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THE IMPACT OF TRADE LIBERALIZATION ON REGIONAL FACTOR REALLOCATION

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IZJAVA

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1. INTRODUCTION

"The study of spatial economics, of the location of production, has a long if somewhat thin history. Von Thünen's analysis of land rent and use around an isolated city was roughly contemporaneous with Ricardo's statement of comparative advantage; the location analysis of Weber, the central place theory of Christaller and Lösch, the regional science of Isard, and the urban systems theory of Henderson are all well-established ideas" (Krugman, 1998, p. 7). Despite a rich tradition of classical location theory spanning more than two centuries, the field never got the recognition within the mainstream economic science and remained relegated to scientific obscurity regardless of the fact that some noted mainstream economists such as Adam Smith, Alfred Marshall and Bertil Ohlin took interest in it. In spite of those and some other important exceptions spatial aspects of economic activity have remained conspicuously absent from mainstream economic theory until the early 1990s.

1.1. THEORETICAL BACKGROUND

It took a simple model developed in Krugman (1991), which is widely regarded as having given birth to something controversially called the "new economic geography", to stimulate the emergence of a new wave of theoretical and (to a lesser extent) empirical work. New economic geography, also termed by some as spatial economics or even geographical economics, is a comparatively novel field of study attempting to discover the forces behind the spatial distribution of economic activity. According to new economic geography paradigm, the dispersion or concentration of economic activity is determined by a number of centrifugal (working toward agglomeration of production) and centripetal (dispersing production across space) forces. This approach inevitably has much in common with older approaches of classical spatial economics, but it nevertheless also has a number of distinctive features that do qualify as a new departure. The common aspect of all the theoretical models dealing with the spatial implications of economic activity is that they utilize the framework of the Dixit-Stiglitz (1977) model of monopolistic competition to construct general equilibrium models, where the interaction of centripetal and centrifugal forces determines the location of production. Such theoretical exercises often include modeling such agglomeration (centripetal) forces as (1) the market-size effect, which induces firms to locate closer to their largest markets thereby reducing transport costs, (2) thick labor markets, where labor supply determines the location of firms, and (3) pure external economies, which remain one of the most commonly used explanations for the agglomeration of economic activity. These forces, working towards complete spatial agglomeration, are counteracted by centripetal forces spreading economic activity away from an industrial agglomeration. Immobile factors of production (such as land and/or an immobile labor force), whose prices are likely to increase with additional demand, will ultimately drive some of the producers to other locations. Pure external diseconomies occurring in large agglomeration are also a possible cause for a dispersion of economic activity, where negative external economies have the effect of increasing firm costs and reducing profits. The interaction of centrifugal and centripetal forces and the strength of the individual effects determine the spatial location of industry in the end run, however, if the determining factors like transport costs, the market size or other factors should change, that would set the same forces into motion again establishing a new equilibrium.

1.2. AIM OF THE THESIS AND ITS SCIENTIFIC CONTRIBUTION

Following Krugman's (1991) approach to modeling economic geography, where perfect mobility of labor was assumed, more recent work starting with Krugman and Venables (1995, 1996) and followed by Puga (1998), Fujita, Krugman, Venables (1999) drops the assumption of perfect labor mobility. Given that most countries experience imperfect inter-regional labor mobility, it is thus needed to study the spatial repercussions of trade liberalization in a more realistic setup. In this thesis, my approach to modeling economic geography is based on the second set of models with imperfect labor mobility. Basing my model loosely on the Fujita, Krugman, Venables approach, I aim to augment their theoretical model by adding the second factor of production, revising the modeling of the external economies to scale and breaking the symmetric location of regions. These alterations of the model change its basic dynamics of factor relocation significantly and allow for the modeling of foreign direct investment flows and the modeling of domestic capital relocation, which was not the case in any of the most noted economic geography models. The changes described are also meant to make the model more realistic, offering a better approximation for the spatial aspects of the relocation of economic activity in reality. As it will be shown in the following chapters, the dynamics of the model compared to its predecessors are significantly amplified. Basic features of this model are outlined in Damijan, Kostevc (2002). My scientific contribution is not limited to the development of an alternative economic geography model, since it includes also an empirical test of some of the model's implications. This is especially important considering the fact that empirical work in the field of economic geography has been lagging far behind the latest theoretical advances.

The features of my version of an economic geography model make its implications very suitable for empirical testing in order to provide conclusive evidence on the importance of economic geography forces in the location of industrial activity. The opening-up of transition countries and their trade integration with the European Union (EU) provides a natural experiment for testing new economic geography (EG) models. The aim of the thesis is to discover whether the predictions of economic geography models hold for transition economies. An empirical analysis will enable me to determine if the process of economic integration in the sampled transition countries has any adverse affects on regional disparities. Some economic geography models contend[1], that liberalized trade tends to produce gains for some regions at the expense of others reflecting in increasing differences in relative regional wages. On the other hand, other models of economic geography predict that trade liberalization will increase regional wage differences only in the first phase, while subsequently lead to a convergences in nominal wages between regions. I therefore intend to test the implications of the effects of trade liberalization with the European Union on inter-regional relocation of manufacturing and inter-regional adjustment of relative wages in transition countries on a sample of five transition countries (Bulgaria, Estonia, Hungary, Romania and Slovenia), in order to provide evidence in support of the models' predictions.

1.3. METHODOLOGY

The methodological approach applied in this thesis is very much in line with the methodology of modern macroeconomic analyses and modern trade analyses. The theoretical analysis is based on a formal mathematical approach to the spatial aspects of factor relocation, whereby many of the techniques common to modern mathematical economics are utilized in order to create a small-scale general equilibrium model.

I base my empirical analysis, on the other hand, on a sample of transition countries and their regional data on employment, wages, output, foreign direct investment, etc (on both NUTS 2 and NUTS 3 levels as well as NUTS 5 level in the case of Slovenia). Both the structure of the gathered data as well as the model's characteristics require the use of panel data techniques for the empirical testing of the model. Both random effects and fixed effects estimators are therefore used in order to verify the predictions of the model in the sample transition countries.

1.4. STRUCTURE OF THE THESIS

The structure of the master's thesis is as follows. Chapter 2 provides a brief overview of factor reallocation and the formation of factor rewards in classical trade theory. The lessons of the classical theory of comparative advantage constitute the basic framework for development of models with spatial features. Chapter 3, on the other hand, provides a brief description of the development of classical theory of location as well as the development of new theories in geographical economics termed "the new economic geography". In chapter 4, I present the derivation of my model and provide an analysis of the most important implications of the model

[1] For further reading on the subject see Krugman, Venables (1995).

in the form of model simulations, which enable a clearer view of the interactions in the model and of the effects of changes in some crucial variables in the model. Chapter 5 describes some of the empirical work already done on the subject of spatial aspects of economic activity, while chapter 6 presents an empirical test of my model on a sample of transition countries. The final chapter summarizes basic findings and provides some possible directions for further research.

2. TRADE LIBERALIZATION AND FACTOR ALLOCATION IN TRADITIONAL TRADE THEORY

Classical trade theory has set the groundwork with respect to the effects of international trade on factor allocation, despite the fact that the relocation of factors of production was never the focus of the work of Adam Smith (1776), with absolute advantage in production as a cause of trade, or the work that followed with David Ricardo (1817), Robert Torrens (1815) and Stuart Mill (1821) in comparative advantage theory. The focus of these theoretical undertakings was primarily on determining the gains from trade between two countries, while factor relocation served just as a part of the process that would ultimately lead to trade gains for both countries. The effects of factor allocation are not analyzed in depth and basically serve the above purpose, while themselves not being focused on.

Neoclassical trade theory switched the focus somewhat from technological differences as the main driving force for trade flows, as was the case in classical trade theory, to differences in factor endowments determining the direction of trade. Neoclassical trade theory assumes perfect intra-country factor mobility, which reduces to zero between countries. Trade in the case of the Heckscher-Ohlin-Samuelson model serves as a substitute for inter-country factor mobility. It also began emphasizing factor relocation as a driving force behind international trade and not just as a residual category.

