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of International  
Economics

# Implications of rising energy and transportation costs for future urban development – a global perspective

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# Implications of rising energy and transportation costs for future urban development – a global perspective

Ingrid Ott, Alkis Henri Otto, Silvia Stiller

The subsequent report is Part I of a research project which is realized in cooperation  
with alstria office REIT-AG.



## Foreword to the HWWI studies

### Part I: The global outlook: the future development of global economic geography

Demography, regional structure, economic activity – a host of different factors are shaping the development and future viability of German cities and conurbations. In order to be able to shape and support urban development successfully, it is necessary to look at and assess development trends. As one of the largest real estate investors in Hamburg, we must create lasting and stable real estate values. Consequently, the possible development scenarios for a city in the long term – and the future viability of Hamburg in particular – are of major importance for alstria office REIT-AG.

Energy prices and transport costs will be important factors influencing urban development in the future and will therefore have an effect on choice of location, investing activity and the building quality sought after in real estate.

Together with the Hamburg Institute of International Economics (HWWI) we have initiated a joint research project to examine the effects of rising transport costs on urban development. The analysis covers several different perspectives: starting with a global view, the project will go on to examine in stages the regional and then the local perspective. In addition, the effects of rising energy costs on the size of Hamburg, on the structure of its city centre and on its economic development will be analysed and trends for the city centre will be concluded from this analysis.

The recommended actions for the city of Hamburg derived from the results of this analysis are intended to show possible courses of development and are based on the guiding principle “Farsighted Growth”.

The examination of the global outlook (Part I) as part of this research project has shown that the regional distribution of businesses and people in this area is essentially dependent on the interplay of agglomeration and dispersion forces. Thus, for example, the concentration of production at one location can be advantageous as a result of increasing economies of scale and increasing demand. However, rising trading costs such as transport costs or costs associated with crossing borders have an adverse effect and favour local – and therefore significantly more dispersed – patterns of production. For this reason there is denser distribution of production units near to the coast because shipping transport is a comparatively cheaper form of transport.

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## Project Outline

The economic landscape, i.e. the regional distribution of firms and people across space, depends on the relative weight of concentration forces on the one hand and of dispersion forces on the other. These forces and their interaction are primarily determined by regional production conditions, mobility of capital and labour, and trade costs. Considering the latter, due to increased liberalization in the last several decades, it is quite reasonable to play down trade costs to transport costs, which on their part are mainly determined by energy costs. Consequently, changing energy prices do not only affect international and interregional trade flows, but due to feedback effects might also affect the distribution of economic activities across space.

Looking at a less aggregate level, energy costs are also relevant to inner city mobility, due to the impact they have on commercial as well as on public transport and commuting. Because of these interdependencies, changing energy prices might have an impact on the spatial structure within cities, namely, the forming of business and residential districts, spatial planning and architecture. Hence, future developments of energy prices and their impact on transport costs can be considered as highly relevant factors that can shape the future development of cities as well as the distribution of economic activities across space.

This is an issue of great significance for Hamburg. As a harbour town, Hamburg is an international logistic turntable and is strongly involved in trade flows. At a less aggregate level, (higher) transport costs can influence inner city mobility, (i.e. the cost of traffic, commercial as well as public transportation and commuting) and in this context can also affect the spatial structure of cities and their suburbs. So far, compared to other European metropolitan cities like Amsterdam, London or Paris, Hamburg is still a city with plenty of space left for further urban expansion. However, concentration processes triggered by rising transport costs might change Hamburg's inner city structure in the coming decades, a development which is highly relevant to urban planning and policy strategies.

In order to get a clear cut picture of the impact of rising transport costs on the future urban development of the city of Hamburg, the Hamburg Institute of International Economics (HWWI) together with alstria have set up a joint research project. In this context, the goal is to derive policy recommendations for a sustainable development of the growing city of Hamburg. The analysis focuses on several perspectives: Beginning at an aggregate level, the analysis will gradually narrow down to more detailed levels. The remainder of the project may therefore be interpreted as zooming in from the global level over the regional down to the local view with the final goal to analyze the impact of rising energy prices on the size, inner city structure and economic development of Hamburg. In detail, the following four topics will be addressed:

Part I: The global view: Future development of the world's economic geography

Part II: The regional view: Development perspectives for the City of Hamburg

Part III: The local view: Inner-city trends

Part IV: Scenario 2030: Hamburg - A city of the future?

This policy paper is the outcome of part I of the project

## 1. Introduction

A quick look at any map is enough in order to realize that economic activity is clearly not distributed randomly across space but that clustering of people and firms is the rule and not the exemption. During the last centuries, ongoing processes of concentration and urbanization have shaped the world's economic geography, i.e. the spatial distribution of economic activities and population. The share of people in urban regions is increasing and at the same time cities play an important role for the economic development and success of a country. Historical data document that for industrialized countries there is a strong positive correlation between growth and agglomeration and hence these countries usually are characterized by a higher degree of urbanization. There are many reasons why people cluster together, among them psychological, sociological, cultural, historical and geographical ones whose interplay is manifold and complex. Of major importance are economic factors that spur the emergence of agglomeration. Within this project attention is laid on the economic rationale underlying the considered agglomeration processes.

Previous to the era of the industrial revolution, mostly natural geography, such as coasts, mountain ranges or natural endowments (e.g. farmland or natural resources) or climatic conditions, was decisive for the settlement of people. However, nowadays, increasing industrialization, accompanied by political and institutional transitions, economic liberalization, ongoing factor mobility (labour and capital), technological progress and regional specialization do not only affect the interactions between economic agents but also the choice of location of firms and individuals.

Technological progress did not only lead to the development of new products and processes but also continuously reduced the cost of interactions within and between countries. Technological innovations have been frequently accompanied by organizational innovations: New forms of trade have emerged as a consequence of production networks and outsourcing. Since WWII, foreign direct investment grew at approximately twice the rate of global trade, which itself has grown at twice the rate of global income. The international division of labour as well as the fragmentation of production processes noticeably increased just as regional specialization did. Recent empirical work has also shown that innovative activity tends to cluster where production concentrates and that innovative activity is more spatially concentrated than production itself. Here the relation between proximity and productivity is especially pronounced.

As a result of improvements in transport infrastructure, the building of cross-border integration areas and the increasing mobility of people and capital, an immense decline in trade and communication costs was achieved. Nevertheless, trade costs still remain high – looking at bilateral trade flows between countries, the median value of the cif/fob ratio is 1.28, i.e. trade

costs are nearly 30% of the value of goods shipped. Transport costs, on their part, depend to a large extent on energy prices; hence, the latter have a crucial impact on international and interregional trade flows and consequently on the distribution of economic activities across space. Nowadays, technical change in the shipping industry is no longer faster than technical change in the goods shipped. Hence, freight rates are no longer falling relative to shipment value. At the same time, transportation of goods is oil-intensive, the costs of which are likely to increase in the coming years. Digital transmission costs, however, can not fall below zero, notwithstanding that the quality and range of electronic communication will continue to improve during the next decades.

These considerations raise some basic questions: Why are economic activity and prosperity spread so unevenly across space? Why do these differences persist and even intensify over time? And which role may be assigned to (changing) transport costs in this context?

