression and solving for W_r yields:

$$W_r = \beta_r^{\frac{1-\varepsilon}{\varepsilon(1-\mu)}} \varepsilon^{\frac{1}{\mu-1}} (\varepsilon-1)^{\frac{\varepsilon-1}{\varepsilon(1-\mu)}} I_r^{-\frac{\mu}{1-\mu}} \alpha^{\frac{-1}{\varepsilon(1-\mu)}} \sum_{s=1}^{R} \left[\left(\frac{T^{D_{rs}}}{I_s}\right)^{1-\varepsilon} E_s \right]^{\frac{1}{\varepsilon(1-\mu)}} \tag{B.18}$$

with $I_r = \left[\sum \lambda_s \left(T^{D_{rs}} p_s\right)^{1-\varepsilon}\right]^{1/(1-\varepsilon)}$. We arrive at the wage equation by logarithmic transformation:

$$\log(W_r) = c + \frac{1-\varepsilon}{\varepsilon(1-\mu)}\log(\beta_r) - \frac{\mu}{1-\mu}\log(I_r) + \frac{1}{\varepsilon(1-\mu)}\log\left[\sum_{s=1}^{R} Y_s \left(\frac{T^{D_{rs}}}{I_s}\right)^{1-\varepsilon}\right] \tag{B.19}$$

Imposing $\mu = 0$ yields equation (4.1).

B.3   The Price Index

Data on regional prices are unavailable. Hence we are forced to approximate I. For each region we focus on two prices: the price in region r of a variety produced in r and the mean price outside r of a variety produced outside r. We obtain the mean distance r by weighing the distances with relative Y, a method that concords with market potential

$$MP = \log\left[\sum_s Y_s e^{-\kappa_2 D_{rs}}\right] \tag{B.20}$$

Regions with the largest market-potential are centres given by table B.1. The distance between a region r and the nearest centre region r^c gives us $T^{D_{rr^c}}$:

$$I_r = \left[\lambda_r W_r^{1-\varepsilon} + (1-\lambda_r)\left(\bar{W}_r T^{D_{rr^c}}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{B.21}$$

where:

$\bar{W}_r$ is the mean wage outside district r

λ_r is region r's share of employment in the mobile sector, proxied by the ratio of employment in r and employment in $EU+$

D_{rr^c} is the distance from region r to its nearest economic centre.

This procedure allows direct estimation the wage equation with factor productivity differences but without intermediate inputs.

The productivity gap between a region and the EU mean affects equation (B.21). With $\mu = 0$, marginal costs are $MC_{ir} = W_{ir}\beta_{ir}$, and equation (B.21) becomes:

$$I_r = \left[\lambda_r \left(W_r \beta_r\right)^{1-\varepsilon} + (1-\lambda_r)\left(\bar{W}T^{D_{r-r^c}}\right)^{1-\varepsilon}\right]^{1/(1-\varepsilon)}. \tag{B.22}$$

where the subscript i has been dropped for notational simplicity.

Table B.1   Regions with largest Market Potential (MP)[a]

	Region	MP		Region	MP
1	Nordrhein-Westfalen	100	19	Zuid-Holland	66
2	Limburg	83	20	Zeeland	65
3	Limburg(B)	81	21	Nord-Pas de Calais	65
4	Luik	79	22	Saarland	65
5	Noord-Brabant	78	23	Luxembourg(B)	65
6	Vlaams-Brabant	77	24	West-Vlaanderen	64
7	Baden-Württemberg	77	25	Picardie	64
8	Rheinland-Pfalz	77	26	Champagne-Ard.	64
9	Gelderland	75	27	Alsace	63
10	Antwerpen	75	28	Noord-Holland	63
11	Waals-Brabant	75	29	Overijssel	62
12	Brussel	74	30	Flevoland	61
13	Namen	73	31	Niedersachsen	60
14	Utrecht	71	32	Lorraine	56
15	Ile de France	70	33	Vorarlberg	56
16	Oost-Vlaanderen	69	34	Ostschweiz	55
17	Hainaut	69	35	Zurich	55
18	Bayern	67			

[a] 35 regions with the largest market potential in 1995, calculated for European NUTS2 regions with $\kappa_2 = 0.007$ and normalized at Nordrhein-Westfalen = 100.

References

Aiginger, K., M. Boeheim, K. Gugler, M. Pfaffermayer and Y. Wolfmayr-Schnitzer, 1999, Specialisation and (geographic) concentration of European manufacturing, Background Paper for 'The competitiveness of European Industry: 1999 Report' of DG Enterprise.

