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Labour migration in Europe and the New Economic Geography

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Abstract: This paper addresses consequences of increased labour migration in Europe due to productivity effects in a core-periphery model. Traditional trade and growth models predict an overall beneficial impact of the accession of the current candidate states to the European Union. However, models incorporating imperfect competition warn that peripheral countries may realise only a small portion of this beneficial impact of the accession. In this paper we go a step further: On the domestic level the countries accession may have negative effects while on the national level the effect will be positive. An empirical indication that benefits of accession may be low is the marginal benefits during the early phases of EU membership for Greece and Ireland and the Neue Länder of Germany.

The following main questions are addressed in this paper. What is the consequence of increased migration within the European Union due to deregulation in the context of the creation of a common market, and what will be the consequence of the extension of the European union with central and eastern European countries?

1 Introduction

This paper addresses consequences of increased labour migration in Europe due to productivity effects in a core-periphery model. Traditional trade and growth models predict an overall beneficial impact of the accession of the current candidate states to the European Union. However, models incorporating imperfect competition warn that peripheral countries may realise only a small portion of this beneficial impact of the accession. In this paper we go a step further: On the domestic level the countries accession may have negative effects while on the national level the effect will be positive. An empirical indication that benefits of accession may be low is the marginal benefits during the early phases of EU membership for Greece and Ireland and the Neue Länder of Germany.

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1.1 Methodology

An integrated model for demand and supply at regional labour markets is used where special attention is paid to the role of institutional changes and accessibility. The model is based on the group of Spatial Applied

¹ We would like to thank J. van Ommeren, J. Oosterhaven, and P. Rietveld for fruitful discussions about monopolistic competition on the labour market. Correspondence to The Netherlands Institute for Spatial Research (RPB), PO Box 30314, 2500 GH The Hague, The Netherlands, e-mail: thissen@rpb.nl.

General Equilibrium Models (SAGE). The main structure of SAGE models is well explained in the literature (cf. Fujita, Krugman and Venables, 1999).

The central innovation presented in this paper is the introduction of monopolistic competition on the labour market in a SAGE model with endogenous commuting and migration behaviour. Monopolistic competition on the labour market exists because every labourer is assumed to have unique qualities and is therefore an imperfect substitute for other labourers. The degree of substitutability may differ among different groups of labourers and is determined by an elasticity of substitution. High-educated people, opposite to people with lower education, can be expected to have a low substitution elasticity. In case of a high substitution elasticity the market becomes comparable to perfect competition. The analyses presented here can deal with both high substitution elasticity (perfect competition) and low substitution elasticity (monopolistic competition).

The productivity of firms depends partly on the quality of labour. In other words, a labourer who is better fitted to do the job increases the overall productivity of the firm. Therefore, agglomeration effects exist on the labour market. A larger pool of potential labourers will increase the productivity of a firm because it may use a more roundabout production process. This more roundabout production process is defined as a better mix of labour-inputs due to increased variety. The more roundabout production process is brought about by a higher variety of labourers due to a larger labour pool. An increase in the variety of labourers will increase the productivity of the firm by a qualitative better potential match of supplied labour and the firm's labour demand. Naturally, this available pool of labourers depends on migration and commuting behaviour.

The analysis provides an explanation for regional differences in labour productivity.² This adds to existing explanations based on failures in product, capital and housing markets by introducing spatially imperfect competitive labour markets. This imperfection not only exists because it is costly to commute, but also because of productivity effects of the spatial dispersion of labour. It extends therefore the analyses as presented in Harrigan (1992) by an integrated microeconomic theoretical foundation of spatial rigidities on the labour market.

1.2 The European Union

Deregulation of migration changes the number of labourers living in the firm's neighbourhood. Due to increased migration and commuting in the EU, the productivity of firms changes because employers can search for better fitting workers in a larger labour pool in a geographical area (due to immigration) or within a larger geographical area (due to increased commuting). These changes in commuting are partly affected by new infrastructure connecting EU member states. This improvement of the transport infrastructure increases the size of the labour pool by enlarging the geographical area where the firm searches for labour.

Institutional barriers such as borders also affect the available labour pool of the firm and thereby the productivity of the firm. In Europe these institutional barriers are about to change dramatically due to the accession of new member states in the EU. Changes in these institutional barriers in Europe have both productivity and welfare effects on the labour market. The central question is whether the net welfare effects will be positive or negative.

2 The Model

² This can easily be extended to a theoretical framework explaining regional and national unemployment using Pissarides (1999) search theory.

In this paper we explore the developments on local labour markets in a spatial applied general equilibrium model. Existing partial modelling and survey approaches towards evaluating the impacts of investments in transport infrastructure, and in industrial, office and housing sites, need to be integrated with firms' location decisions as follows from economic geography. All institutional changes mentioned have spatially differentiated impacts on the functioning of transport, production, housing and labour markets, with strong mutual interactions.

It is assumed that the labour market is characterised by monopolistic competition with economies of scale with respect to increased varieties of labourers in the production process. Moreover, it is assumed that each individual supplies a unique labour input. The productivity effects of increased variety of labourers imply that diversity of labour allows producers to use a more 'roundabout' production process and lower unit costs at given input prices. From a regional perspective it implies that the productivity of production increases if an industry has better access to different labour markets.