Generally, the spatial allocation of cities, firms and people depends on the interaction of two major effects: agglomeration forces and dispersion forces. The former support the emergence and the broadening of concentration, while the latter work against it. The analysis of the determinants driving these forces as well as the consequences of their interaction for the spatial distribution, lies at the heart of geographical economics. In the seminal core-periphery paper, which dates back to 1991, the 2008 Nobel laureate Paul Krugman illustrates that trade costs, which to a large extent depend upon transport costs, play a decisive role for the dominance of either agglomeration or dispersion force and hence for the finally resulting distribution of economic activity. All things being equal, for firms it is more profitable to locate in agglomerations – and to take advantage of economies of agglomeration and of a large market potential – the lower the transport costs for the transfer, of production factors, and of goods to consumer markets are. Empirical studies also highlight the effect that agglomeration must be advantageous for individuals clustering within the same neighborhoods. Rosenthal and Strange (2004), who survey analysis of firm level data to investigate the magnitude and determinants of spatial productivity variations, report a consensus view that proximity must be good for productivity. Due to their analysis, over a wide range of city sizes, doubling the city size is associated with a productivity increase of some 3-8%. These effects are not only significant but also generally larger in higher technology sectors. In an international context, Frankel and Romer (1999) or Redding and Venables (2004) find that a one percentage point increase in the share of exports in GDP, which also could be understood as reflecting better market access, raises income by up to 0.25-1%.

How should we think of future developments? We are currently in an era of globalization, in which some economic activity is dispersing from existing centres. It is probable that the decline in trade costs of the last decades will come to an end and that at least within European inner trade flows the level of transport costs will have a strong impact on the location decision of



firms. But what determines which sectors move and where the sectors go? At the end, will prosperity be widely dispersed, or will some regions of the world continue to be left behind? It is quite reasonable to assume that costs to overcome physical distance will not only drive decisions within firms but also affect their choice of location. Hence, in extreme, these costs will affect regional and inner-city structures.

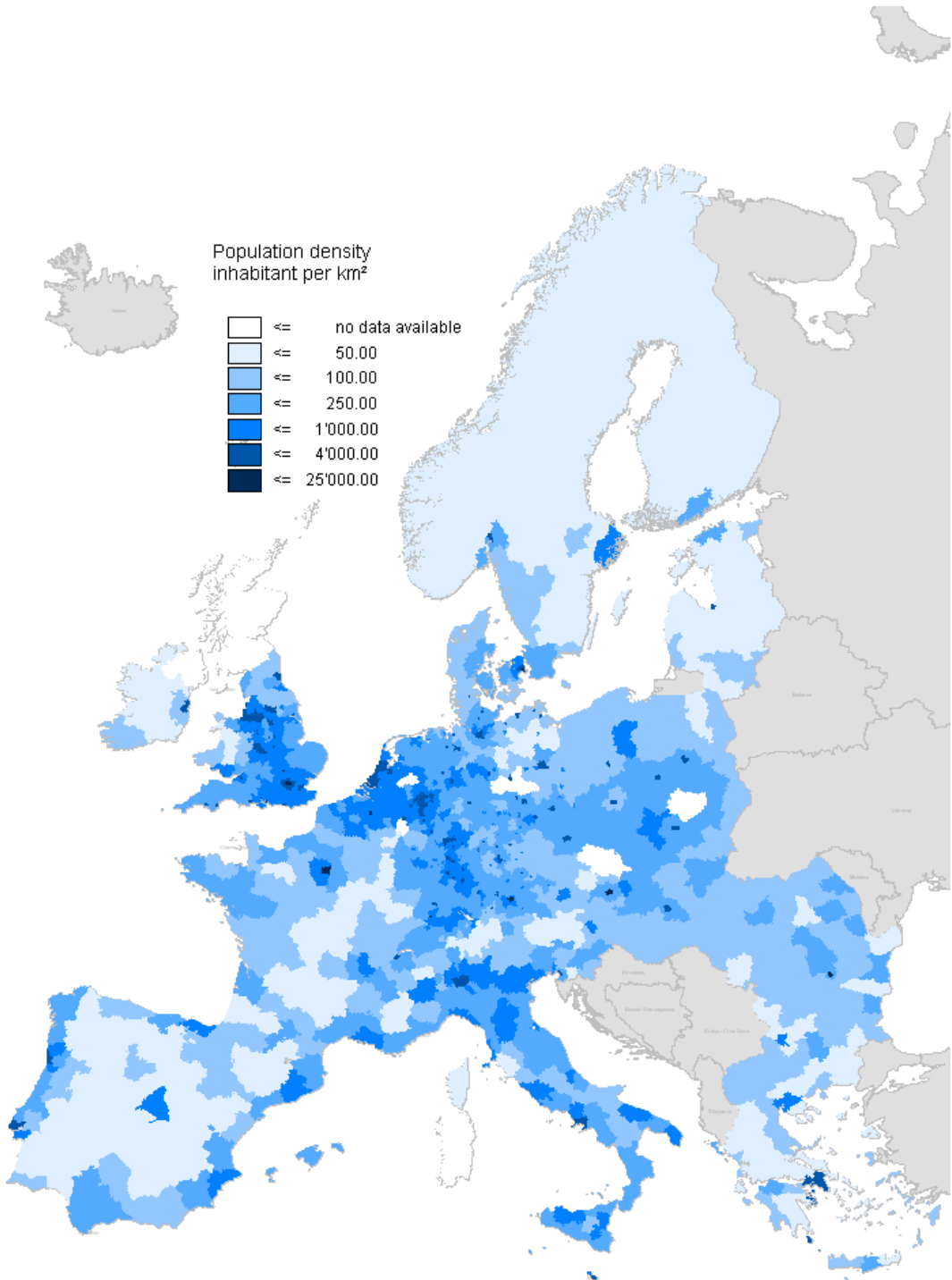
Against this background, the paper gives an overview of the current distribution of economic activity as measured by population density and income as indicators of the regional economic potential. We then proceed with describing the developments of the bigger cities in the European Union (EU) in order to assess whether they are still marked by increasing agglomeration density. Then a brief sketch of the main arguments of geographical economics will be given and hypotheses regarding the future strength of agglomeration and dispersion forces in Europe will be discussed. A crucial parameter within this theoretical framework is the level of transport costs. Their main components, e.g. energy prices, are reviewed afterwards. Furthermore, an outlook on future scenarios regarding the development of energy costs is given and will be related to current spatial developments in Europe as well as to basic conclusions drawn from the scientific field of geographical economics.

## 2. Increased urbanization

Economic geography has changed at all spatial scales – not just at the level of continents but also within countries and regions. The most important of these sub-national changes is a continuously growing rate of urbanization, i.e. the emergence and growth of economically successful agglomerated cities and regions on the one hand and declining peripheral and rural ones on the other. These processes are often associated with movements to booming coastal regions, and people leaving lagging regions in the interior or in more remote areas of countries.

In 2008, the share of the total world's population of 6.075 billion people living in urban areas amounted to 50 %, for the first time in history (see UN 2009). However, the degree of urbanization strongly differs between continents: While Australia, New Zealand and North America surpassed a level of 80 % of urbanization in 2007 and 72 % of Europe's population is living in urban areas, in developing regions a level of only 50 % of urbanization will be reached around 2019. While the 100 largest cities worldwide had on average 0.7 million inhabitants in 1900, this number increased tenfold up to 6.3 million in the year 2000. Two thirds of them are in developing countries. About 10 % of the world's population live in so-called 'megacities' with more than 10 million inhabitants. Today, there are 19 megacities in the world, and this number is predicted to increase to 27 in 2025. After the classification of the United Nations, only two of them are in North America (New York and Los Angeles) and two

Figure 1: Population Density in the European Union, 2005\*



Source: Eurostat (2009); HWWI.