2.1. CLASSICAL TRADE THEORY OF COMPARATIVE ADVANTAGE (RICARDO-TORRENS-MILL MODEL)

Classical trade theory of comparative advantage with its basis in absolute advantages in production assumes only one factor of production (labor) and different technologies across the trading countries. Differing production functions (different technologies) are the cause of trade in classical theory, due to the fact that the output that can be obtained from one unit of labor differs across countries. With the assumptions of constant returns to scale in the production functions and of only one factor of production used, the production possibility frontier functions are linear. Classical trade theory also presumes no distortions such as imperfect competition or taxation (no government involvement in the working of the internal markets) and crucially also no transport costs.

Given these assumptions, a non-trading country would produce and consume at the same point on its production possibility frontier, whereby the point of production would be determined by consumer preferences. Consumer preferences would therefore also determine the amounts of labor used in the production of a certain good under the given technology. Consumer tastes, in fact, end up reallocating the only factor of production, as is the case in other theories. Production in autarky satisfies the demand and there is no incentive for further factor reallocation once a stable equilibrium is reached. Some part of the labor force is employed in the production of one good, with the rest of the labor employed producing the other good.

Supposing that each country has an absolute advantage in the production of a specific good allowing it to produce more output with a single unit of labor than the other country, that would allow trade between those two countries to be mutually beneficial. Consumers in both countries would be better off if trade between the two countries were liberalized, due to the fact that they could consume on a higher indifference curve than they did in autarky. It can be shown therefore that profitable production specialization is possible in this case. Considering the case in Table 1, which shows the outputs of goods *X* and *Y* produced from one unit of labor in the home and foreign country, it can be shown that the reallocation of labor from the sector with a disadvantage (absolute in this case) in production to the sector with the absolute advantage can increase world production of both commodities.

Table 1: **Marginal products of labor**

	Home	Foreign
X	$\alpha_h = 20$	$\alpha_f = 30$
Y	$\beta_h = 20$	$\beta_f = 10$

Source: Markusen et.al (1995)

It is clear that the home country has an absolute (and comparative) advantage in the production of good *Y*, while the foreign country's absolute (and comparative) advantage is in production of good *X*. Reallocation of labor from the production of good *X* to good *Y* in the home country and from the production of good *Y* to good *X* in the foreign country can have positive effects on the overall production in both countries, which can be observed from Table 2.

Table 2: **Changes in output due to labor reallocation of one worker from *X* to *Y* in the home country and one worker from *Y* to *X* in the foreign country**

	Home	Foreign	Total
X	-20	+30	+10
Y	+20	-10	+10

Source: Markusen et.al (1995)

Table 2 shows that there is a possibility of increasing world production of both commodities through specialization. Moving one worker in the opposite direction in the two countries increases the world production of both commodities by 10 units. The same could be shown in the case of comparative advantage, where one country would be absolutely less efficient in the production of both goods, but comparatively more efficient in the production of one good. Gains from trade are possible if the ratios of the marginal products of labor differ between the countries.

World production increases for each unit of labor moved from a sector with comparative disadvantages to a sector with comparative advantages, which means that reallocation of labor will continue until complete specialization is achieved. Trade liberalization in the case of the classical theory of comparative advantage leads to both countries specializing in the production of one good, where they have an advantage, while relying on imports of other good(s). The whole of a country's labor force is concentrated in the production of a single good, with no production in any other sector. Complete specialization in this case is due to the fact that the production possibility frontier is linear. Ratios of marginal products remain unchanged for all units of labor used, which makes complete specialization rational and in fact optimal. It is also important to note that Ricardian type models assume perfect labor mobility between sectors, hence, no additional costs are incurred due to the reallocation of labor. Labor is homogenous across all sectors, hence, workers are relocated instantaneously with no additional training necessary.

In the Ricardian model (1817), comparative advantage is determined by the relative productivity of labor in producing commodities or, equivalently, by international differences in production functions. Another important addition to the model is the introduction of factor costs, despite the fact that changes in nominal wages are not fully explained by the model.

Wages in autarky in both countries are set exogenously and the wages determine the prices of final products. Because of perfect competition in the labor market, the value of the marginal product of labor must equal the wage rate in each sector:

(1) $$p_x^a \alpha_h = w_h \quad \text{and} \quad p_y^a \beta_h = w_h \ ,$$

where p_x^a represents the autarkic price of good x and p_y^a the autarkic price of good y, w_h represents nominal wages in the home country, while α_h, β_h are the marginal products of labor in the production of goods x and y respectively. Considering that prices are determined endogenously, (1), it can be rearranged:

(2) $$p_x^a = \frac{w_h}{\alpha_h} \quad \text{and} \quad p_y^a = \frac{w_h}{\beta_h} \ .$$

From (2) it immediately follows that the relative price in autarky is independent of the wage rate for both countries.

(3) $$p_h^a = \frac{p_x^a}{p_y^a} = \frac{\beta_h}{\alpha_h}$$

Equation (3) reflects what Ricardo referred to as the *Labor Theory of Value* (Markusen et.al., 1995, p. 90), where the relative prices must equal relative costs in terms of labor inputs. Hence, if sector Y has a relatively low marginal product and sector X has a relatively high marginal product, the home country is likely to have its comparative advantage in good X (the home country relative price of good X relative to good Y will be lower than the foreign country relative price). The wage rate on the other hand, as long as it is the same in both sectors, has no effect on the relative commodity prices.

The nominal wage rate is relevant only in determining "real wages", or the living standard of laborers. From (1) real wages equal marginal labor productivities:

(4) $$w_h / p_x^a = \alpha_h \quad \text{and} \quad w_h / p_y^a = \beta_h \ .$$

Graphically these "real wages" can be interpreted as end points on the budget line of an individual worker[2].

Comparative advantage concept fails to fully explain the labor market developments once the economy moves from autarky to free trade. The theory does not offer a definite answer with regard to changes in nominal wages after the commencement of unrestricted trade, mainly due to the fact that it avoids labor market issues by assuming perfect labor mobility and homogeneity. Perfectly mobile labor allows equal wage rates in both sectors prior to free trade, whereby excess demand in the comparative advantage sector is being instantaneously satisfied by the influx of workers from the sector with comparative disadvantages. Because the economy produces (and, in autarky, also consumes) somewhere on the production possibility frontier, there is no unemployment and the only available workers can in fact come from the comparative disadvantage sector.

Considering (4) again, it can be seen that the wage is dependent on the price a commodity can achieve in free trade and the marginal product of labor in the production of that commodity. With no workers employed in the disadvantaged sector, wages remain equal for all workers in the economy even after the trade liberalization. The ratio of the free trade nominal wage and the autarky wage in the country depends on change in the free trade price of the export product. If the free trade nominal price of the export product rises compared to the autarky price, which can be expected, then assuming a constant marginal product of labor in the production of the export,

[2] Assuming that a worker owns 1 unit of labor, β is the maximum amount of Y that can be purchased if all income is spent on Y; similarly, α is the maximum amount of X that can be purchased if all income is spent on X.

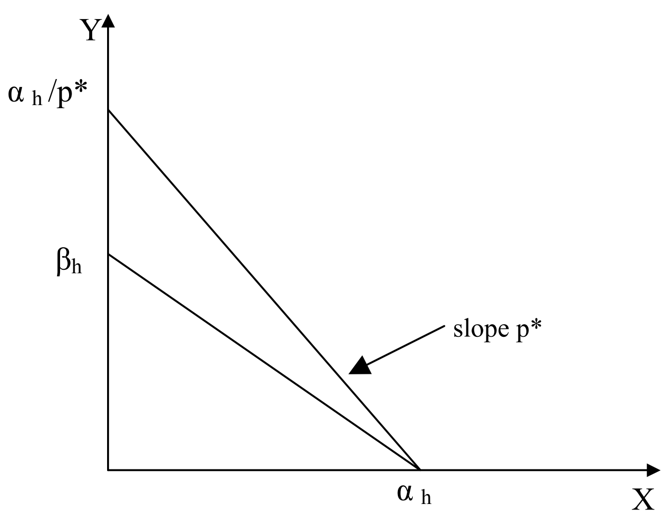
nominal wages also rise. We know that the relative price of the export good will be above its autarky level and the opposite holds for the import product. Hence, there are three possible scenarios in the case of the rise in relative prices:

- the rise in relative prices is due to a rise in the price of the export good, while the price of the import good remains unchanged (a faster rise in the price of the export good compared to the import good also suffices);
- the rise in relative prices is due to a fall in the price of the import good, with the price of the export good remaining unchanged (a faster fall in the price of the import good compared to export good also suffices);
- the rise in relative prices is due both to a fall in import prices as well as a rise in export prices.