Spatial applied general equilibrium modelling is still a largely uncharted area of scientific research. In the domain of theory, the use of SAGE models is already a recent development, while small operational empirical SAGE models are around for only a few years. The modelling of imperfect factor markets in the context of SAGE models is an extremely fruitful contribution. In this respect it is surprising that although consumer product variety (Krugman, 1991), intermediate goods variety (Venables, 1996) and capital goods variety (Ethier, 1982) has been thoroughly analysed while no attention has been paid to imperfect competition on the labour market due to labour variety. The modelling of monopolistic competition on labour markets, as presented in this paper, with internal economies of scale in the context of a SAGE is entirely new.

In this section we only give a verbal explanation of the model. We refer to Appendix A for a formal discussion of the model focussing on the labour market. A general discussion of models in the tradition of the New Economic Geography can be found in Baldwin et al (2003), and an application of a full-fledged applied Spatial CGE model with monopolistic competition and vertical linkages can be found in Thissen (2004).

2.1 Labour market

Adequate modelling of the labour market should take both commuting and migration into account simultaneously. Given the substantial imbalances at regional labour markets, commuting is indispensable to achieve equilibrium between demand and supply. Since the quality and prices of the various transport modes are important determinants of commuting flows, transport systems will have strong impacts on labour markets. In the long run, migration has also an effect on the regional supply of labour and thereby on the commuting flows between regions.

Commuting is mainly affected by transportation costs and wage differentials. The main factors determining migration are the relative gain in earnings (wage rate) from moving to another region given moving costs. Other important factors are the preference of labourers to live in a certain type of area, and institutional factors such as immigration laws. Cultural barriers such as languages and preferences regarding living environment influence the choice of the labourer's residence via the fixed moving costs.

Central to the presented analyses is the potential for improving the match between supply and demand of labour via increased commuting possibilities when transport infrastructure improves or institutions change. This may lead to an increase in the productivity of workers since employers can search for better fitting workers in a larger geographical area. Changes in preferences and institutional changes may also improve productivity of workers in a geographical area because emigration and immigration will lead to a change in

the size of the available pool of labourers. Of course, the increase in productivity in one region goes at the expense of the productivity growth in other regions. The main question is whether the net effect will be positive or negative.

2.1.1 Production and the demand for Labour

On the aggregate level production may be modelled using a standard formulation with constant returns to scale. Subsequently, in a second step, labour demand is based on economies of scale in the labour force. This is based on the basic Ethier (1982) insight applied to the labour market, where a larger available labour pool will lead to increased productivity due to a more roundabout production process.

It is assumed that the labour market is characterised by monopolistic competition and works on a regional level. Thus, all labour is assumed to be unique and a larger amount of variety in the labour force induces economies of scale. These productivity effects of increased variety of labourers incorporated in a Dixit-Stiglitz (1977) 'love of variety' production function implies that diversity of labour gives producers the opportunity to use a more 'roundabout' production process and lower unit costs at given input prices.³

The number of varieties in a region is determined endogenously in the model by migration, while the amount of labour per inhabitant is determined by institutions and assumed equal and constant for all regions.

2.1.2 Commuting and equilibrium on the labour market

Above we described the demand for labour. However, there is no mechanism that guarantees the equality of labour demanded and labour supplied in a region. While labour demand is mainly affected by the wage rate (see above), it is assumed that the labour supplied is affected by regional attractiveness. To attract more workers employers may increase the attractiveness of a region via increasing the wage rate until the increase in the wage rate reduces the demand for labour and an equilibrium is reached.

2.1.3 Long run effects: migration

Migration plays a special role in the new economic geography literature (Krugman, 1988). Free labour mobility normally leads to extreme agglomeration effects in the model. Therefore, constraints are set on the migration of labour to prevent extreme concentration of production and labour. A model with commuting behaviour but without migration behaviour is only capable of addressing short run issues. To adequately analyse long run effects on labour and product markets we have to extend the model with migration.

In this paper it is shown how labour migration may be modelled in a theoretically sound way. The fundamental behaviour behind migration is based on wage differentials between regions, the availability of houses in different regions and the preference for spacious houses and neighbourhoods.

We have assumed that on the labour market all labourers are unique. The uniqueness of the different labourers, the extent to which they are different, is determined by the substitution elasticity between labourers. Based on this difference there is a regional-specific demand for labour. This implies however, that the suppliers of labour have some monopoly power given that they are aware of their uniqueness. Therefore, we assume monopolistic competition on the labour market. In a market characterised by monopolistic competition exists wage setting behaviour of labourers. This wage setting behaviour combined with a no-profit condition determines migration behaviour in the model.

³ This is comparable to the love of variety effect of intermediate goods in the model of Venables (1996).

It is important to notice what the no-profit condition implies here. For as long as the gains of migration exceed the cost, labourers will migrate to other regions. In this sense there is free entry in every region. We assume that labourers have perfect knowledge about labour market conditions and there is equilibrium. The expected wage earned in a region is therefore equal to the average wage earned in that region.