\* NUTS 3 except London (Greater London) and Paris (Agglomeration Paris).

of them in Europe (Istanbul and Moscow). The bigger part of today's megacities can be found in less developed regions like China and India. However, especially these regions suffer from negative agglomeration effects and are reaching their limits of growth, i.e. economic, ecological and social disadvantages are rising.

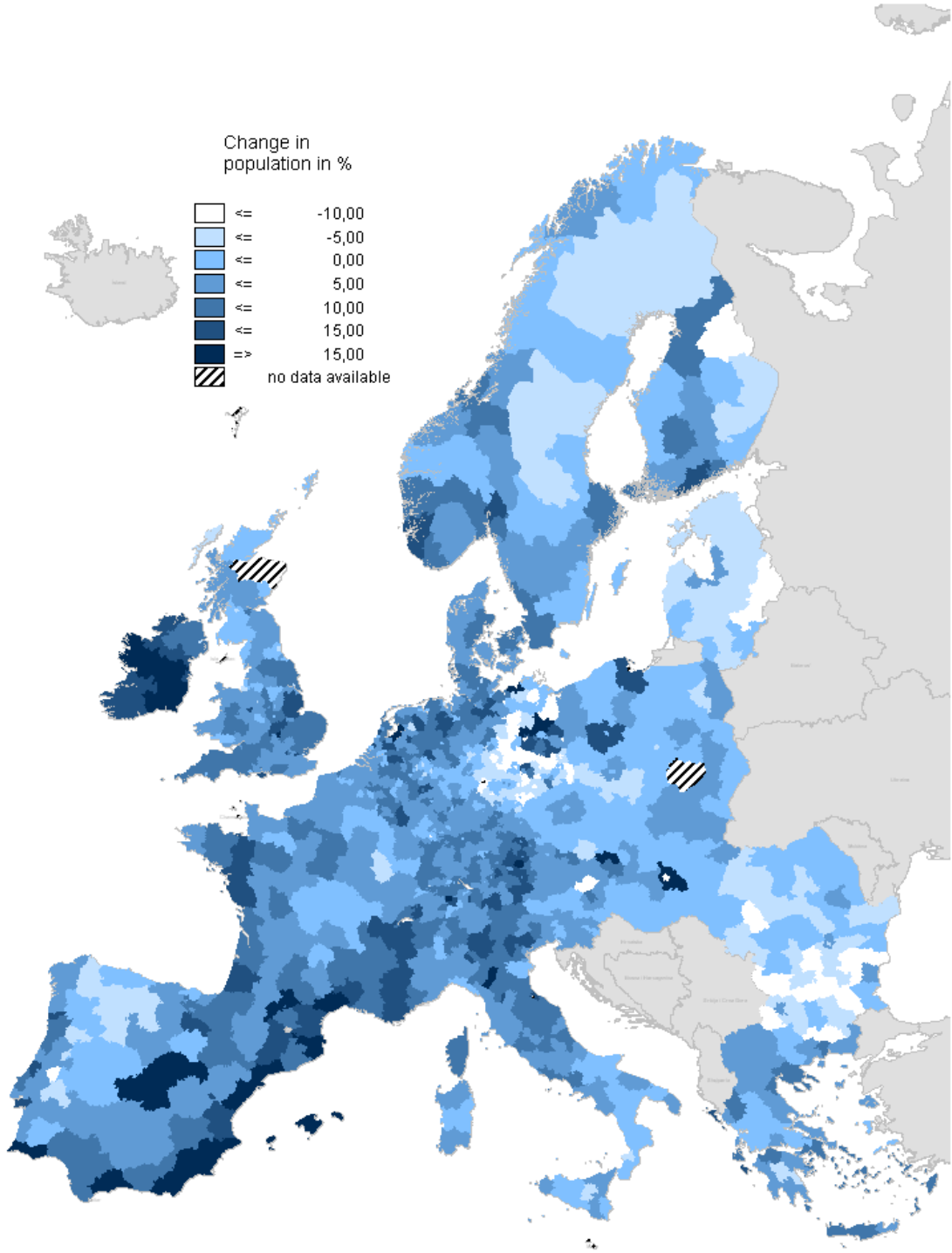
Like the rest of the world, the EU is also marked by distinct regional disparities, which can be illustrated by the spatial patterns of population density (see Figure 1). Densely populated regions are also leading economic centres as measured by income per capita.<sup>1</sup> The conglomerate of the most important of them form the so-called 'blue banana', an area reaching from the industrial centres of Northern England across the Benelux countries and the Ruhr region down to the Italian metropolises of Milan and Turin. While this classification quite accurately described the economic structure of Europe some decades ago, the blue banana today is not clear-cut anymore: Paris, Madrid, Barcelona, but also Hamburg, Stockholm and Dublin established themselves as centres of growth out of the old geographic structures. Even though still suffering of the Soviet Union's aftermath with respect to demographic and economic development, the eastern European Union member states have also to be mentioned in the row of big metropolises: Especially Warsaw, Bucharest and Budapest are – also due to their role as capital cities – leading agglomerations of their respective countries. On the other hand, there are vast regions with low population density prevailing such as the northern part of Scandinavia, Western Ireland, Romania, and Bulgaria. As a consequence, nowadays one could speak of a blue 'star'.

Further evidence for the hypothesis that in recent years urbanized and coastal regions attracted people from rural areas is depicted in Figure 2 that shows the regional population growth between 1995 and 2005. Among metropolitan areas that pulled citizens from peripheral regions are Madrid, Barcelona, Paris, Vienna, Budapest, Berlin, Milan, Athens, Copenhagen, Helsinki, Stockholm, or Poznan. Moreover, population growth rates in many coastal regions have been above the average growth rate, which is mostly apparent in the Mediterranean

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<sup>1</sup> In the following analyzes the geographic definition for all cities is the particular NUTS 3-level of Eurostat. Because of the strong extension of Paris and London, the following demographic analyzes are additionally based on NUTS 1 definitions for the two mentioned cities.

Figure 2: Regional population growth in Europe 1995 -2005



Source: Eurostat (2009); Statistics Denmark (2009); Central Statistical Office of Poland (2009); HWWI.

area, the Atlantic coast of Portugal and France. Conversely, the population of rural areas all around Europe and especially in East Germany, Romania and Bulgaria as well as in the Baltic States decreased sharply.