Although it is reasonable to expect higher post-trade nominal wages, it is by no means the only possible outcome of trade liberalization.

Real wages, on the other hand, rise with international trade but only in terms of the import good, while remaining the same in the case of the export goods. That can be graphically represented by the intercept of the free trade price ratio with the axis of the imported commodity. This intercept will be somewhere above the autarky intercept (depending on the post-trade price ratio) while the intercept with axis of the exported commodity does not change from autarky to free trade (Figure 1).

Figure 1: **Budget line of an individual worker in the home country**



Source: Markusen et.al., 1995, pg. 91

Given that the home country in Figure 1 exports commodity *X* and that the free trade price ratio is p^* it is obvious that the intercept with the *Y* axis, which represents the real wage in terms of the import good, is above the autarky intercept.

The implications of the Ricardo-Torrens-Mill model as far as factor reallocation is concerned are quite basic. Namely, labor, as the only factor of production, exhibits perfect inter-sectoral mobility, which is also reflected in the linear form of the production possibility curve in Figure 1. Any additional unit of labor can be costlessly and instantaneously reallocated from the import sector to the export sector ultimately leading to complete specialization. Given that, the Ricardo-Torrens-Mill model has no spatial features, meaning that both production and consumption take place at a single point in a particular country, regional factor reallocation is not an issue in this model.

2.2. NEOCLASSICAL TRADE THEORY (HECKSCHER-OHLIN-SAMUELSON MODEL)

Ricardo-Torrens-Mill model of comparative advantage offers some clear answers with its comparatively simple specification including constant opportunity costs, the likelihood of a complete specialization in trade, and the subsequent existence of positive income gains from trade for all workers in both countries.[3] In practice, such clear-cut outcomes of trade are rarely observed, with certain segments of the workforce benefiting more than others and in certain sectors of the economy labor can actually be made worse off by trade. It is imperative therefore to move beyond the Ricardian theory with more realistic models such as the Heckscher-Ohlin-Samuelson model.

In this chapter, factor relocation in the framework of the Heckscher-Ohlin[4] or Heckscher-Ohlin-Samuelson model (henceforth HOS model) is presented. HOS model introduces a second factor of production into the model (capital), which yields richer and more realistic implications of trade. In the second significant modification to the model, the assumption of differing technologies between the trading countries is forfeited and equal production/cost functions are assumed. Given the above modifications of the Ricardian model and combined with flexible (variable) technical coefficients in the production function, the production possibility frontier assumes a concave form, reflecting the fact that the opportunity costs of production are increasing with the quantity produced. The ensuing shape of the production possibility frontier ultimately leads to the possibility of incomplete specialization resulting from trade. This modification introduces an additional element of realism with production of multiple commodities preserved

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[3] This is the case unless one country is much larger than the other and hence does not specialize completely.
[4] For a more detailed look at the evolution and rationale behind the HOS model see also Heckscher (1919), Ohlin (1933).

even after trade has been liberalized, while instances of complete specialization in the production of a single commodity are very rare. HOS model shows that trade can cause a redistribution of real income between sectors and also a redistribution of factor rewards, while providing aggregate gains for the economy as a whole. The redistribution effects have been widely used by opponents of free trade as an argument for protectionism.

The HOS model of international trade adopts and maintains some crucial assumptions about the production characteristics in both countries:

- first, the production functions exhibit constant returns to scale in the production of both goods, but differ between the two in relative usage of factors, one commodity remaining labor intensive, the other capital intensive;
- second, total supplies of labor and capital are fixed and both labor and capital are homogenous and perfectly mobile within a country. This assumption effectively prevents any wage and/or interest rate differentials in a country;
- third, there is a strict assumption of perfect competition in all markets, with no distortions such as labor unions or taxes, that would influence production or consumption decisions. The above assumptions also guarantee full employment of both factors of production;
- fourth, consumption in both countries is proposed to be identical and homogeneous;
- finally, the most important assumption of the HOS model, which is also its defining characteristic, is that countries differ only in their relative factor endowments. Again, perfect mobility of both goods and factors is assumed, hence, no transport costs are incurred.

The fact that the two countries have different relative factor endowments coupled with identical demand patterns is reflected in different relative factor prices. In autarky, the capital abundant country is faced with relatively inexpensive capital and the labor abundant country has, hence, relatively inexpensive labor. Trade between the two will develop with the relatively labor abundant country exporting labor intensive commodities, while the capital abundant country will have a price advantage in the production of capital-intensive goods. This process will, assuming no impediments to trade such as trade restrictions or transport costs, lead to an equalization of final goods price ratios in the two countries at some intermediate level. This, however, does not by itself imply that an equilibrium position has been reached. Also required is the condition that access supply and demand for both commodities are zero.

Since international trade in Heckscher-Ohlin-Samuelson theory is determined by national differences in factor endowments or stemming from different relative factor prices, it should be evident that trade must, as a result, influence the prices of factors of production (Markusen et.al., 1995, p. 108). The factor price equalization theorem, as one of the integral four theorems[5] comprising the HOS theory, investigates the effects of trade on factor prices.

Factor price equalization

Factor price equalization (henceforth FPE) theorem states that international trade in commodities, under the assumption of the HOS model and notwithstanding the international immobility of factors, equalizes the factor prices across countries (Gandolfo, 1994, p. 85). It is important to note also that equalization occurs not only for relative factor prices ($\omega = w/r$), but also absolute factor prices, that is $w_1 = w_2$ and $r_1 = r_2$.

Both Heckscher (1919) and Ohlin (1933) claimed that both relative and absolute factor prices equalize internationally as a result of international trade generated by relative scarcity of the factors of production among countries, but both failed to put forward conclusive evidence to support their proposition. Samuelson (1948, 1949) proved that, under a set of given conditions, factor prices can be equalized internationally as a consequence of free international trade. It should also be noted that A.C. Lerner managed to prove the theorem some fifteen years ahead of Samuelson[6], but did not publish his work until 1952.

Mathematical treatment of the factor price equalization theorem

Samuelson and Lerner introduced graphical proof of the FPE theorem, while Gandolfo (1994, p. 85), Borkakoti (1998, p. 163) and some other authors offer mathematical proof of the theorem. I shall review Borkakoti's treatment in this section. [7]

Invoking the assumption that both trading countries produce some of both goods (no possibility of complete specialization), the wage and rental equations can be written out without specifying which country is considered, since internationally identical technology guarantees that sectoral factor ratios will be internationally identical if factor prices are equalized.

Supposing the economy produces two goods x and y, by using two factors of production, capital (K) and labor (L). Good x is the numeraire of the system such that p is the relative price of good y. Good x is assumed to be the relatively capital intensive good, while good y is the relatively labor intensive good.

[5] The remaining three theorems are the Heckscher-Ohlin theorem, the Stolper-Samuelson theorem and the Rybczynski theorem.
[6] A. C. Lerner wrote his paper in 1933, but it did not get published until 1952. In his 1949 paper Samuelson duly recognizes Lerner's work.
[7] The price equalization theorem in different settings has been analyzed also by Beladi, Naqvi (1987) and Falvey (1999).