This leaves us with the determination of the fixed costs in the no-profit condition. It is clear that this fixed cost is related to the people's regional locational preference and the situation on the housing market. When people want to move somewhere the relative tension on the housing market, and thereby the housing prices, should be relatively low to make it worthwhile. Of course also the opposite reasoning holds. In general, the fixed migration costs should be low enough for people to move.

The fixed costs increase or decrease depending on the relative tension on the housing market and to what extent people like to migrate. In case there is no additional information about two regions except its size and the wage rate the following holds:

1. The dispersion of people is equal, given an equal wage rate between regions. If nothing is known about living preferences it can be expected that people are dispersed over the whole country.
2. In the case of the Netherlands it follows from research by the Dutch Ministry of Housing, Spatial Planning and the Environment (2000) that people prefer living space. Thus, given an equal wage rate in different regions, people prefer to move towards less densely populated areas. From this it follows that, *Ceteris Paribus*, people will keep moving until they are equally dispersed over the country and the population density is equal.

Additional research is needed to ascertain that it is allowed to extrapolate these results for living preferences in the Netherlands to the rest of Europe.

We assume that the housing markets behaves like a competitive market in the sense that additional houses can be built in certain regions and houses can be vacant in other regions and in equilibrium regional housing prices will be equal. We assume that the rationing on the housing market operates via a pricing mechanism. Given the demand for houses the prices are set. This will result in cheaper houses in regions with many vacant houses and expensive houses in regions where there is a relative high demand for housing.

2.2 Spatial general equilibrium

We have to model the rest of the macro-economy, consumption and equilibrium conditions to have a spatial CGE model. Total income is used for consumption since there is only one good and no investment. Finally the macro economic equilibrium conditions should hold. That is, total demand should equal total supply in the model. This should be the case for both the goods market as well as the labour market.

The model can easily be extended with more markets and actors like the government. This does however not add to the main argument of this paper and is therefore not discussed.

2.3 Extensions of the model

The model can be easily extended with endogenous unemployment and vacancies using Pissarides (2000) search behaviour.⁴ The search model extends the model with results on the labour market known from the literature. The model can also easily be extended with a love of variety by consumers (Dixit and Stiglitz, 1977) and productivity effects of intermediate goods Venables (1996) and investment goods Ethier (1982).

⁴ See van Ommeren and Rietveld (2001) for the technical details.

Because this model is focused on the working of the labour market rather than on the operation of product markets, we simply refer to the literature for an extension of the model in these directions

3 Results

First the main theoretical results obtained with the model will be described using graphical analysis. Subsequently it will be discussed how these results affect the development of the European Union and especially the extension of the European Union with new member states. Finally a smaller case study will be presented for a few Central Eastern European Countries (CEEC): Austria and its surrounding countries who all want to become a member of the European Union.

3.1 Model Results

The model results are all derived graphically based on the model described in the previous section. Three main cases are distinguished. The main questions that are answered and the subjects discussed can be summarised in the following way.

- i. Cross-border commuting. What happens if economic integration takes place and two countries abolish barriers associated with the border between two countries?
- ii. New infrastructure. The European Union tries to stimulate border regions to strengthen economic integration. One of the ways to strengthen regions is by improving the infrastructure. What is the consequence of this new infrastructure connecting two regions.
- iii. Migration. What are the consequences of the free movement of labour between member states of the European Union in general and especially in the context of the extension of the EU.

These three different effects that can be derived from the model are discussed in more detail in the following three subsections.

The graphical analysis presented in the Figures 1 to 3 uses the following symbols. There are two representative firms, which are depicted as factories. One of these firms is located in country A and the other firm is located in country B. These firms draw their labour from a labour pool. The size of this labour pool is determined by the amount of labourers living in the labour area of the firm. The small drawn figures represent a number of labourers living at that spot. The labour area of the firm is defined as the area in which potential labourers are still willing to commute to the firm. A circle around the firm depicts this labour area of the firm. The number of drawn figures in the circle represents the size of the labour pool. By defining the labour area of the firm as a circle it is implicitly assumed that the firm is located on a flat space where access from any point in this space to the firm is depends only on the geometrical distance to the firm. In other words we abstract from mountains, rivers and roads. The assumption of no roads is relaxed while discussing the effects of new infrastructure.