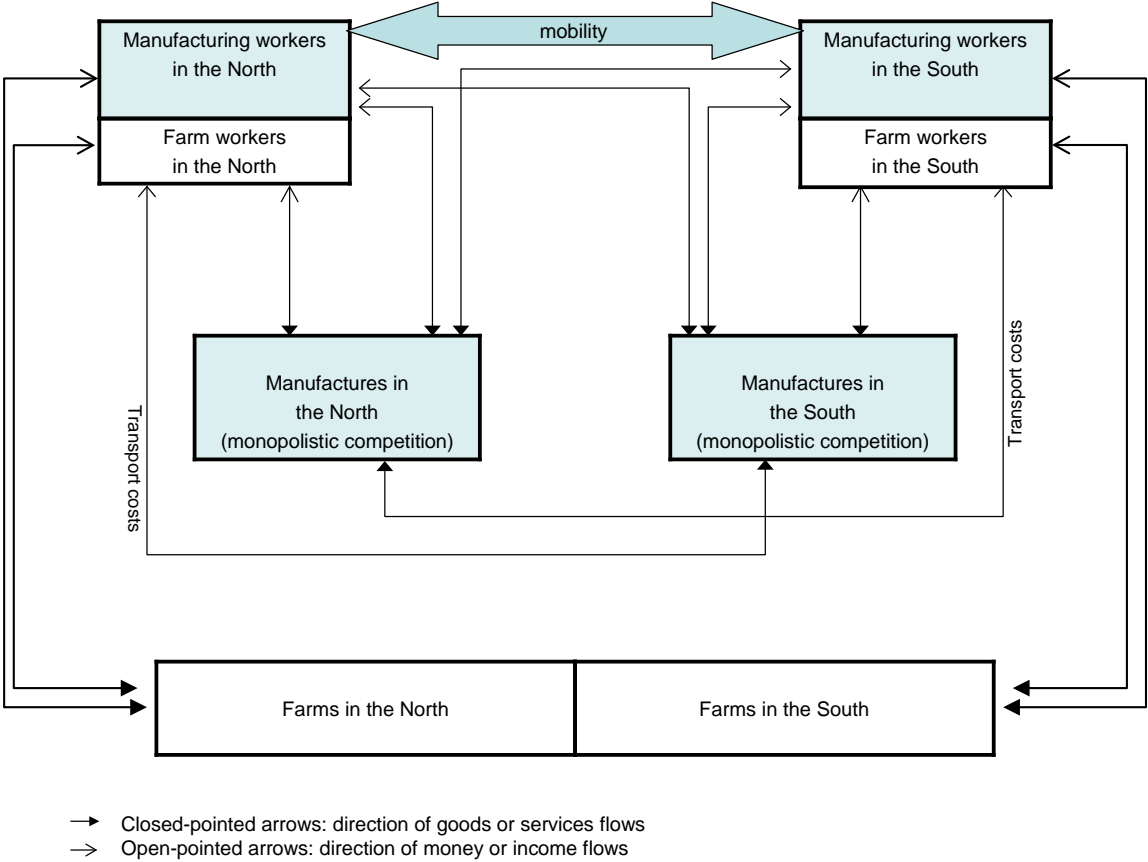
### 3. Geographical economics in a nutshell

In this chapter, attention is laid on the economic rationale behind clustering and agglomeration as the outcome of individual utility and profit maximization behaviour. A formal approach to address this issue is given by *Geographical Economics* (sometimes also denoted as New Economic Geography) whose roots lie firmly in *International Economics*, *Modern International Trade* and *Economic Growth Theory*. Basically, geographical economics adds the location of economic activity to these theories (see Brakman et al. 2009 for an excellent overview). The defining issue is the need to explain concentrations of population and of economic activity, e.g. the distinction between manufacturing belt and farm belt, the existence of cities, or the role of industrial clusters. Broadly speaking, all these concentrations form and survive because of some form of agglomeration economies, in which spatial concentration itself creates the favourable economic environment that supports further or continued concentration. The main objective of this strand of literature is not only to derive the self-reinforcing character of spatial concentration but also to model the sources of increasing returns to spatial concentration and as a result to learn something about how and when these returns may change, and then explore how the economy's concentration processes change with them. As it will become apparent, the fundamental trade-off in spatial economics refers to the interplay between local production conditions, factor mobility, and transport costs.

#### *3.1 Some building blocks and the core model*

The purpose here is to show, as clearly and simply as possible, how the interactions among increasing returns at the level of the firm, transport costs, and factor mobility can cause spatial economic structure to emerge and to change. In doing so, we rely on the seminal work of Krugman (1991), who introduces the interdependencies between these various factors in a general equilibrium framework, i.e. the resulting spatial distribution of economic activity is the favoured situation from the point of view of both firms and workers.

Figure 4: Structure of the core model



Source: HWWI, following Brakman et al. 2009

Figure 4 describes the structure of the core model of geographical economics. It identifies two regions, labelled North and South. Consumers in both regions consist of farm workers and workers in the manufacturing sector, thereby also referring to the two sectors that exist in both regions: a perfectly competitive agricultural sector producing a homogenous good and a monopolistically competitive industry or manufacturing sector, in which firms produce close but not perfect substitutes. Note that these two labels need not always be interpreted literally but that they are utilized to represent all sectors characterized by conditions of homogenous goods and perfect competition ('agriculture') and those sectors that produce heterogeneous goods in which, e.g. due to ongoing innovation, a certain margin for monopolistic behaviour exists ('manufacturing'). Farm workers do not migrate but earn their income by working on farms in their home region. However, workers in the manufacturing sector are mobile across space, as denoted by the shaded arrow. Additionally, the shaded boxes indicate mobility of workers in the manufacturing sector. In the extreme case of when all manufacturing takes place in a single region, i.e. the North, both manufacturing workers and manufactures in the South disappear. Bilateral transfers are indicated with double-pointed arrows, which have the following characteristics: The closed-pointed arrows show the direction of goods or services flows, while the open-pointed arrows indicate the direction of income and spending.

Consumers spend their income on both agricultural goods and manufactures. Agricultural goods are homogeneous; hence, consumers do not care about the region where they are produced. Spending by consumers on manufactures, however, has to be allocated on the varieties produced in both regions. As a consequence of the transport costs of manufactures and all things being equal, consuming imported varieties is more expensive than consuming products from the domestic market. However, since consumers have a preference for variety, they will always consume some units of all varieties of manufactures produced, whether at home or abroad.

As it becomes apparent, the main building blocks of Geographical Economics are given by the assumptions about (i) production conditions, market structures and individual preferences, (ii) transport costs, and (iii) factor mobility. Their interaction affects the spatial distribution of economic activity. In order to build a consistent model, some of these assumptions are quite restrictive:

- *Production conditions, market structures, and individual preferences (so-called Dixit-Stiglitz setting):* The most restrictive assumption is clearly the heavy dependence of production conditions on the market structure of monopolistic competition.<sup>2</sup> This implies that a multiplicity of firms produces close but not perfect substitutes that enter symmetrically into consumer demand. The individuals' preferences display the characteristics of love-for-variety, i.e. each individual consumes a certain amount of all inputs and utility out of consumption increases with the amount of varieties being consumed. In the two-region setting, this also implies that individuals consume goods from both regions.
- *Transport costs* are utilized in order to introduce space in the models. The export of goods and services from one country or region to another involves time, effort, and hence costs. Goods have to be physically loaded and unloaded, transported by truck, train, ship, or plane, packed, insured, traded, etc. before they reach their destination. There they have to be unpacked, checked, assembled, and displayed before they can be sold to the consumer or an intermediate firm. A distribution and maintenance network has to be established, and the exporter will have to familiarize himself/herself with the (legal) rules and procedures in another country, usually in another language and embedded in a different culture. As indicated, transport costs arise as a consequence of both physical distance, which may be hampered or alleviated by geographical phenomena such as mountain ranges or easy access to good waterways, or political, cultural, and social distance, which also requires time and effort in order to successfully engage in international business. The presumption is that as transport costs rise it will become more difficult to trade goods and services between nations or regions. Within the utilized framework, transport costs among regions

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<sup>2</sup> See Dixit-Stiglitz (1977) for the seminal work on monopolistic competition. With respect to the production side, the Dixit-Stiglitz setting offers a way to deal with increasing returns at the level of an individual firm. The corresponding markets have a large number of firms, usually represented as a continuum, each of them producing a single good.

take a very special form: Manufacturing goods are subject to transport costs while shipment of agricultural goods, for simplicity, is assumed costless.