We can define the following variables as:

$k_j = K_j/L_j$ … sectoral capital-labor ratio ($j = x, y$)[8]
$f_j(k_j)$ … sectoral per capita production function ($j = x, y$)
$\omega = w/r$ … wage-rental ratio

The production function is assumed to exhibit the following neoclassical properties:

$$(1) \qquad f_j(k_j) > 0, \; f_j'(k_j) > 0, \; f_j''(k_j) < 0 \quad \text{for all } k_j > 0$$
$$f_j(0) = 0, f_j(\infty) = \infty, \; f_j'(0) = \infty, \; f_j'(\infty) = 0 \qquad j = x, y \;.$$

According to the specified function (1), output is increasing with increases in the capital-labor ratio, but the marginal productivity of k_j is decreasing. The function therefore assumes a quasi-concave shape.

Borkakoti (1998, p. 126) defines the following simple model of autarkic production, where the wage-rental ratio (ω) is defined as:

$$(2) \qquad \omega = \frac{f_x(k_x)}{f_x'(k_x)} - k_x \quad \text{and} \quad \omega = \frac{f_y(k_y)}{f_y'(k_y)} - k_y \,.$$

Equation (2) can be derived by equaling the marginal productivity of each of the two factors of production with the costs of the two factors. It presents the equations for factor-intensity curves, with each equation relating wage-rental ratio to sectoral capital-labor ratio. Assuming perfectly competitive markets (and also perfect factor mobility between sectors) same rental and wage rates must prevail in both the sectors (noting also that good x is the numeraire). The rental rate is therefore equal to the marginal product of capital (3) and the wage rate can be derived combining equations (2) and (3).

$$(3) \qquad r = f_x'(k_x) = p f_y'(k_y) \,,$$

$$(4) \qquad w = \left[f_x(k_x) - k_x f_x'\right] = p\left[f_y(k_y) - k_y f_y'\right].$$

Equations (2) and (3) can be rewritten in the following implicit form:

$$(5) \qquad f_x'(k_x) - p f_y'(k_y) = 0$$

[8] From the factor intensities of both goods, we know that $k_x > k_y$.

(6) $\left[f_x(k_x)-k_x f_x^{'}\right]-p\left[f_y(k_y)-k_y f_y^{'}\right]=0$

There are two equations, but three unknowns, namely k_x, k_y and p. p may be taken as a given, since, at equilibrium, p is determined by international demand and supply. Therefore, there are two equations to determine two unknowns, namely k_x and k_y. To show that a unique solution exists we need to prove that the Jacobian matrix of (5) and (6) is non-vanishing. We have the following Jacobian matrix of second derivatives:

(7) $$|J| = \begin{vmatrix} f_x^{''} & -pf_x^{''} \\ -f_x^{''}k_x & -pf_y^{''}k_y \end{vmatrix}$$

$$\therefore |J| = pf_x^{''}f_y^{''}(k_x - k_y)$$

In view of the factor-intensity condition and the specifications of the production function, it can be seen that $|J| > 0$. Thus $|J| \neq 0$, and unique solutions[9] k_x^* and k_y^* exist for a given p^*. This is sufficient because k_x^* and k_y^* will determine r^* and w^* in equations (3) and (4) (Borkakoti, 1998, pp. 162-164). Given that technology is internationally identical, which is one of the basic assumptions of HOS model, r^* and w^* must be the same in both countries.

HOS model yields somewhat richer results with respect to factor reallocation then those presented in the preceding section for the Ricardo-Torrens-Mill model. Similarly as in the case of the Ricardo-Torrens-Mill model perfect inter-sectoral factor mobility is assumed, however it does not lead to complete specialization due to increasing opportunity costs of production. HOS model, unlike Ricardian type models, also assumes perfect inter-regional mobility of labor and capital, instantaneously preventing any wage rate or rental rate differentials from occurring between regions. Hence, the HOS model predicts perfect inter-regional factor mobility within a country, while, on the other hand, completely restricting factor movements between countries. Ultimately, factor prices according to the HOS model will be uniform across sectors and geographical locations.

[9] Since the determinant of the Jacobian matrix of second derivatives (7) is not zero, there is only one solution to the model (matrix $|J|$ is namely nonsingular). The resulting k_x^* and k_y^* are unique solutions to the model.

3. THE EVOLUTION OF ECONOMIC GEOGRAPHY

In the preceding chapter, I attempted to outline the basic features of factor relocation in mainstream trade theory, i.e. the Ricardo-Torrens-Mill and Heckscher-Ohlin-Samuelson models. Mainstream economics, as evident from the preceding chapter, neglected all spatial aspects of factor relocation in its approach to explaining the implications of trade on factors of production. The aim of the following chapter is to present the evolution of economic geography from classical theory of location to the latest developments in economic geography.

3.1. CLASSICAL THEORY OF LOCATION

"Spatial economics concentrates attention on two pervasive features of economic life: distance and area. The role of distance is exemplified by the fact that transport costs affect not just market prices, but also location of production facilities" (Blaug, 1997, p. 596). Despite the fact that Cantillon, Steuart and Smith showed much interest in the systematic spatial patterns associated with distance and area, such problems have almost wholly dropped out of sight in the economic writings since 1800. Mainstream economic science remained confined to the analysis of an economic world without spatial dimensions until 1950, while spatial economics and particularly the location of economic activity, flourished and matured throughout the nineteenth century in complete isolation from the mainstream economic science.

3.1.1. The isolated state by von Thünen

One of the main reasons for the relative obscurity of the classical theory of location lies in the fact that the "father" of location theory as well as the majority of his followers were German, which at that time caused a severe hindrance to the dissemination of their ideas to the English speaking core of theoretical economists.

The history of classical location theory begins with the publication of "The Isolated State" by Johan Heinrich von Thünen in 1826. Unlike the aforementioned eighteen-century writers that merely touched on the implications of distance and area, von Thünen had the vision to postulate a geographical model highlighting distance and area as the very essence of its construction. He envisioned an "ideal" or "isolated state" as a homogenous, featureless plain of equal fertility without roads or navigable rivers and restricted in the use of horse-drawn wagons as the only mode of transportation, having a single town at its center producing all manufactured articles and supplied by the farmers in the plain with all its agricultural products.[10] Von Thünen's ideal state

[10] Manufacturing sector was never the focus of von Thünen's work. He attempted to use his model to optimize farm production in Germany in response to the English farming tradition.

was isolated from the rest of the world on all sides by impenetrable wilderness. With this model state von Thünen attempted to discover the principles, which would, in such circumstances, determine the prices that farmers receive for their products, the rents that are earned by various units of land, and the associated patterns of land use that accompany such prices and rents. He constructed a variety of abstract assumptions with the intention of isolating transport costs as a linear function of distance from all other factors, which influence the location of agricultural production. His model led him to the conclusion that optimal structure of agricultural production should assume a form of concentric circles around the city and he went on to apply his model to the choice of the varieties of grain to be produced at a certain location as well as the intensity with which the crops will be cultivated. Von Thünen faced enormous difficulties trying to solve his "crop theory" and "intensity theory" due to the fact that different crops by themselves were not equally land using or intensive and it became difficult to separate the problems of location and the intensity of agricultural production. He then ended up with the intensity rule, which states that the more intensive crops are grown nearer to the center of the state, with the crop intensity falling as we move away from it.

As far as land rent is concerned, von Thünen reaches the same conclusions as Ricardo although von Thünen's method was more elegant and simple, stating basically that the closest land with the more intensive products is more expensive to rent and vice versa. Marginal productivity of land determines the rent and rent will end up limiting the use of scarce land to the point where its marginal product is equal in all of its uses.