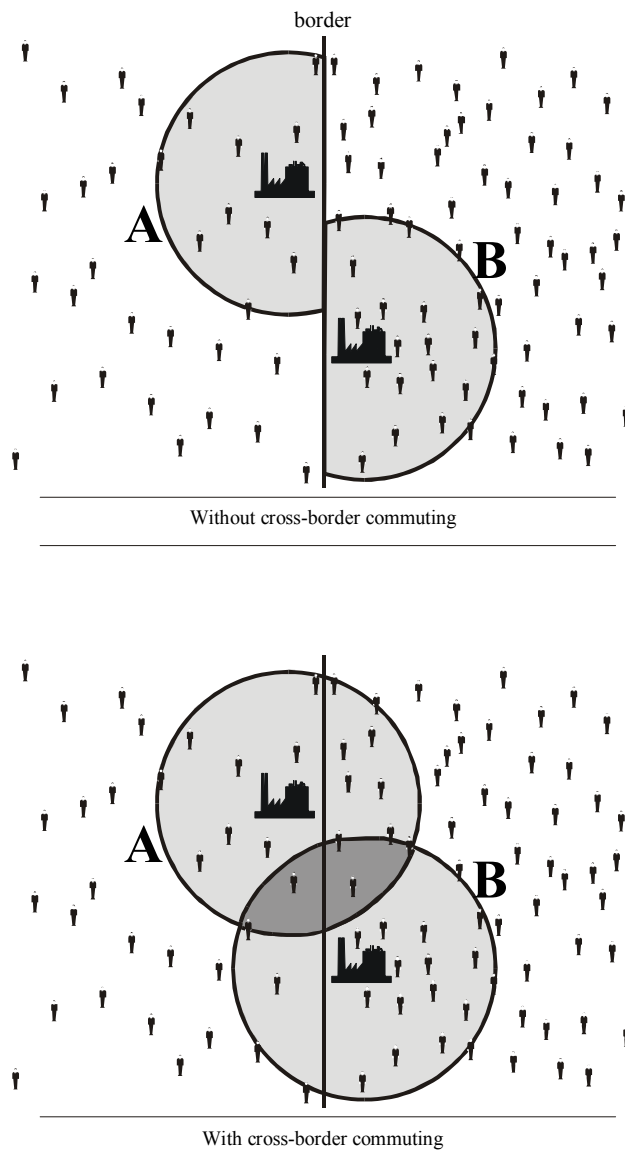
Country B is more densely populated than country A. The firm in country B can draw its labour from a larger labour pool and, all other things equal, has therefore a higher productivity.

3.1.1 Cross-border commuting

First we discuss the effects of reducing impediments to working in a neighbouring country. These effects are discussed using Figure 1. A way to reduce barriers to cross-border commuting is simply to relax the conditions for labourers to work in neighbouring countries. Thus, making it easy for them to get a working permit without having to give them a residence permit. Increased cross-border commuting will mainly have

effects on the border regions, although these effects may spread out to the rest of the country. One of the goals of the European Union is to create a common market with free cross-border commuting between the member states.

Figure 1: Cross-border commuting



In the top of Figure 1 the two firms are located close to the border in countries A and B, respectively. Their labour area is not a perfect circle. It has been cut off because of high impediments to cross-border commuting. At the bottom of the Figure the situation is depicted without cross-border impediments. The difference is that without impediments to cross-border commuting the labour area is again a perfect circle.

The first effect of reducing impediments to cross-border commuting is straightforward. The labour area of the firms becomes larger thereby increasing the size of the labour pool of both firms and increasing their productivity. This increase in productivity will also drive up wages.

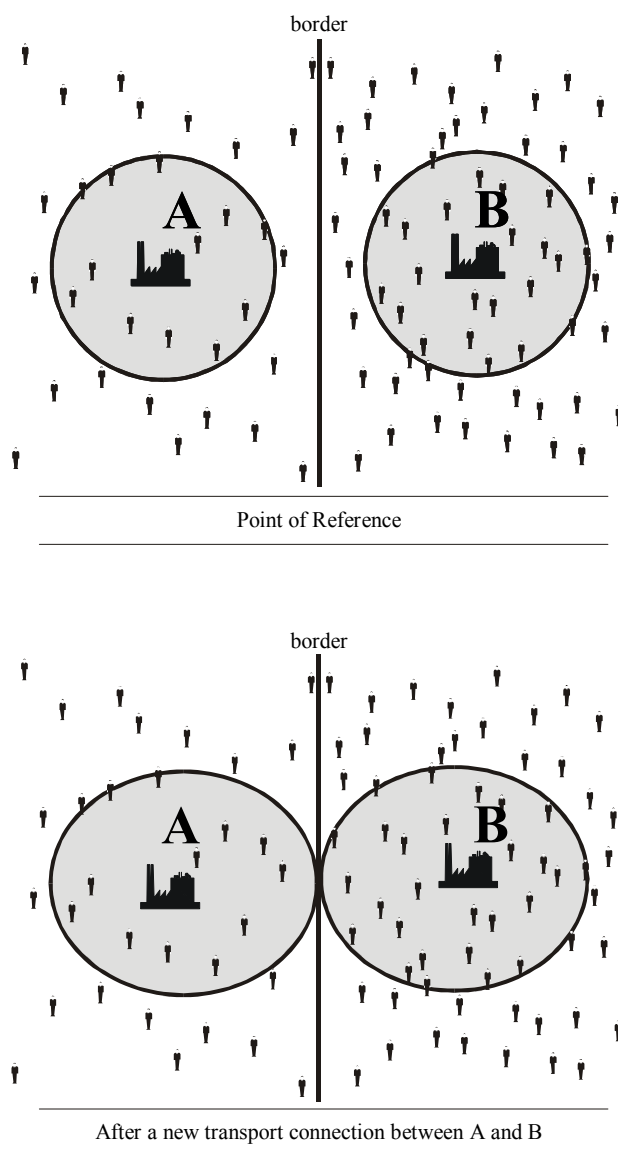
The second effect is that the firms start competing for labour in the area covered by both firms (the darker shaded area in the Figure). This will increase productivity and wages in the area because workers will work in the more productive firm (as it can offer a higher wage rate). Thus production in the high productive firm (the firm in Country B) will increase at the cost of the production in the low productive firm (the firm in Country A). The net effect will be an increase in overall production. Note that although the effects are Pareto optimal with respect to the national product of both countries, they are *not* Pareto optimal with respect to the

domestic product of both countries. Country B with the higher agglomeration and higher productivity of firms will gain at the cost of country A with less productive firms.