Aiginger, K. and S. Davies, 2001, Industrial specialisation and geographic concentration: Two sides of the same coin? Not for Europe, Working Paper 23/2000, University of Linz.

Aiginger, K. and W. Leitner, 2002, Regional concentration in the United States and Europe: Who follows whom?, *Weltwirtschaftliches Archiv*, vol. 138(4), pp. 652–679.

Aiginger, K. and E. Rossi-Hansberg, 2003, Specialization versus concentration: A note on theory and evidence, Mimeo, University of Linz.

Amiti, M., 1998, New trade theories and industrial location in the EU: A survey of evidence, *Oxford Review of Economic Policy*, vol. 14, no. 2, pp. 45–53.

Amiti, M., 1999, Specialization patterns in Europe, *Weltwirtschaftliches Archiv*, vol. 135, no. 4, pp. 573–593.

Audretsch, D. and M. Feldman, 1996, R&D spillovers and the geography of poduction and innovation, *American Economic Review*, vol. 86, no. 3, pp. 630–640.

Baldwin, R. and R. Forslid, 1999, The core-periphery model and endogenous growth: Stabilising and de-stabilising integration, Working Paper 6899, NBER.

Baldwin, R., R. Forslid, P. Martin, G. Ottaviano and F. Robert-Nicoud, 2003, *Economic Geography and Public Policy*, Princeton University Press.

Baldwin, R., P. Martin and G. Ottaviano, 2001, Global income divergence, trade and industrialization: the geography of growth take-offs, *Journal of Economic Growth*, vol. 6, pp. 5–37.

Baldwin, R. and P. Martin, 2003, Agglomeration and regional growth, in V. Henderson and J.F. Thisse, eds., *Handbook of Regional and Urban Economics: Cities and Geography*,

North-Holland, Amsterdam.

Barrios, S. and E. Strobl, 2002, Industry mobility and concentration in the European Union, Documento de Trabajo 2002-19, FEDEA.

Bijvoet, C. and C. Koopmans, 2004, De effectiviteit van regionaal beleid, Rapport 751, Stichting voor Economich Onderzoek der Universiteit van Amsterdam.

Black, D. and V. Henderson, 1999, A theory of urban growth, *Journal of Political Economy*, vol. 107, no. 2, pp. 252–284.

Bottazzi, L. and G. Peri, 2003, Innovation and spillovers in regions: Evidence from European patent data, *European Economic Review*, vol. 47, no. 4, pp. 687–710.

Brakman, S. and H. Garretsen, 2003, Rethinking the 'new' geographical economics, *Regional Studies*, vol. 37, no. 6&7, pp. 637–648.

Brakman, S., H. Garretsen and C. van Marrewijk, 2001, *An Introduction to Geographical Economics*, Cambridge University Press.

Brakman, S., H. Garretsen and M. Schramm, 2004a, The strategic bombing of German cities during World War II and its impact on city growth, *Journal of Economic Geography*, vol. 4, no. 2, pp. 201–218.

Brakman, S., H. Garretsen and M. Schramm, 2004b, Putting new economic geography to the test: Free-ness of trade and agglomeration in the EU regions, mimeo, University of Utrecht.

Brülhart, M., 1998, Industrial specialisation in the European Union, *Journal of Common Market Studies*, vol. 36, no. 3, pp. 319–346.

Brülhart, M., 2001, Growing alike or growing apart? Industrial specialisation of EU countries, in C. Wyplosz, ed., *The Impact of EMU on Europe and Developing Countries*, Oxford University Press.

Brülhart, M., M. Crozet and P. Koenig, 2004, Enlargement and the EU periphery: The impact of changing market potential, Discussion Paper 270, HWWA.

Brülhart, M. and J. Torstensson, 1998, Regional integration, scale economies and industry location in the European Union, Mimeo, University of Manchester.

Brülhart, M. and R. Traeger, 2003, An account of geographic concentration patterns in Europe, Research Paper 2003/11, The University of Nottingham.

Brülhart, M. and F. Trionfetti, 2002, A test of trade theories when expenditure is home biased, Mimeo, University of Lausanne.

Centraal Planbureau, 1999, Bedrijfslocatiemonitor regionale verkenningen 2010-2020: In gesprek met de regio's, Werkdocument.

Cliff, A. and J. Ord, 1981, *Spatial Processes: Models and Applications*, London: Pion.

Combes, P. and H. Overman, 2003, The spatial distribution of economic activities in the EU, Discussion Paper 3999, CEPR.

Cornet, M. and M. Rensman, 2001, The location of R&D in the Netherlands. Trends, determinants and policy, Document 14, CPB, The Hague.