3.1.2. The continuation of the Germanic tradition

One of the later authors who recognized the value of von Thünen's work was also Wilhelm Launhardt, known for his contributions to the pure theory of welfare economics and a representative of the German classical economics. His interests lay primarily in the field of locational theory and spatial economics. He used von Thünen's conclusions but supplemented his supply-determined theory of location of agricultural activities by an analysis of the role of market areas in the location of industrial plants. Launhardt managed to create a mathematical model of von Thünen's work, which allowed for new applications of the theory. He developed the rent bid function, which has been constantly reproduced without any acknowledgement to Launhardt. Despite the fact that von Thünen deals with transport costs and location of activity, his analysis resembles the analysis of market supply areas and does not include any form of a demand function or general equilibrium. It was Launhardt that first directly addressed the problem of optimum location of industrial enterprise.[11] He states the so-called three points problem of

[11] Launhardt published the paper "The Determination of Practical Location of an Industrial Enterprise" in 1882.

classical location theory: how to find an optimum location of a plant that produces a single product at constant costs and faces a given fixed market outlet and two given fixed locations where raw materials are extracted.[12] It was in 1909 that Alfred Weber co-authored his classic book "Theory of location of industries", where Launhardt solutions of three-point problem were rediscovered.[13] Launhardt's work offered a number of original ideas:

- the first explicit least-cost location of an industrial plant relative to a given, fixed market;
- the first explicit list of various economic forces other than freight charges which influence the least-cost location;
- the discovery of all three methods for solving the three-points problem that were known until the invention of linear programming.

Nevertheless, the effect of those ideas was somewhat spoiled by his erroneous claims that (Blaug, 1997, p. 604):

- he solved the n-points problem in location theory;
- that all his solutions relied on linear transport functions;
- that he had not touched on the question of where to locate the plant when both consumers and suppliers of raw materials are dispersed.

Alfred Weber's (1909) "Theory of the Location of Industries" is regarded as the first successful treatise in location theory in the sense of inspiring continuous interest and ongoing analytical activity in location theory as a specialized branch of economics. Weber's text was prevented from becoming the first complete and comprehensive analysis of location theory by the omission of any consideration of market sales and supply areas.[14] Weber went beyond Launhardt's analysis in introducing the effects of differences in labor costs and "agglomeration" economies. Even in the handling of the three-points problem his co-author George Pick managed to develop a simpler and more general graphic technique than anything available to Launhardt. Pick develops the solution of the n-points problem, which enables Weber to introduce a graphic system of "isodopanes"-contours of equal increments in total transfer costs above the level of minimum transfer costs at some initial location. Like von Thünen, Weber assumes a similar model of an isolated state, but instead of assuming a single point of consumption in the center of the state, he proposes several points of consumption and several sources of power and raw materials.

Criticism of Weber's work concentrates on the fact that (Blaug, 1997, p. 608):

[12] The optimum location being the one that minimizes the transport costs per unit of output.
[13] The authors were not aware of Laundhardt's work at the time of publishing.
[14] In 1935 the first comprehensive analysis becomes the "Beiträge zur Standortstheorie" by Tord Palander.

- he neglected to include any form of a demand function, that would enable the model to function as a general equilibrium model;
- he focused squarely on the case of producers and consumers concentrated at a single or multiple points of location instead of them being dispersed continuously over economic space;
- he operates with linear transport functions and spuriously generalizes the analysis by the use of purely fictitious "ideal weights";
- he casts the entire question of plant location in an engineering rather than economic context.

Further development of the classical spatial economics turned to the demand side in an attempt to develop a general equilibrium treatment of spatial questions. With the emergence of monopolistic competition theory, which brings forth the notion of spatial differentiation as one of the sources of a firm's monopolistic power of price-making, new authors such as Hotelling, Chamberlin, Leamer, Palander and others got associated with these developments in modeling spatial competition. This strain of spatial economics was given added incentive by the work of August Lösch with "The Economics of Location" (1939), which reviewed a century of theoretical work about the economics of spatial phenomena from a consistent general equilibrium standpoint. Lösch combines all leading elements of classical location theory with von Thünen's analysis of real production serving a punctiform market, Launhardt's work on punctiform production serving an areal market, Weber's theory of transport and least-cost sitting of industrial plants as well as Hotelling's analysis of spatial competition under conditions of duopoly and oligopoly. Lösch achieved a formal superiority over the classical principles and methods of the "founding fathers" of spatial economics but only at the expense of increasing remoteness from practical location decisions.

Walter Isard's book "Location and Space-Economy" (1956) had the aim of finally closing the divide between classical location theory and mainstream economics. Mainstream economics had confined itself to a 'wonderland of no spatial dimensions' and he placed a part of the blame for this imbalance on the fact that classical location theory was conceived in the outdated language of partial equilibrium, constant coefficients, linear transport costs and given demand configurations. Isard argued that it was possible to derive all partial location theories of von Thünen, Launhardt and Weber from the first-order condition for a maximum. Although an elegant solution, it still has many problems if factor substitution between inputs is allowed. Classical location theory enables a formation of three broad groups of factors that determine the location of production (Blaug, 1997, p. 611):

- transport and certain other transfer costs that vary more or less regularly with distance;

- costs associated with labor, power, water, taxes, interest, climate, topography and the political environment, which, however stable geographically, do not vary systematically with distance from any given reference point;
- general agglomeration and deglomeration economies whose operation is independent of location.

Only first of this factors lends itself to powerful and significant generalizations and even these are seriously threatened once we drop the assumption that transport rates are strictly proportional to weight and distance in all directions over straight-line, airplane routes.

Alfred Marshall (1876) illustrates his original concept of external economies with an example of industrial location. Although he does not deal specifically with spatial economics or attempts to explain the location of industrial activity, most of the literature in this area follows Marshall in identifying three reasons for localization. First, the concentration of several firms in one location offers a pooled market for industry-specific skills, ensuring a lower probability of unemployment and a lower probability for excess labor demand. Second, localized industries can support the production of non-tradable specialized inputs. Third, information spillovers can give clustered firms a better production function than isolated producers (Krugman, 1991, pp. 484-485).

Bertil Ohlin's (1933) seminal book "Interregional and International Trade" presents a connection between (neo)classical trade theory and classical location theory. Ohlin bases his discussion loosely on von Thünen's model of the isolated state as he analyses the possible location of production of final and intermediate goods, taking into account specific industry characteristics. His contribution lies primarily in generalizing the model to include multiple locations of production, multiple locations of resources as well as multiple consumer markets. He proposes that location of industry is governed by the local distribution of natural resources and other productive factors and by the transportability of goods, while the local distribution of consumer markets depend chiefly upon the distribution of natural resources, labor and capital. Ohlin also presents a case on the spatial aspects of intra-country real wage equalization combining effects of labor mobility, differences in endowments, and agglomeration effects. He correctly identifies many of the possible sources of agglomeration and dispersion of industries and in many aspects sets the groundwork for the development of modern economic geography.

3.1.3. Legacy of the classical location theory

The increasing unwillingness to base the analysis of industrial location on linear transport functions and a steady decline of transport costs as a share of the total delivered cost of a product, have contributed more than anything else to the effective demise of the classical location theory.

Classical theory of the location of industrial activity was positioned heavily on the assumption of perfect competition, but if firms compete spatially by f.o.b. pricing, the market structure is one of monopolistic, not perfect competition. In the early twentieth century, there were no comprehensive and applicable monopolistic competition models, moreover, there has been some debate whether classical location theory was in fact designed to explain all the observed spatial variations in economic activity or to provide what Samuelson has termed 'qualitative calculus', i.e. a statement of the algebraic sign of the changes in output and prices that can be expected from given changes in spatial circumstances. Classical location theory has been to a large extent swallowed up by the so-called "regional sciences", which replaced any attempt at a coherent theory of spatial location by a veritable portfolio of partial but operational techniques deriving from roots which frequently lie outside the economic science. These methods have been largely used by geographers and spatial geometrists, who have made models of urban systems and devised systems for determining the location of production. Even modern urban and regional economics is largely macroeconomic in spirit and, hence, has little room for microeconomic forms of the classical agricultural and industrial location theory (Blaug, 1997, p. 611).