3.1.2 New infrastructure

The effect of new and improved infrastructure between two countries is graphically presented in Figure 2. The improved infrastructure increases and changes the shape of the labour area such that the size of the firm's labour pool increases. The consequence is that productivity of both firms increases, production increases, and wages go up. Thus, new infrastructure gives a Pareto optimal effect for both nationals and countries.

Figure 2: New infrastructure

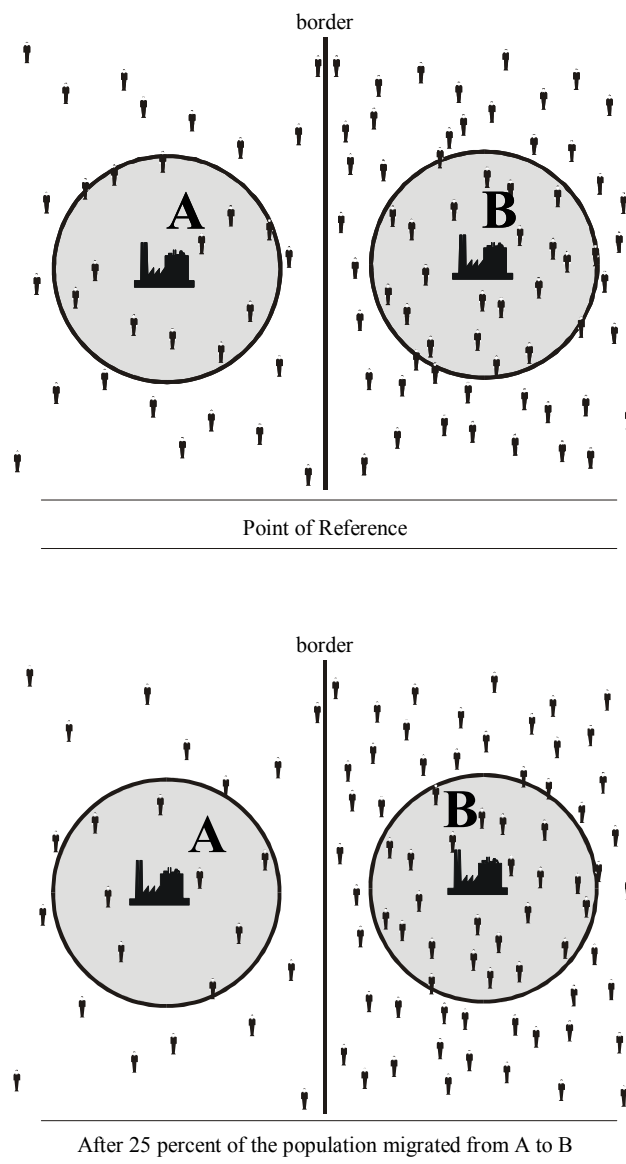


The new infrastructure is here supposed to be a straight road connecting both firms. Note that the effects can easily become mixed when cross-border commuting is allowed and the labour area extends over the border. The effects will be less strong if the labour area extends over the border and cross-border commuting is not allowed.

3.1.3 Migration

The last case to discuss is the result when we allow for migration between both countries. In this case we assume free mobility of labour, as is the intention in the European Union. In general, people will migrate from low wage areas to high wage areas. Migration will continue until the wage difference equals the migration costs. These migration costs are not only the financial costs involved with moving, but also non-financial costs such as cultural differences (language differences etc.) that have to be overcome.

Figure 3: Migration



In Figure 3 the firm in country A is less productive than the firm in country B. Therefore, some people will migrate from country A to country B. This will result in an increased size of the labour pool of the firm in country B at the cost of the labour pool of the firm in country A. In other words, productivity and wage differences increase. However, by migrating from A to B, the labour supply in country A reduces and the

wage rate is pushed up given the amount of capital. The new equilibrium is supposed to be reached after 25 percent has migrated from country A to country B.⁵

In the long run the utility of labour corrected for migration costs should be equal for labourers in all countries. This is the result of the spatial free entry condition. This implies that people keep migrating until the disutility of migrating (leaving its own culture and local advantages such as low housing prices) outweighs the gain in salary to be made in an other country.

Overcoming bureaucracy and rules prohibiting people from migrating may be seen as a specific form of the disutility of migration. The institutional changes in the EU that reduce these barriers to labour migration can therefore be interpreted as a reduction of the cost to migrate. A reduction of these costs will lead to higher welfare.

However, although all people gain from labour mobility, the free movement of labour is bad for country A and good for country B with respect to the domestic product of both countries. Thus, using normal statistics like a country's GDP, the outcome is not Pareto optimal with respect to countries.