Crozet, M., 2004, Do migrants follow market potentials? An estimation of a new economic geography model, *Journal of Economic Geography*, vol. 4, pp. 439–458.

Davis, D. and D. Weinstein, 1999, Economic geography and regional production structure: An empirical investigation, *European Economic Review*, vol. 43, pp. 379–407.

Davis, D. and D. Weinstein, 2002, Bones, bombs, and break points: The geography of economic activity, *American Economic Review*, vol. 92, no. 5, pp. 1269–1289.

Davis, D. and D. Weinstein, 2003, Market access, economic geography and comparative advantage: an empirical test, *Journal of International Economics*, vol. 59, pp. 1–23.

De Nardis, S., A. Goglio and M. Malgarini, 1996, Regional specialization and shocks in Europe: Some evidence from regional data, *Weltwirtschaftliches Archiv*, vol. 132, no. 2, pp. 197–214.

Dixit, A. and V. Norman, 1980, *Theory of International Trade: a Dual, General Equilibrium Approach*, Cambridge University Press, London.

Dixit, A. and J. Stiglitz, 1977, Monopolistic competition and optimal product diversity, *American Economic Review*, vol. 67, pp. 297–308.

Dupont, V. and P. Martin, 2003, Subsidies to poor regions and inequalities: Some unpleasant arithmetic, Discussion Paper 4107, CEPR.

Ederveen, S., J. Gorter, R. de Mooij and R. Nahuis, 2002, *Funds and Games: The Economics of European Cohesion Policy*, CPB & Koninklijke De Swart, The Hague.

Ellison, G. and E. Glaeser, 1997, Geographic concentration in US manufacturing industries: A dartboard approach, *The Journal of Political Economy*, vol. 105, no. 5, pp. 889–927.

European Commission, 2003, Regulation (EC) No 1059/2003 of the European Parliament and the European Coucil of 26 may 2003 on the establishment of a common classification of territorial units for statistics (NUTS), *Official Journal of the European Communities*, vol. L 154.

European Commission, 2004, A new partnership for cohesion: Convergence, competitiveness, cooperation, Third Cohesion Report.

Forslid, R., 2004, Regional policy, integration, and the location of industry in a multiregional framework, Working Paper 4630, CEPR.

Forslid, R., J. Haaland and K. Midelfart-Knarvik, 2002, A U-shaped Europe? A simulation study of industrial location, *Journal of International Economics*, vol. 57, pp. 273–297.

Fujita, M., P. Krugman and A. Venables, 1999, *The Spatial Economy: Cities, Regions, and International Trade*, MIT Press, Cambridge, Mass.

Fujita, M. and J.F. Thisse, 2002, *Economics of Agglomeration: Cities, Industrial Location, and Regional Growth*, Cambridge University Press, Cambridge.

Gorter, J., 2001, The economic geography of Europe, *CPB Report*, no. 2001/4, pp. 22–28.

56

Greenaway, D. and R. Hine, 1991, Intra-industry specialization, trade expansion and adjustment in the European, *Journal of Common Market Studies*, vol. 29, no. 6, pp. 603–622.

Grossman, G.M. and E. Helpman, 1991, *Innovation and Growth in the Global Economy*, MIT Press, Cambridge Mass.

Haaland, J., H. Kind, K. Midelfart-Knarvik and J. Torstensson, 1999, What determines the economic geography of Europe?, Discussion paper 2072, CEPR.

Hallet, M., 2000, Regional specialisation and concentration in the EU, Economic Paper 141, European Commission.

Harrigan, J., 2001, Specialization and the volume of trade: Do the data obey the laws?, Working Paper 8675, NBER.

Head, K. and T. Mayer, 2003a, The empirics of agglomeration and trade, Discussion Paper 3985, CEPR.

Head, K. and T. Mayer, 2003b, The empirics of agglomeration and trade, in J. Henderson and J.F. Thisse, eds., *Handbook of Regional and Urban Economics*, North-Holland, Amsterdam.

Head, K. and J. Ries, 2001, Increasing returns versus national product differentiation as an explanation for the pattern of US-Canada trade, *American Economic Review*, vol. 91, no. 4, pp. 858–879.

Helg, R., P. Manasse and R. Rovelli, 1995, How much (a)symmetry in Europe? Evidence from industrial sectors, *European Economic Review*, vol. 39, no. 5, pp. 1017–1041.

Helpman, E., 1998, The size of regions, in D. Pines, E. Sadka and I. Zilcha, eds., *Topics in Public Economics*, Cambridge University Press.

Hinloopen, J. van and C. van Marrewijk, 2003, Economische concentratie: De empirie, Preadvies, KVS.