Classical theory of location of industrial production has been overlooked time and time again by the mainstream economic science, which is in some part due to the historical circumstances of its development, but it is largely the result of the fact that classical location theory is more a respiratory of general maxims about the role of spatial factors, which are yet to be fully encompassed in a comprehensive and applicable general equilibrium model. Once the writings of German classical location theorist became more broadly available, the methods used in the construction and solution of those models were no longer as relevant from the perspective of mainstream economics as they could have been half a century earlier.[15]

Classical location theory introduced many of the basic concepts that were later revived by economic geography. It also managed to accurately define most of the causes and consequences of agglomeration of economic activity. Due to the fact that the necessary mathematical techniques for modeling spatial economics were yet to be developed, classical location theory focused primarily on the descriptive analysis of the spatial issues and thus failed to reach its full potential.

[15] For a more intuitive look at the evolution of spatial aspects in economic theory see Krugman (1995).

3.2. MODERN DEVELOPMENTS IN SPATIAL ECONOMICS

The previous section (3.1.) offered a brief outline of the tradition of spatial economics from the early nineteenth to the middle of the twentieth century, whereas this section gives an outline of the more recent developments in the field of spatial economics, which have occurred in the last decade. The goal of explaining and determining the location of economic activity remained the same, the only difference being that the development of more sophisticated theoretical tools allows modern spatial economics to implement formalized mathematical models, which enable a more thorough and detailed analysis.

Traditional trade theories, some of which I briefly described in chapter 2, fail to explain why even a priori similar regions with respect to endowments, technologies or policy regimes develop very different production structures. Moreover, these structures of production stand in sharp contrast to the changing pattern of comparative advantage of regions. Recent contributions to spatial economics have developed a novel approach to the theory of spatial allocation and went a long way in altering the perception of the effects of distance and area. This new approach is based primarily on microeconomic concepts of monopolistic competition where firms cluster together to exploit economies of scale arising from their common labor pool, forward and backward linkages using each other's intermediate products, and from other positive externalities attributed to the close proximity of the firms functioning in a given cluster (agglomeration). This causes regions or even countries that seem identical (or very similar) in their underlying characteristics to turn out to be very different. Much of the work in this area logically focuses on how the propensity of firms and workers to agglomerate in space changes as regions become more integrated.

3.2.1. New economic geography

This new approach to spatial aspects of economics was somewhat awkwardly termed "new economic geography". While this denotation serves the purpose of differentiating the field from the classical spatial economics, it has some very obvious deficiencies. First, it implies a strong connection with geography, which is certainly not the case as has been argued by geographers themselves.[16] Second, the term "new" will inevitably have to "fall of" as time passes. Fujita, Thisse (1996), Martin (1999) and Brackman et.al. (2001) suggest that "geographical economics" should be used instead, which works towards reinforcing the fact that this is a theory developed by economists and not geographers. "Spatial economics" as was proposed by Fujita, Krugman

[16] "Ron Martin (1999) summarizes their objections and concludes that what he calls the 'new geographical economics' represents a case of mistaken identity: it is not new, and it most certainly is not geography." (Neary, 2001, p. 557)

and Venables (1999) in the seminal book might describe the actual meaning of the theory best, while other terms in use, such as “urban economics”, “new regional science” and some others, fail to reflect the full meaning of the theory and its implications. The term “spatial economics”, on the other hand, fails to break the connection with classical spatial economics. The two strains of geographical economics (classical and new) differ substantially despite having some obvious similarities, which warrants a clearer separation of the two. Modern methods and theoretical tools allow geographical economics to go far beyond simple picturesque depictions of the nineteenth century by applying building blocks such as increasing returns to scale, technological and pecuniary spillovers, as well as imperfect competition, which were not available to von Thünen and Launhardt and other classical authors. Nowadays, geographical economics has its roots firmly in international economics and modern international trade as well as economic growth theory, while adding the location of economic activity to these theories.

3.2.2. The point of view of traditional and “new trade theory”

Comparative advantage

Economic theory has traditionally taken to explaining differences in production structures mainly through differences in underlying characteristics (endowments, technology), which make space itself uneven. In this framework, economic integration leads regions to specialize according to their comparative advantage (Ottaviano, Puga, 1998). In a spatial sense, therefore models of comparative advantage predict that with constant returns to scale and perfect competition when all underlying differences between regions will be absent, economic activity will be evenly spread across space. In a world of non-increasing returns to scale, small differences in underlying characteristics and existing transport costs, the competition between firms lowers the profitability of competing companies in a market relative to those companies that face fewer local competitors. This forces firms to disperse spatially.[17] Product and factor market competition to which competitors are exposed provide reasons for firms to locate far from each other, but these must be set against the forces, which tend to pull firms together. Comparative advantage, while still relevant, provides only a weak explanation for a remarkable spatial concentration of economic activity. Furthermore, when more things are mobile than not, traditional trade theory fails to provide any clear-cut predictions of the pattern of specialization and trade (Ottaviano, Puga, 1998).

[17] In the limit case, such an economy is characterized by a sort of “backyard capitalism”: each consumer becoming a Robinson Crusoe producing for his own consumption. In the case of competing firms each would produce a product for a mall market consisting of the workers they employ and farmers.

Market access

Increasing returns to scale turn out to be the decisive factor that prevents traditional trade theories from explaining spatial concentration of industry. Models of trade with increasing returns and imperfect competition explain why countries without a significant comparative advantage with respect to each other can develop different production structures on the basis of their different access to markets. The implications of these models for location and the effect economic integration has on them are formalized by Krugman and Venables (1990). Their model assumes that the world is divided into a large "core" country and a small "peripheral" country. The two have the same factor endowments, with the large country assuming a greater share of the total world endowments of factors. This difference in endowments is meant to reflect better access to markets of the larger country. Authors modeled two sectors of production: a perfectly competitive agricultural sector and a monopolistically competitive manufacturing sector producing differentiated manufactures under increasing returns to scale.

The model predicts that in equilibrium the core country will have a larger number of firms and a larger share of the manufacturing industry, making it a net exporter of manufacturing products. Furthermore, as trade costs decline (presumably as a consequence of economic integration) the difference between the two shares of manufacturing industry will change non-monotonically. Because of scale economies each variety is produced at only one location (each firm produces its own variety of the product, satisfying all of the world's demand for that product). Given that trade costs exist, more firms are likely to set up production in the country with the larger market so as to minimize trade costs in the larger fraction of their sales.[18] The crucial thing that is shown through this model is that the tendency to locate in the larger market is stronger for values of trade costs that are neither too high nor too low. With high trade costs, location is determined, similarly as in the case of comparative advantage based models, by product market competition, while with lower trade costs factor market competition takes over the determination of the location of economic activity.[19] This and similar models manage to highlight the fundamental ambiguity of the effects of economic integration on the relative competitiveness of core and peripheral regions, but still face many important shortcomings:

- first, the model assumes some underlying differences in country size, while not providing any answers to the question why such differences occurred in the first place;
- second, it fails to explain why firms in a particular sector would locate close to each other;

[18] Smaller fraction of sales will satisfy the demand of the smaller country and so incurring transport costs.
[19] The production in this case will follow lower costs of factors.

- finally, it presents industrial development as taking place gradually, while in practice industrialization often takes the form of waves.

3.2.3. Endogenous core-periphery patterns

Models of imperfect competition, production with increasing returns and trade costs, predict that firms and workers tend to locate close to larger markets, while large markets are in turn those where more firms and workers locate. Geographical economics (or new economic geography) attempts to formalize this kind of cumulative causation mechanisms to show that regions which are similar, or even identical in underlying structure, can endogenously differentiate into rich "core" and poor "peripheral" regions.

Several mechanisms for such cumulative causation have been developed. Krugman (1991) shows that the interaction of labor migration across regions with increasing returns and trade costs creates a tendency for firms and workers to cluster together as regions integrate. Perfect labor mobility is questionable at best in an international context with high barriers to migration limiting the role of labor mobility as a driving force for agglomeration. Ottaviano (2001) expands Krugman's model by introducing self-fulfilling and self-rewarding expectations. In doing so, he shows how impediments to trade and factor mobility can affect the relative importance of history (initial endowments) and expectations (initial beliefs) in determining the evolution of the spatial distribution of economic activities. Venables (1996) addresses this question by introducing vertical linkages between upstream and downstream industries, when both of them are imperfectly competitive.