- *Factor mobility*: The geographical distribution of resources is assumed to be partly exogenous by immobile factors (or the so-called first nature geography) and partly endogenous thereby relying on mobile factors that are not nailed down to a certain location. Each region has at its disposal mobile and immobile inputs, e.g. capital, firms and labor. While immobile inputs do not migrate from one location to another per definition, mobile inputs move to the region where they effectuate the highest productivity and therefore the highest real income. As a consequence, the regional distribution of economic activity might change when labour migrates and/or when firms relocate. Note that the behaviour of firms and workers might reinforce each other, thereby inducing a self-reinforcing process of agglomeration.

Now recall that the entire workforce includes mobile workers in the manufacturing sector and immobile workers in the agricultural sector. Agricultural workers have the same wage rate in all regions because of the free transport of agricultural goods and because these goods are produced with constant returns. In contrast, wages of manufacturing workers may differ both in nominal and in real terms, between the locations, thereby including the regional price index. Mobile workers move to the region offering the higher real wage. Regional real wages, however, depend upon the distribution of manufacturing in the following sense:<sup>3</sup> Aggregate income of a region is the sum of all manufacturing and agricultural workers' wage incomes. If a location becomes larger and hence able to offer more varieties, the price index falls as a consequence of increased competition and since consumers value variety. The corresponding *price index-effect* makes the larger region more attractive due to the following effects:

- (i) Since a higher variety of goods is now produced within the region a smaller share of manufactures has to be imported and overall transport costs decline for people living in the larger region.
- (ii) Additionally, real wages are higher in bigger regions that perform under a lower price index as a consequence of the larger number of the region's varieties and the resulting downward pressure on prices. Or put differently, the cost of attaining a certain level of utility decreases.

These effects give rise to a process described as *cumulative causation*, which can be understood in the following way: Concentrating production of manufactures in the larger market makes it possible to benefit from scale economies, and at the same time to economize on transport

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<sup>3</sup> An *equilibrium* is given by the simultaneous solution of those equations determining the income of each region, the price index for manufactures consumed in that region, the wage rate of the workers in that region, and the real wage rate in that region.



costs. This increases the real wage of manufacturing workers in the larger market, which makes this region the most attractive place to live. Because activities are attracted towards the preferred location, labour has now an incentive to migrate towards it, increasing its attractiveness even further. Eventually, a disproportionately large share of activity ends up there and the corresponding region becomes the core of the economy. As long as perfect factor mobility is assumed, the combination of economies of scale and transport costs is responsible for the clustering of all footloose activity in a single location. This region then functions as the core in which all manufactures are produced, while the periphery's role is reduced to the home for immobile agricultural labour which has to import all the needed manufactures from the core. Consequently, the location with the larger home market has now a more than proportionally larger manufacturing sector and therefore also exports manufactured goods. This phenomenon, which crucially depends upon the existence of transport costs, is known as the *home market-effect*.

### 3.2 The impact of (changing) transport costs on the core-periphery pattern

Suppose that the initial situation is characterized by all manufacturing concentrated in one region, say the North. To determine whether this is an equilibrium, we ask whether a small group of workers moving from the North to the South would receive a higher real wage than the workers left behind, since only then they have an incentive to leave the North. If so, a core-periphery geography is *not* an equilibrium; that means that concentration in the North will shrink in the course of time due to emigration, and manufacturing will shift to the peripheral South, which will thereby become a growing agglomeration. If on the contrary the real wage in the South is smaller than the one in the North, there is no incentive for workers to migrate to the South. Hence concentration of manufacturing will be self-sustaining, agglomeration forces are dominating, and the existing core-periphery pattern *is* an equilibrium.

To conclude: A core-periphery structure is sustainable if manufacturing workers will not move out of the North. In short, to analyze whether or not a core-periphery pattern is sustainable, one might start with considering a situation in which the entire manufacturing is concentrated in one single region and then compare real wage levels in both regions. As long as real wages are higher in the North than those in the South, the existing core-periphery pattern is sustainable because manufacturing workers will not emigrate from the North.

Given low transport costs, the overall income in the North exceeds income in the South. Since all mobile workers immigrate to the North, this region has all the income generated by the manufacturing sector. Additionally, the price index in the South is higher since people there have to import all the manufactures they wish to consume. These two facts support the persistence of the existing core-periphery structure. But imagine what happens if starting from initially low transport costs the latter increase? Several interacting effects have to be taken into account:

- (i) Given that the core in the North does not have to import manufactures, the South is relatively more expensive, and therefore unattractive, as a place for manufacturing workers to locate. The reason for that is the high *costs of living* in the South.
- (ii) If a firm decides to settle in the South, it would incur a transport cost disadvantage in the following sense: The higher the level of transport costs the more expensive, and hence the less attractive manufactures from the South are for consumers living in the North (*transport cost disadvantage*).
- (iii) Conversely it follows that the income level in the South becomes more important to firms in the South, since they may sell their products in the domestic market without having to bear any transport costs. If transport costs rise, goods manufactured in the North become more expensive exports and demand for them decreases, while demand for domestic goods increases. In the end, this leads to a shift of demand from the North to the South.

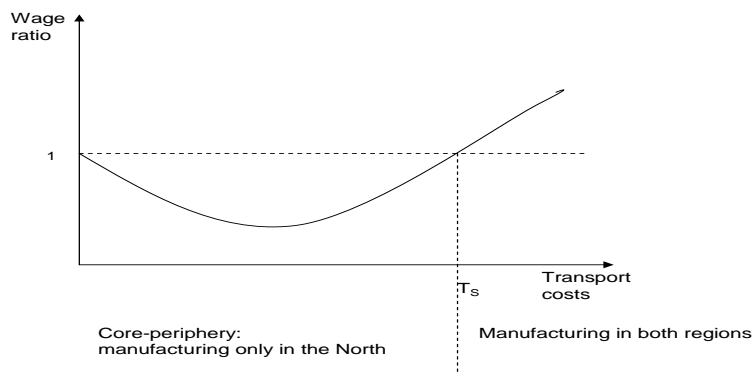
Effects (i) and (ii) work in favour of locations in the North while effect (iii) favours the South. Whether or not it is worth for a firm to relocate from the North to the South depends upon the interaction of these forces and upon which of them dominates.