3.1.4 Overall results

The overall results depend on the relative strength of the different effects and may differ for border regions. The results for the different cases are summarised in Table 1 with respect to their Pareto optimality. The overall results are clear-cut. People always gain from the free mobility of labour, although countries may lose. Countries with more agglomeration are expected to gain while countries with less agglomeration in the periphery will loose.

Tabel 1: Pareto optimality of the results for the three main cases

	Pareto optimal	Non- Pareto optimal
cross-border migration	national product	domestic product
new infrastructure	always	always
migration	nationals	domestic product

3.2 The European Union

The present situation is of great importance to analyse the effects of free labour mobility in the EU, and the effect of extension of the EU to the East. For, the model predicts that agglomerations will gain while the periphery will loose. The agglomeration is here not only the most densely populated country, but also the country with the highest productivity. The present situation in Europe is given by the Figures 4 and 5. Both Figures show that Europe already represents a core-periphery economy. The core is the hart of the union, from Denmark to Italy. The present periphery is Ireland, Spain, Portugal and Greece.

⁵ In order to have an example that is graphically clear we have chosen for the arbitrary number of 25 percent. It is unlikely that this many people will migrate given the historical experience of low migration in Europe.

Figure 4: Population density in Europe

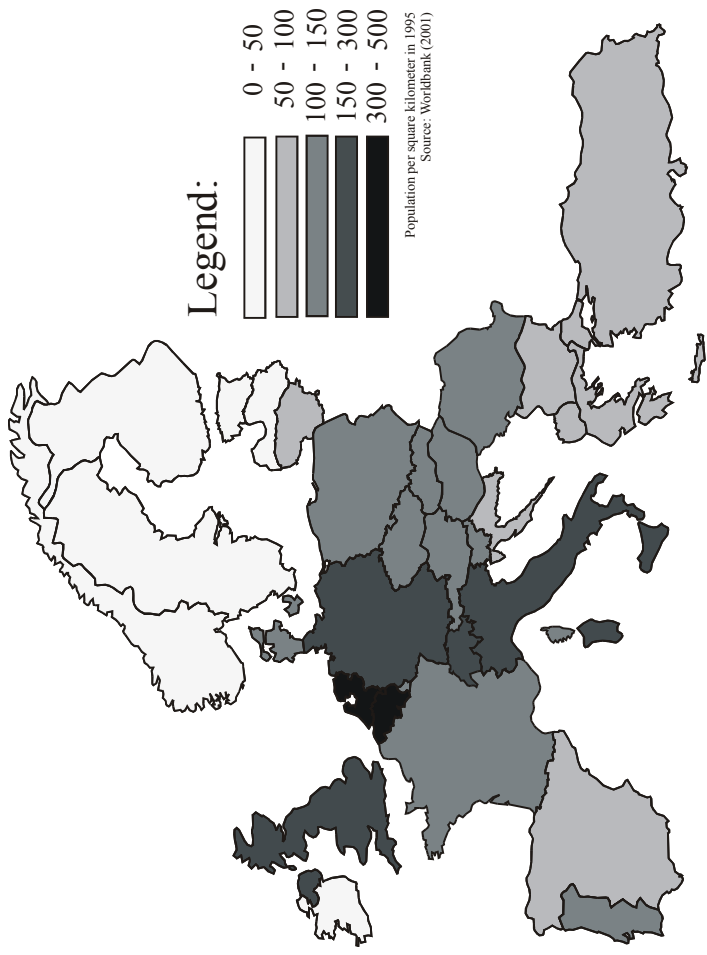
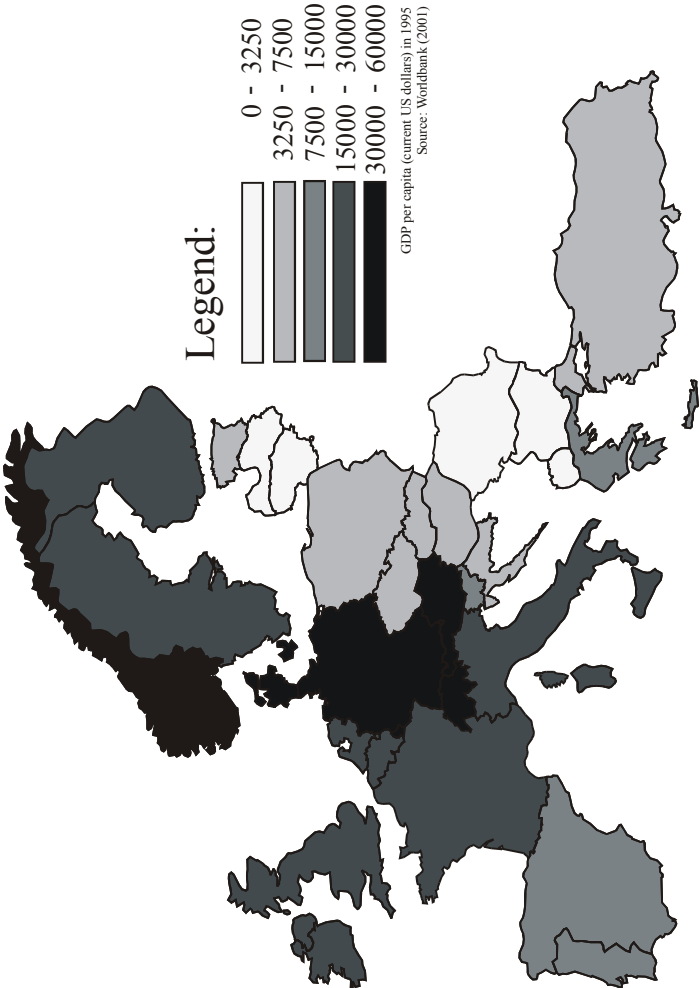