Migration-induced demand linkages

Krugman (1991) states that given the mobility of certain factors, the pressure put on these factors by concentration of economic activity will be eased. Factor mobility will enable demand for factors to be satisfied instantaneously and small differences in the size of industry across regions can be built up. Even a priori identical regions can become differentiated into an industrialized core and a deindustrialized periphery.

Krugman's model is in essence very similar to the earlier Krugman and Venables (1990) model with two regions and two sectors (monopolistically competitive industry and perfectly competitive agriculture). There are some important differences though. First, each of the two sectors uses a specific factor, there is no intersectoral relocation of factors. Second, only workers are mobile between regions, while farmers (or land) are not. Finally, both regions are identical in every respect, including their endowment of immobile factors.

The model predicts that if a firm moved from one location to the other, the competition in the second location would increase in the product and labor markets, tending to reduce local profits and making the initial firm relocation unprofitable.[20] However, workers are attracted to the large region by the rise in demand for labor and the rise in the number of varieties produced. More workers increase local expenditure by increasing profits and attracting new firms. Whether the overall effect of entry is to increase or decrease the profitability of local firms, depends on the parameters of the model.

Once trade costs fall bellow a certain threshold, firms will cluster together exploiting demand linkages to each other's workers, while still competing in distant markets. There is though a range of trade costs for which agglomeration forces are too weak to destabilize the symmetric equilibrium, but strong enough to ensure that even though all firms were concentrated in one region, it would still be a locally stable equilibrium. With falling trade costs, a small firm's relocation from one region to another (from region 1 to region 2) will raise profits in region 2 and reduce profits in region 1. The industrial structures in the two regions are hence diverging. The stronger the preference for variety (the lower the elasticity of substitution between varieties), the higher the importance of having more varieties produced locally. The preference for variety also weakens local competition by making each producer a monopolist in the production of his variety. A larger share of manufactures in consumer expenditure also favors agglomeration because it augments the impact of immigration on the size of the local market for manufactures. By introducing intersectoral mobility in Krugman's (1991) model, Puga (1998) highlights the importance of labor supply elasticity. No matter how strong the incentives for the agglomeration of industry are, this can only take place if firms in a region can draw workers from elsewhere. A high elasticity of the labor supply from agriculture to manufacturing allows firms to attract workers from the agricultural sector in their own region with smaller wage increases, thus favoring agglomeration.

Input-output cost and demand linkages

Krugman's model (1991) relies on the assumption that workers move to regions that are doing relatively better in terms of manufacturing employment, which tends to eliminate interregional real wage rate differentials. There is evidence of such adjustment processes in the United States, while there is little evidence of labor reallocation across Europe, despite large inter-country wage differences. Generally, barriers to international migration make worker mobility a more suitable explanation for agglomeration in a regional rather then international context.

[20] If there were no labor migration, this would be the end of the story and the two regions would remain identical. This is an important change from the Krugman and Venables (1990) model, where intersectoral labor migration allows the manufacturing sector in the larger region to grow on the basis of the agricultural labor force.

Venables (1996) addresses this issue by arguing that the reason firms tend to agglomerate is not only due to linkages working through supply and demand for goods from consumers, but also due to direct input-output linkages amongst themselves. This means a formalization of Hirschman (1958) – type of “forward” and “backward” linkages between industrial firms in the economy. For a downstream industry to bestow a backward linkage on an upstream industry it is not enough that there is a buyer-supplier relationship; it must be the case that an increase in the output of the downstream industry, by enlarging the market for intermediates it uses, induces the upstream industry to produce at a more efficient scale and vice versa. To study the implications, Venables considers a “two country-two sector” model with immobile labor. Besides a perfectly competitive sector, he models an upstream and downstream imperfectly competitive industries, where the goods produced by upstream firms are inputs to downstream firms. Krugman and Venables (1995) rework the model by collapsing the upstream and downstream industries to a single imperfectly competitive sector, in which the output of each firm is sold both as a final good to consumers as well as an intermediate good to all other firms.

The effects of trade liberalization in such a framework depend on whether differences across regions in industrial employment levels are accompanied by differences in wages or not[21]. The relationship between integration and industrial location in this case is, in a qualitative sense[22], identical to that in Krugman’s (1991) model, if we assume the existence agricultural labor supply that is perfectly elastic to the demand from the manufacturing sector. Falls in trade costs first make agglomerations sustainable, and then destabilize the symmetric equilibrium, leading regions to endogenously differentiate into an industrialized core and a deindustrailized periphery. Similarly to Krugman (1991), the end result is a monotonic relationship between trade costs and agglomeration and concentration of production assuming that wages between the regions stay equal[23]. Linkages driving the agglomeration are different in both models with the increased demand for workers being replaced here by expenditure on intermediates, which is satisfied by newly arriving firms in Krugman, Venables (1995).

[21] The version of the model, where wages are equal in both regions, assumes the existence of agricultural labor supply that is perfectly elastic to the demand from manufacturing sector. The supply of the agricultural labor force has to be large enough so that it does not run out. If, and only if, this conditions hold, can the labor demand by the manufacturing sector be satisfied without an increase in wages and without interregional labor mobility (Ottaviano, Puga, 1998).

[22] If the share of intermediates in firm’s costs is the same as the share of manufactures in consumer expenditure, then also in a quantitative sense.

[23] The case of non-equal regional wages is discussed later in this section.

Endogenous growth, factor accumulation and intertemporal growth

Baldwin (1997) suggests yet another alternative way in which agglomeration may occur without factor migration. He shows that factor accumulation can play the same role as migration in fostering agglomeration through linkages. The structure of the model is similar to Krugman and Venables (1990) with the addition of research and development activity that uses labor to invent and patent new manufactures. Patents are non-tradable, so production occurs where invention takes place. Decreasing returns to patent accumulation imply that the economy eventually reaches equilibrium where no more innovation takes place. The crucial question then becomes whether profits accruing to new patents increase or decrease with the number of firms in a given location. These profits are determined as the balance between the attractiveness of the larger market and the unattractiveness arising from product and factor market competition. If the case of the former prevails, then invention pays more in the larger market. As in Krugman (1991), this happens for low trade costs, a large share of expenditures devoted to the differentiated products and low elasticities of substitution (Ottaviano, Puga, 1998).

Walz (1996) develops a model where migration and aggregate increasing returns to scale at the local level can trigger agglomeration and faster growth. Martin and Ottaviano (1996, 1998) consider instead increasing returns at the firm level showing that local technological externalities in factor accumulation reinforce the incentives toward agglomeration stemming from local pecuniary[24] externalities in production. These authors also introduce an intertemporal version of forward and backward linkages. As with static linkages, the end result is agglomeration, one location specializing in innovation and manufacturing, the other in the traditional production. Similarly as in the other models seen so far (with the exception of Krugman, Venables (1995) with non-equal regional wages), there is again a monotonic relationship between trade cost reduction and agglomeration predicted by the models.

3.2.4. Dispersion forces working against agglomeration

Labor mobility as a dispersion force

Puga (1998) presents a model combining interregional labor migration and input-output linkages as forces that may drive agglomeration; he also takes a closer look at the interaction between constant and increasing returns activities in the labor market.

[24] Pecuniary externalities are associated with either demand or supply linkages rather then purely technological spillovers. For example, if one firm's actions affect the demand for the product of another firm whose price exceeds marginal costs, this is as much a real externality as if one firm's research and development spills over into the general knowledge pool (Krugman, 1991, p. 485).