Now consider the sustainability of a prevailing core-periphery-structure and the role of increasing transport costs in this context. Manufacturing workers migrate to the region displaying the highest real wage. If no transport costs arise, location does not matter and all mobile factors migrate to the location with the highest productivity as determined by the production structure. If starting from zero transport costs, we consider a small increase of them; the prevailing agglomeration structure is still sustainable as long as the South is unattractive due to the high cost of living (see argument (i) mentioned above). Now suppose a slight increase of transport costs.<sup>4</sup> Then firstly the real wage in the South, is still smaller than the one in the North and the disadvantages of the South as discussed in the context of (i) and (ii) still dominate. As a consequence, the initial core-periphery structure remains stable. But after having passed a certain level of transport costs, the third argument becomes relevant: Then it becomes increasingly hard for firms from the North to sell their products in the South, which is the immediate consequence of the increased transport costs. The initially existing production advantages fade away thereby increasing the price index in the North, while at the same time the price index in the South decreases. This effect is enhanced by further increases in transport costs, until finally it becomes so strong that the so far prevailing core-periphery-structure is broken. This situation arises when the wage ratio between South and North exceeds unity and workers migrate from the North to the South.

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<sup>4</sup> Formally, then two cases have to be considered. In this text we only discuss the interesting case in which the so-called no-black-hole condition is fulfilled. This condition requires some parameter constellations to hold in order to guarantee that agglomeration forces are not so strong that a core-periphery-structure is, independent of the level of transport costs, always an equilibrium. See e.g. Fujita et al. (2001) for a discussion of details.

Figure 5: Wage ratio as function of transport costs



Source: HWWI

The corresponding level of transportation costs is denoted by  $T_s$  in Figure 5. The level of transport costs is depicted at the horizontal axis, while the vertical axis reflects the ratio between real wages in the South and the North. Given the identical levels of both wage rates, their ratio equals unity as depicted by the dotted line. The function, as a result, illustrates how the wage ratio is affected by changes in transport costs. Whenever the graph lies below unity, real wages in the North exceed those in the South and the prevailing core-periphery-structure remains a stable outcome for the workers' location decision. However, this is the case only for low levels of transport costs. As the latter increase, the existing structure is initially even strengthened (as a consequence of effects (i) and (ii) as discussed before), then it declines, until finally effect (iii) dominates. This is the case if a certain threshold level of transport costs, denoted by  $T_s$  in Figure 5, is reached. Then, the initially stable core-periphery structure is broken and manufacturing takes place in both locations. The concrete distribution of manufactures (e.g. equal distribution) depends upon the structural parameters of the economies.

Note that with complete agglomeration, i.e., given that all manufactures are produced in a single region, trade between regions will be of the inter-industry type (e.g. food for manufactures). If in contrast the manufacturing industry is located in both regions, trade will also be of intra-industry type due to love-for-variety preferences. Besides trading manufactured goods for agricultural products, different varieties of the differentiated manufactured products will be traded between both regions.

## 4. Trade, trade costs and the decisive role of transport costs: Historical facts

Since 1950 real world trade has grown at an annual rate of 6.2%. This remarkable increase in trade was influenced by a variety of factors. One of these driving factors was the fact that world GDP grew by 3.8% year (WTO 2008). Furthermore, the boost in the international exchange of goods and services was facilitated by tremendous cuts of trade costs. This was possible because technological progress in the logistics and transportation sector as well as major trade liberalizations were achieved. The decline in trade costs allowed all countries involved to realize welfare- increasing gains from trade and also fostered GDP growth, mainly in developing countries. As a consequence, during the globalization process a large number of industries have moved from developed countries to developing countries in Asia, Eastern Europe, or South America.

Most of international trade is merchandise trade. In 2007 merchandise trade accounted for about 13 833 billion US-Dollars or roughly 81% of overall world trade (UNCTAD 2008). The share of commercial services in world trade has remained relatively constant at 20% for more than 25 years.

Despite the historic decline in trade costs, in many countries current trade costs are still substantially high. Typically they include various types of costs, namely transport costs, border costs, and retail- and wholesale costs. *Transport costs* mainly consist of freight costs and the time value of goods in transit, while *border costs* include costs of exchange rates, language, policy (tariffs and non-tariff trade barriers), information, and security. Anderson and van Wincoop (2004) report that for a representative industrialized country trade costs amount to an *ad valorem* tax equivalent of 170%, where transport costs account for 21%, border-related costs account for 44%, and retail and wholesale costs account for 55%.<sup>5</sup> If we abstract trade costs from sales costs, which occur either in international or in national trade, and focus solely on international costs of trade we are still confronted with a trade barrier equivalent to an *ad valorem* tax of 74%.

### 4.1. Transport costs

The importance of improvements in infrastructure and of better transport technologies for deeper national and international economic integration is evident. Numerous examples show trade expansionary effects of investments in infrastructure and the developments of new carriers. For instance, the World Bank reports that the construction of the Erie canal in the 19<sup>th</sup> century reduced the transport costs between Buffalo and New York City by 85%. Furthermore, technical innovations like the steamboat facilitated intensified trade between the United States and Europe in the pre-World War I era, a period that is now considered as the first wave

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<sup>5</sup> Calculation:  $1,21 * 1,44 * 1,55 - 1 = 1,7 = 170\%$ .

of globalization. As a consequence, prices for major bulks like wheat or iron in US and European markets as well as within Europe converged considerably. Larger freight ships, the invention of the container and new innovative logistic concepts enabled the second wave of globalization. While cost reductions during the first wave of globalization allowed for more inter-industry trade, further technical progress in the transportation sector enabled an increase of intra-industry trade, i.e. the exchange of more or less similar goods, during the second wave of globalization (World Bank 2009).

While infrastructure like roads, tracks, and airports can be produced and hence modified by human beings, there are also exogenously given and unchangeable geographical conditions that can be an important obstacle for trade. For instance, in intercontinental trade the ship is by far the cheapest and therefore most important mode of international transport. As a consequence, sea transports measured in tons amount to more than 70% of extra-EU trade (Eurostat 2008). In a globalizing world access to the sea, either direct access or by inland waterways, is an important prerequisite for taking full advantage of intensified international economic integration.

Cost minimizing companies will try to utilize the cheapest mode of transport. Here the key determinant is the distance to the relevant markets. In the last decades, the workhorse of European transports has been road transports. Table 1 depicts the European modal split based on *transport performance in tonne-kilometres*. In 2005 road transports dominated with a modal share of 44.2% followed by sea freight, which accounted for roughly 40% of the transports. If we measure transport performance in tonnes, it becomes apparent that most of European transports rely on road transports. The almost identical share of sea transports arises, because ships are the cheapest and, hence, the dominant mode of transport for long distances. For the remaining modal share of about 15%, railway transport was the most important with an overall share of 10%.