Figure 4: GDP per Capita in Europe



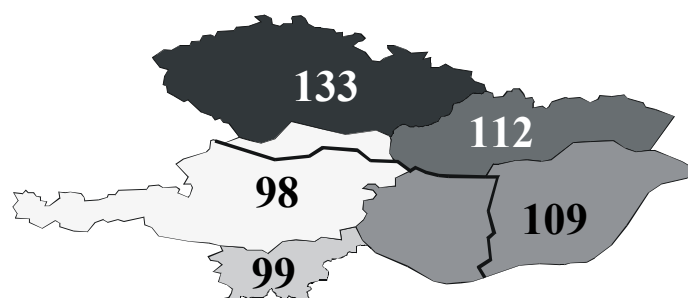
Thus, the countries in the hart of Europe are the countries which have the most to gain from an extension of the EU with the Central and Eastern European Countries. In other words, the present periphery has the most to loose if the European Union is extended to the East. The hart of Europe will probably move a little bit more to the right due to the extension. This makes it even more disadvantageous for countries in the Western Periphery. This may be an explanation for the severe reluctance of the countries in the Western periphery of the EU to an extension to the east. Given the analyses presented in the previous section it should however be noted that countries might loose while people will not. The size of the gains is determined by the migration costs, or in other words, the cost of people to migrate to the centre of the European Union. The people living in the centre of the European Union have the most to gain because they don't have to move and have no migration costs.

3.3 A case study: Austria and its neighbours

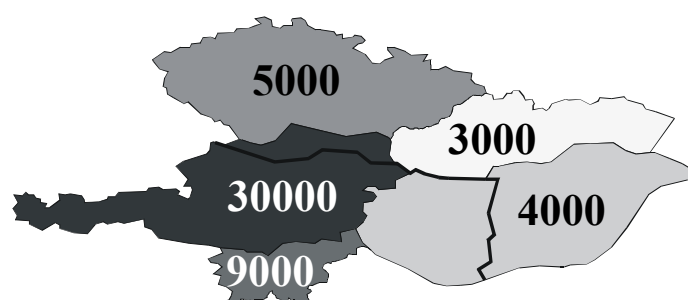
The most interesting case is Austria, which is surrounded by countries that want to become member of the European Union. The situation of Austria and its neighbours with respect to production per capita and population density is depicted in Figure 5. Clearly, Austria has a lot to gain from the extension of the EU. It is not densely populated while it is far more productive than its neighbouring countries. Moreover, it is situated in the hart of the European Union. The model predicts that people will migrate to Austria, which will subsequently gain in productivity.

Following the model it is surprising that Austria is against free movement of labour between Austria and the CEEC's. In the context of the model the only disadvantage for Austria may be a short run negative effects when capital markets are inflexible. When there is a high inflow of labour and capital is immobile between the countries, the negative effect of the reduction in the capital to labour ratio may outweigh the positive agglomeration effect.

Figure 5: Population density and GDP per Capita in Austria and its surrounding CEECs⁶



Population density
(Population per square kilometer in 1995)



GDP per Capita
(current 1995 US dollars)

Thus, the only reason for Austria to be against labour immigration from neighbouring countries which follows from the model is the danger of submerging in a huge flow of foreign labour without additional capital. This seems highly unlikely given Europe's low record of labour migration (also in the European Union)

4 Concluding remarks

In this paper it is argued that an increase in commuting possibilities will lead to an increase of the productivity of workers since employers can search for better fitting workers within a larger geographical area. Institutional changes such as the removal of barriers to migration (borders) and changes in peoples preferences where to live may also improve productivity of workers within a geographical area because of a larger available pool of labourers due to immigration. Of course, the increase in productivity in one region goes at the expense of the productivity growth in other regions. We argue that, given the presented model, reduced commuting costs and reduced migration costs will lead to positive net welfare effects due to the improvements in the working of the labour market and associated productivity gains. Moreover, it is concluded that for the population the effects are always Pareto optimal. Only on the country level Pareto optimality no longer holds.

⁶ Source, Worldbank (2001).