Krugman, P., 1991, Increasing returns and economic geography, *Journal of Policital Economy*, vol. 99, pp. 483–499.

Lammers, K. and S. Stiller, 2000, Regionalpolitische implikationen der neuen ökonomischen geographie, Discussion Paper 85, HWWA.

Marshall, A., 1920, *Principles of Economics*, Macmillan, London, 8th ed.

Martin, P., 1998, Regional policies, growth and geography in Europe, *The World Economy*, vol. 21, pp. 757–774.

Martin, P. and G.I.P. Ottaviano, 2001, Growth and agglomeration, *International Economic Review*, vol. 42, pp. 947–968.

Martin, R., 2001, EMU versus the regions? Regional convergence and divergence in Euroland, *Journal of Economic Geography*, vol. 1, pp. 51–81.

Midelfart, K., 2004, Regional policy design: An analysis of relocation, efficiency and equity, Discussion Paper 4321, CEPR.

Midelfart, K., H. Overman and A. Venables, 2003, Monetary union and the economic geography of Europe, *Journal of Common Market Studies*, vol. 41, pp. 847–868.

Midelfart-Knarvik, K. and H. Overman, 2002, Delocation and European integration: Is structural spending jusitified?, *Economic Policy*, vol. 0, no. 35, pp. 321–351.

Midelfart-Knarvik, K., H. Overman, S. Redding and A. Venables, 2000, The location of European industry, Economic Paper 318, DG ECFIN.

Midelfart-Knarvik, K., H. Overman, S. Redding and A. Venables, 2002, Integration and industrial specialisation in the European Union, *Revue Economique*, vol. 52, no. 3, pp. 469–481.

Minsterie van Economische Zaken, 2004, Pieken in de delta: Gebiedsgerichte economische perspectieven.

Molle, W., 1997, The regional economic structure of the European Union: An analysis of long-term development, in K. Peschel, ed., *Regional Growth and Regional Policy Within the Framework of European Integration*, pp. 66–86, Heidelberg: Physica.

Neary, J.P., 2001, Of hypes and hyperbolas: Introducing the new economic geography, *Journal of Economic Literature*, vol. 39, pp. 536–561.

Niebuhr, A., 2004, Market access and regional disparities : New economic geography in Europe, Discussion Paper 269, HWWA.

Ottaviano, G., 2002, Regional policy in the global economy: Insights from new economic geography, Discussion Paper 211, HWWA.

Ottaviano, G., 2003, Regional policy in the global economy: Insights from new economic geography, *Regional Studies*, vol. 37, pp. 665–673.

Ottaviano, G. and F. Robert-Nicoud, 2004, The 'genome' of NEG models with vertical linkages: A positive and normative synthesis, Discussion Paper 4600, CEPR.

Ottaviano, G., T. Tabuchi and J.F. Thisse, 2002, Agglomeration and trade revisited, *International Economic Review*, vol. 43, pp. 409–435.

Puga, D., 1999, The rise and fall of regional inequalities, *European Economic Review*, vol. 43, pp. 303–334.

Puga, D., 2002, European regional policies in light of recent location theories, *Journal of Economic Geography*, vol. 2, pp. 373–406.

Redding, S. and A. Venables, 2000, Economic geography and international inequality, Discussion Paper 2568, CEPR.

Ricci, L.A., 1999, Economic geography and comparative advantage: Agglomeration versus specialization, *European Economic Review*, vol. 43, pp. 357–377.

Robert-Nicoud, F., 2004, The structure of simple 'new economic geography' models, Discussion Paper 4326, CEPR.

Rodriguez-Pose, A. and U. Fratesi, 2004, Between development and social policies: The impact of European Structural Funds in Objective 1 regions, *Regional Studies*, vol. 38, no. 1, pp. 97–113.

Romer, P.M., 1990, Endogenous technical change, *Journal of Policital Economy*, vol. 98, no. 5, pp. S71–S102.

Tabuchi, T. and J.F. Thisse, 2002, Regional specialization and transport costs, Discussion Paper 3542, CEPR.

Tiefelsdorf, M. and B. Boots, 1995, The exact distribution of Moran's I, *Environment and Planning*, vol. 27, no. 6, pp. 985–999.

Trionfetti, F., 2001, Using home-biased demand to test trade theories, *Weltwirtschaftliches Archiv*, vol. 137, no. 3, pp. 404–426.

Venables, A., 1996, Equilibrium locations of vertically linked industries, *International Economic Review*, vol. 37, pp. 341–359.

Yamamoto, K., 2003, Agglomeration and growth with innovation in the intermediate goods sector, *Regional Science and Urban Economics*, vol. 33, pp. 335–360.