Tab 1: Modal split (tonne-kilometres) in the EU in %

	Road	Rail	Inland Waterway	Pipeline	Sea	Air
1995	42.1	12.1	4.0	3.6	38.2	0.1
2000	43.0	10.8	3.8	3.4	38.8	0.1
2005	44.2	10.0	3.3	3.4	39.1	0.1

Source: EU Energy and Transport Figures

4.2 Border Costs

Since World War II, there have been continuous efforts on the multilateral level to tear down trade barriers and to liberalize international trade. Remarkable improvements were achieved in lowering international tariff rates. Over the course of many negotiations under the General

Agreement on Tariffs and Trade (GATT), the tariff for industrial commodities was abated from an average of 50% to less than 5% (Grossmann et al 2006). In the mid 90s the GATT Uruguay Round resulted in an overhaul of international trade regulations and ended the special status of agricultural commodities, fibres, and textiles, which are now subject to trade negotiations and agreements controlled by the newly founded World Trade Organization (WTO). Furthermore, the common use of non-tariff trade barriers, the improper use of subsidies, anti-dumping policies and retaliatory tariffs were restricted and the scope of world trade regulations was expanded by the General Agreement on Trade and Services (GATS) and the agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

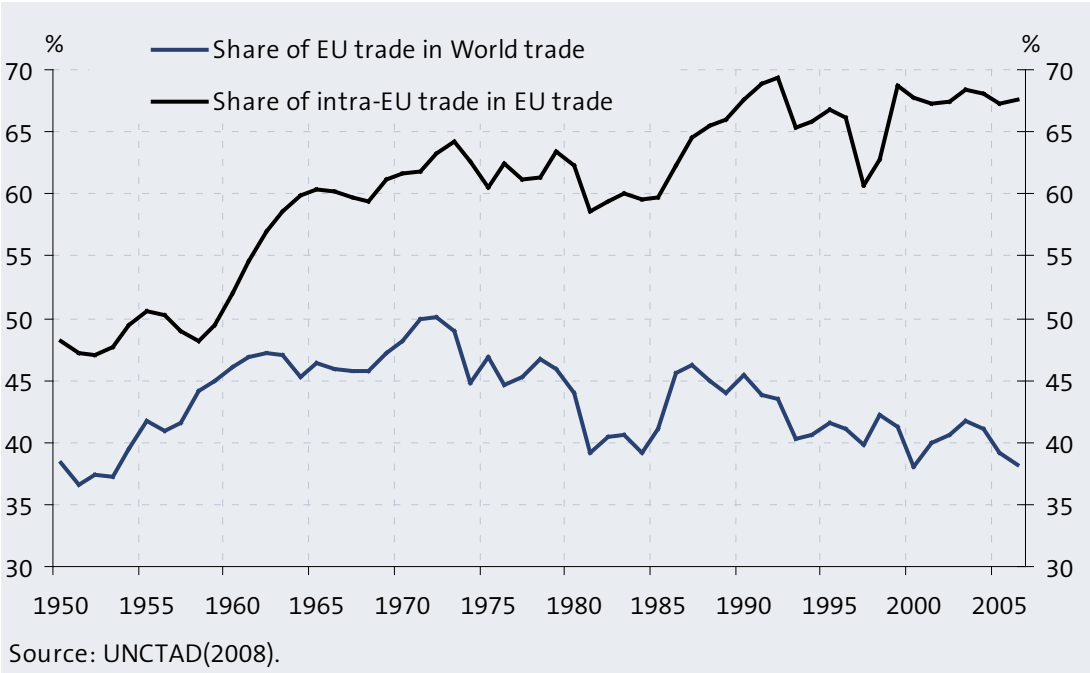
Apart from multilateral trade agreements, a large number of preferential trade agreements (PTA) have shaped the landscape of international trade. PTAs are trade agreements between selected trading partners. One of the most prominent examples is the European Union. In general, there are two possible economic effects of PTAs. The first effect is the trade creation effect and the second is the trade diversion effect. *Trade creation* means that expensive imports from a trade partner are replaced by cheaper third country imports. On the contrary, *trade diversion* means that cheaper third country imports are replaced by more expensive trade partner imports. All in all, the trade-creating effects of PTAs are considered to dominate. After the repeated failure of the WTO Doha Round PTAs are likely to gain further importance (see Koopmann and Vogel (2008)). As a consequence, it can be expected that tariffs for extra-EU will decline in the future, though at a slower pace.

At the the European Union level, policy barriers like tariffs hardly exist any more. Ongoing harmonisations of European quality standards, regulations and legislations have also reduced non-tariff barriers to trade remarkably. Furthermore, exchange rate risks within the EU were reduced substantially by the European Monetary System and the establishment of the Euro-zone in 1999.

## 5. The importance of intra-EU trade

In 2006 EU(27) trade amounted to 38% of world trade. The rapid increase in world trade observed in the last decades was accompanied by a substantial increase in both extra-EU and intra-EU trade. Here extra-EU trade is defined as the trade between the EU and the rest of the world. Figure 6 depicts that over time intra-EU trade has increasingly gained importance. In 1957, the year the treaty of Rome was signed, the share of intra-EU trade in overall EU trade was below 50% (UNCTAD 2008). Falling trade costs in the second half of the 20<sup>th</sup> century, due to technological progress in the transport sector, the single market program, and the fall of the iron curtain fostered both inter-industry and intra-industry trade growth within in the EU (World Bank 2009). As a consequence, the share of intra-EU trade in overall EU trade 2006 was more than two thirds and intra-EU trade accounted for more than 25% of world trade.

Figure 6: EU trade (in US-Dollars)



The European transportation grid has proven to be highly capable. Apart from 25% of world trade also national transports were handled in 2006. Though there is still a need for further investments in road and railway networks, especially in Eastern Europe, it can be expected that for the EU as a whole the cost-reducing effect of infrastructure investments on trade costs will be quite modest. Furthermore, the almost complete liberalization of European freight markets already ensures high competition (see Woodburn et al 2008), so that one can only expect little benefits, if any, from further liberalizations. However, in competitive markets, prices equal marginal costs. From that we can conclude that any cost changes will be handed over to customers. Therefore, trade costs within the EU will be directly influenced by changes in energy costs, technical progress in the transportation sector or by changes in security costs.

### 6. Future trade costs in the EU: Energy prices, time costs and technical progress

The transportation sector is a primary energy consumer. More than 30% of EU total final energy and almost 60% of total oil product deliveries to final consumers in 2005 were consumed in the transport sector. More explicitly road transports – the dominating mode of intra-EU transport – consumed 82% of total energy in the transport sector (Capros et al 2008). As a consequence the development of energy costs will have a large impact on transport costs.

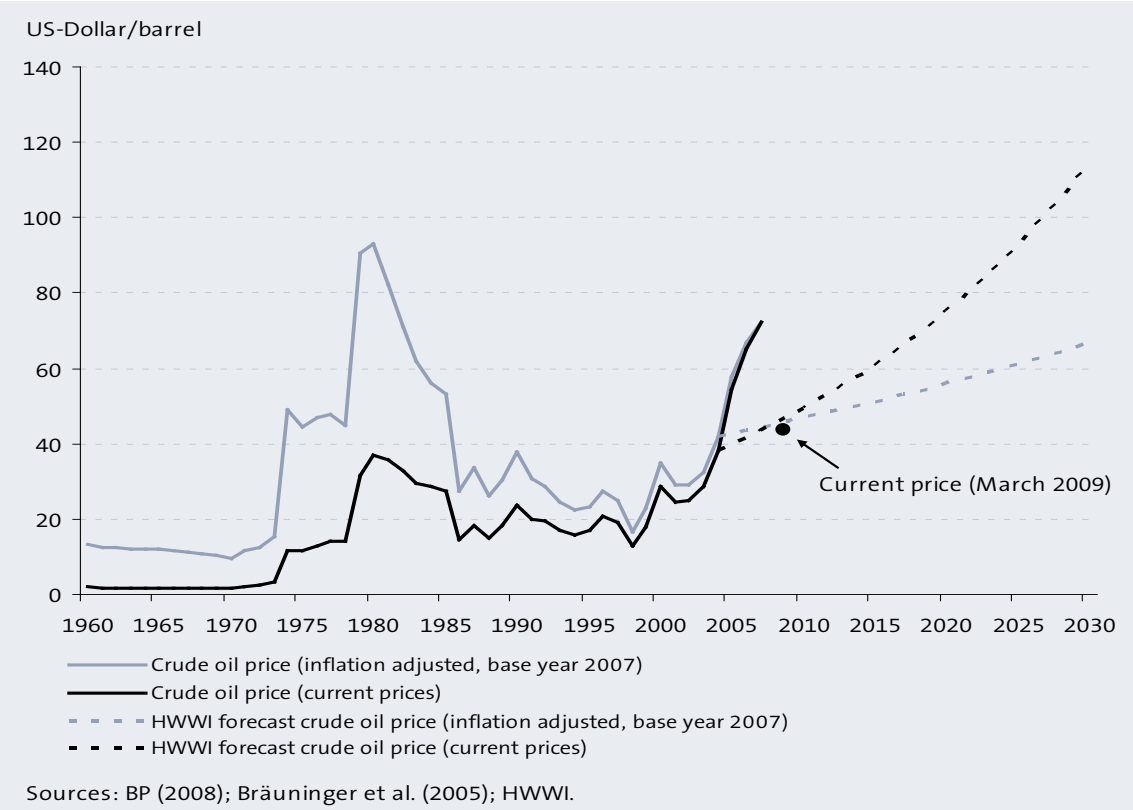
Though market imperfections and economic policies both influence energy prices in the short- and medium-run, in the long-run supply and demand forces govern the long-run trend of