The main question analysed in this paper considered the consequences of increased labour migration in Europe due to investment in infrastructure and institutional changes such as the extension of the EU. The results were straightforward. Infrastructure investment in EU border regions enhances economic growth and stimulates economic integration in the form of commuting in the border area. Thus, infrastructure projects connecting border regions fit very well in the objectives of the European Regional Development Fund. It was found that reducing impediments to cross-border commuting will lead to increased economic growth. Migration also leads to increased economic growth in the European Union. Moreover, with respect to the inhabitants of the European Union the results are Pareto optimal. This is however not the case on the country level. European Union member states may be faced by a decline in their GDP. This leads us to the following additional conclusion. GDP growth is not a good measure to analyse the welfare of countries. GDP per capita is a better way to measure welfare effects. However, GDP per capita is not the best way to measure welfare because living preferences should also be taken into account. In the case study it was found that monopolistic give no explanation for Austria to be against an extension of the EU and the Associated increase in labour migration. Only in case of an extreme inflow of labour there could be a short-run negative effect on Austria's economic growth. Such a high inflow of labour can however be considered unlikely given the European Union's history of low labour migration (also after the extension of the EU with countries like Spain, Portugal and Ireland which all had a significant lower per capita income than in the rest of the EU).

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A. Mathematical Appendix

In this mathematical Appendix we will describe the model discussed in Section 4. We will focus on the addition this paper makes on the labour market. A general discussion of models in the tradition of the New Economic Geography can be found in Baldwin et al (2003), and an application of a full-fledged applied Spatial CGE model with monopolistic competition and vertical linkages can be found in Thissen (2004).

Conform the standard analyses in the NEG literature we use a Dixit-Stiglitz monopolistic competition framework to model the labour market. Moreover, production is modelled using a typical two tier production function. The upper tier is a simple production function with only labour as a production factor. The second tier is a CES (constant elasticity of production) specification that determines the demand for labour varieties from different regions. In the upper tier production y in region j is described by:

$$(1.1) \quad y_j = A_j L_j$$

Where L is the amount of labour productive units used in production. The labour productive units are described in the lower tier where F is the commuting matrix describing the commuting from region i to region j .

$$(1.2) \quad L_j = \left(\sum_i F_{i,j} \frac{\sigma-1}{\sigma} \right)^{\frac{\sigma}{\sigma-1}}$$

Having a profit maximising firm we can minimize the costs of the input L subject to (1.2). We therefore have:

$$(1.3) \quad \min \text{cost}_{L_j} = \sum_i \omega_j (1 + \tau_{i,j}) F_{i,j}$$

Where ω_j equals the wage rate paid in region j and $\tau_{i,j}$ equals the additional amount that the employer has for an employee to commute between regions i and j . Thus, the actual wage v_i received by an employee in region i is the wage ω_j and the compensation for commuting $\tau_{i,j}$:

$$(1.4) \quad v_i = \frac{\sum_j \omega_j (1 + \tau_{i,j}) F_{i,j}}{\sum_j F_{i,j}}$$

We have chosen here for the employer to pay a compensation for commuting. This compensation is included in the wage paid to the employee as the largest part of the costs, being travel time, is both produced and consumed by the employee. The compensation is therefore used for the consumption of other goods than transport. However, it should be stressed that this way to model these costs is not relevant for the main conclusions drawn in this paper.

From the minimization problem described in equation (1.3) we can derive the regional demand for labour. We have therefore:

$$(1.5) \quad f_{i,j} = [\omega_j (1 + \tau_{i,j})]^{-\sigma} L_j \left(\sum_i [\omega_j (1 + \tau_{i,j})]^{1-\sigma} \right)^{\frac{\sigma}{1-\sigma}}$$

From this demand equation we can easily derive the equation for the price index for the labour productive units:

$$(1.6) \quad w_j = \left(\sum_i [\omega_j (1 + \tau_{i,j})]^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

The cost function for commuting can be described by a standard logarithmic function:

$$(1.7) \quad \tau_{i,j} = e^{-\eta(tp_{i,j})}$$

Where $tp_{i,j}$ is a distance or time travel matrix. The following two equations tell us that what is earned with production will be paid to the production factor and what is earned will be spent on consumption. For simplicity it is assumed that one only consumes goods from ones own market (no trade). These two equations close the product and factor markets.

$$(1.8) \quad p_j Y_j = w_j L_j$$

$$(1.9) \quad v_i \sum_j f_{i,j} = p_i Y_i$$

To model migration we take a simple straightforward approach. We define Utility in a region as the product of utility derived from consumption u_i^c and utility derived from living in a certain area u_i^l . In equilibrium utility should be equal over the regions. Migration clears this market. The consumer utility is only specified as a function with as argument the amount of goods consumed. The reason is that any ‘normal’ behaving utility function will do. We therefore have:

$$(1.10) \quad u = u_i^c u_i^l$$

$$(1.11) \quad u_i^c = f(y_i)$$

The utility of living is a decreasing function in the amount of people living in a certain area. This describes the scarcity of space in case more people want to live in a certain region.

$$(1.12) \quad u_i^l = \ln \left(\kappa_i \frac{L m_i}{\sigma_i} \right)$$

To determine the utility level we have to specify the condition that the total amount of people is given:

$$(1.13) \quad \bar{o} = \sum_i F_{i,j} = \sum_j F_{i,j}$$

This describes the compete model. It would be easy to extend the model with monopolistic competition on product markets or with vertical linkages. It would also be possible to specify a neoclassical labor market with monopolistic competition, letting the laborers set their wage rate (or labor supply) optimizing a

monopoly profit on their special skills. However, in order to focus on the main arguments of this paper we simply refer to the relevant literature.