energy prices. In the transport sector the most important energy resource today and also in the next decades is crude oil. Alternative energy resources and new technologies like bio fuels, hydrogen fuel cells or electricity will gain importance, but currently these technologies are at an early stage and in the foreseeable future will only be of limited importance for the transportation sector.

In the long run, the supply of oil depends mainly upon the exploration of new sources. Apart from that, other sources like oil sands or coal-to-liquid will increase oil supply once they become profitable due to a sustained increase in oil prices. On the demand side, two major factors are relevant. On the one hand world economic growth – especially catch-up processes in developing countries like China and India – will increase the demand for oil in the future. On the other hand technical progress will lead to a reduction in the oil intensity of production thereby mitigating the effect of economic growth on demand.

Figure 7 shows historic oil prices and the HWWI forecast of future oil prices in real terms that we will use for this study as well as for future studies. The projection is based on the assumption that annual real world GDP growth till 2030 will be 2,8% and demand for oil will increase annually by 1,7%<sup>6</sup>. As a result, the annual growth rate of the inflation adjusted oil price will be 1,8%.

Figure 7: Historic crude oil prices and HWWI forecast



<sup>6</sup> For a more detailed description of the forecast see Bräuninger et al. (2005).



While time and energy costs are very likely to rise in the future, one factor that will continue to reduce transport costs is technological progress in the logistics and shipping sector. For instance, an inspection of the data shows that for many modes of transport the oil intensity per unit of output declined steadily in the past. Higher energy efficiency of engines allowed the construction of more frugal vehicles or, like in maritime transport, the construction of larger ships that reduced the fuel costs per freight unit. A projection of future trends of energy intensity in the transport sector published by the European Commission (Capros et al. 2007) holds the view that energy intensity of transports will decline until 2030 at an annual rate of 1.14%. Moreover, it can be expected that further progress in computer and communication technologies will allow transportation firms to respond more effectively to congestions and bottlenecks in the transportation system, thereby saving time and energy (see Woodburn et al. 2008).

However, given the projected price increase in oil of 1.8% and oil intensity gains of 1.14% per year we expect that energy costs per tonne will rise in the next two decades. The expected increase in transport costs per tonne is attenuated by the fact that due to technological and economic progress it also can be expected that the value of goods (value per tonne) shipped between different locations will also rise.

Overall, the increase in energy prices will increase production costs for transport companies. Depending on the mode of transport, companies may develop different strategies in response to the soaring energy prices. For instance, the shipping sector usually responds to higher energy prices by lowering the speed of vessels. An increase in speed requires a disproportionate large increase in power, which therefore raises fuel costs disproportionately, too. Hence, by lowering speed transport companies can reduce the need for fuel disproportionately, which dampens the increase in costs. However, as noted above, transport costs also contain time costs. Lowering speed leads to longer transit times such that time costs of transportation go up, so there is a trade-off between fuel costs and time costs. The expected increase in the value of goods traded will raise the importance of time costs of transports in the future. Furthermore, another cost-increasing factor could be a growing need for more security of freight transports.

This analysis of the impact of trade costs on European regions assumes that the increase in oil prices and time costs will have a greater impact on trade costs than cost-reducing technical progress. Hence, the overall effect on trade costs will be positive.

## 7. Conclusions

As argued before, the theory of economic geography explains the core-periphery structure and its sustainability as the result of interplay between agglomeration and dispersion forces. While economies of scale and increasing demand make it favourable to concentrate production in one location, increasing trade costs like transport or border costs, work in the opposite direction and support local and hence more disperse production patterns.

The decline of trade costs observed during the last 60 years has weakened dispersion forces all over the world as well as in Europe, thereby fostering regional concentration of production. In Europe, as a consequence of intensified intra-EU trade, agglomerated regions and especially cities benefitted from this development and their population figures grew faster than those of rural areas. At the same time the rapid growth of world and extra-EU trade has strengthened the role of seaborne trade and has therefore helped coastal regions to attract export oriented industrial activities and with this workers in the manufacturing sector.

Due to the argumentation carried out before, we assume that trade costs in Europe will increase moderately during the following decades. This basically increases regional prices for those products that have to be imported, thereby inducing an incentive for firms to decentralize production.

However, whether an increase in trade costs will amplify dispersion forces enough to induce a break in the core-periphery pattern depends on the technology of industries and on product specific trade costs. Consequently, based on their different economic structure, European regions will be affected differently and in order to assess the prospects for a particular region one has to consider the regional economic structure in greater detail.

In general, the dispersion effect is stronger the more production conditions are characterized by perfect competition, the more important local demand is compared to world wide demand and the higher transport costs are. If the world market is relevant, firms might also react to increases in transport costs by moving production closer to foreign markets. The first strategy is to relocate or to set up new production plants close to coastal areas. Since hinterland transport is much more expensive than transport by ships, this relocation might reduce overall transport costs. A second strategy, given that the increase in transport costs is high compared to the efficiency gains of production in one location, is to establish new small production plants in foreign markets (foreign direct investment).

If production conditions are characterized by strong increasing returns to scale the relationship between proximity and productivity probably becomes the dominating force. Then concentration arises even in case of relatively high transport costs and in order to break the concentration forces transport costs have to increase by a significant amount. However, strong increasing returns to scale arise mainly in knowledge based industries. At the same time, a growing number of these activities are characterized by very low transport cost. The reason for this is an increase in digitization as well as the ongoing spread of the Internet and of related reorganizations of working processes. For instance, due to increasing returns to scale (network effects) and decreasing transport and telecommunication costs financial centres like Frankfurt/Main are very likely to attract more and more financial services and to successfully establish online-trading platforms, while financial sub-centres in other cities are likely to lose these activities. The same argument holds for all kinds of knowledge- intensive or creative

activities like engineering, programming, or research, where transport costs play a rather minor role and network effects dominate.

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