First, a comparison of the outcomes with and without interregional labor migration shows that labor mobility both quickens agglomeration, with workers moving to the region with higher wages, as well as makes it stronger when it occurs. Second, if wage differences are not eliminated by migration, they act as a dispersion force by increasing production costs for firms producing in locations with relatively many other firms. Third, this dispersion force can moderate agglomeration and sustain non-extreme equilibria, in which all regions have manufacturing, even if in different proportions. Fourth, firms find higher local wages discouraging as regions become more integrated, so for low trade costs the price of non-tradable factors determines location.

Venables (1996) points out that with zero trade costs firms locate in regions with lower wages. Supposing that wages are increasing in industrial employment and trade costs are sufficiently close to zero, then agglomeration in one region cannot be an equilibrium. Krugman and Venables (1995) illustrate this with examples in which for low trade costs some firms relocate to regions with lower wages, but not to the extent of allowing full convergence. Puga (1998) and Krugman, Venables (1995) show that an inverted *U*-shape relationship is possible with regard to agglomeration, which is in clear contrast with Krugman's (1991) proposed monotonic relationship.

Non-tradability as a dispersion force

There is another possible reason why integration can lead to a convergence of income levels. Helpman (1997) shows that an inclusion of the non-tradable housing sector into the model can cause deagglomeration after the initial concentration of production. Helpman uses the basic structure of Krugman's (1991) model, but replaces the agricultural sector with a non-tradable housing sector. Helpman finds that a reduction in trade costs improves the availability of manufactures in less congested areas and induces workers to migrate out of more congested areas to save housing costs. This obviously works against agglomeration.

3.2.5. Industrial specialization

The models revised so far ignored the potential for specialization of industries, which simply means agglomeration on a more disaggregated level than overall manufacturing. One of the strongest trends in geographical economics has been the increasing specialization of countries in different manufacturing sectors (Brülhart, 1996).

Krugman, Venables (1996) consider a structure of the model similar to the Krugman, Venables (1995) model, but with one main difference: the two productive manufacturing sectors are imperfectly competitive, and firms in each sector sell and buy a higher proportion of intermediates to and from firms in the same sector than to and from firms in the other sector. When a firm moves to a region under consideration, the beneficial cost and demand linkages more intensely affect firms in the same sector, while increased product and labor market competition harm both sectors equally. This results in each region specializing in the production of one sector, as the first mover will be followed by other firms from the same sector, while firms of the other sector will be gradually driven out of the region, due to the negative effects of increased competition in product and labor markets.

Venables (1998) expanded this model to a continuum of imperfectly competitive sectors and a perfectly competitive sector. With only two locations, he shows that there are bounds to sustainable regional differences between regions and that the maximum share of total industry, that the region can capture, first increases but decreases later during a process of regional integration. However, within these bounds the actual division of sectors between regions is indeterminate.

3.2.6. Implications of modern spatial economics

The previous section dealt with a brief overview of most of the main strains of economic geography theory, developed in the last decade. Comparative advantage based theories, representing a clear link to traditional trade theory, fail to fully explain the spatial distribution of economic activity through differences in factor endowments.

New economic geography theory took to modeling the spatial aspects of economic activity by introducing a large variety of centripetal (centrifugal) forces working towards (against) the agglomeration of production. The development of economic geography has seen the mathematical formalization of such centripetal forces as market access of manufacturing firms, labor migration across regions inducing factor demand linkages, input-output cost and demand linkages, as well as factor accumulation effects. These forces enable and foster the agglomeration of industrial production in certain regions but have an opposite effect on the rest of the country. This leads to a divergence between the affected regions in the share of manufacturing, wages and other indicators. Centrifugal forces such as high transport costs, increasing factor costs (labor) and costs of non-tradable factors, on the other hand, work toward reversing the agglomeration effects and enabling industry to disperse more evenly across space.

The combination of these centrifugal and centripetal forces ultimately determines the location of industry across countries and regions, with the prevailing force dictating whether economic activity will be spatially concentrated or evenly distributed between regions and countries.

4. A TWO FACTOR, THREE NON-SYMMETRIC REGION MODEL OF ECONOMIC GEOGRAPHY

The basic structure of the model relies on the implementation of the Dixit-Stiglitz (1977) monopolistic competition model (DS model henceforth) and other modules in a broader spatial framework in order to explore the implications of factor reallocation on the location of economic activity. The foundation for the implementation of the DS model was laid by Paul Krugman (1991) and later by Fujita, Krugman, Venables (1999) (henceforth FKV model), whose model combined monopolistic competition with production in multiple locations and the incurrence of transport costs between those locations.

Krugman's (1991) breakthrough model, described briefly in the previous chapter, assumes perfect labor mobility as an agglomeration force, leading to a monotonic relationship between decreasing trade costs and relative regional wages. Fujita, Krugman, Venables (1999) model, on the other hand, abandons the perfect labor mobility, which causes the now infamous *U*-shaped relationship between trade costs and relative wages to occur. These two models present only the two extreme points in the evolution of economic geography models, where a large number of other possibilities in modeling of spatial economics have been considered.

In developing my own economic geography model, I revise some of the failings of the preceding models. First, in line with the *FKV* model, I drop the assumption of perfect labor mobility instituted by Krugman (1991), which is unrealistic at best, and model labor as immobile between locations. Second, both the Krugman model as well as the *FKV* model use labor as the only factor of production, which I amend by introducing capital as the second factor of production, enabling the model to yield some predictions with respect to the direction of foreign direct investment and other capital movements. Finally, I also replace the *FKV* model's unrealistic assumption of symmetric home region location with non-symmetric position of home regions vis-à-vis the foreign country. My aim with the model is to discover what effects trade liberalization may have on the convergence or divergence between home regions, as well as to present the effects that other variables may have on this process (primarily foreign direct investment).

Similarly as in the *FKV* model, I also consider an economy with two sectors, agriculture and manufacturing. The agricultural sector produces a single homogenous good under a perfectly competitive market structure, whereas the manufacturing sector provides a large variety of differentiated goods[25]. Assuming an infinite number of potential manufacturing varieties, the

[25] Agricultural sector presents a residual to the main, manufacturing sector, and the fact that it is a perfectly competitive sector producing homogenous goods represents a counterpart to the increasing returns, monopolistic manufacturing sector.

product space can be represented as continuum, which enables me to avoid the possible integer constraints on the number of goods.

In this chapter, I intend to develop my own version of the spatial model for the allocation of production factors[26], whereby I first revise the consumer behavior functions as presented in the *FKV* model (Fujita, Krugman, Venables, 1999, pp. 46-49). In the modeling of consumer behavior, no explicit mention is given to the location of production. In section 4.2, multiple locations of production are explicitly modeled and "iceberg" form transport costs are introduced. Producer behavior functions will be greatly modified as compared to the *FKV* model by the inclusion of the second production factor (capital) and the modeling of external returns to scale in section 4.3, while the ensuing wage and interest rate equations, as well as their basic implications, will be presented in section 4.4. In section 4.5, some basic normalizations will be applied to the wage and interest rate equations in order to simplify some of the interactions. Breaking of the home region symmetry towards the foreign country is an important modification of the *FKV* model, whereby I assume that the smaller home region is closer to the foreign country than the central home region. The asymmetrical model and its implications are presented in section 4.7, whereas in section 4.8, a number of numeric simulations of such a model are carried out. This enables a better understanding of the underlying mechanisms and allows for some simple conclusions to be made with regard to behavior of the model when some of the more important exogenous variables are modified.

4.1. CONSUMER BEHAVIOR

All consumers share the same basic Cobb-Douglas preferences for the two basic types of goods:

(1) $$U = M^{\mu} A^{1-\mu},$$

where *M* represents the composite index of the consumption of manufactured goods, *A* is the consumption of the agricultural good, and μ is the constant representing the expenditure share of manufactured goods in the consumption.

M is a quantity index of all manufactured goods where a subutility function for manufacturing varieties is defined over a continuum of manufacturing varieties. *m(i)* denotes the consumption of each available variety; and *n* is the range (number) of varieties produced (number of available varieties). As in the *FKV* model (Fujita, Krugman, Venables, 1999, p. 46), *M* is assumed to be defined by a CES function:

[26] The model was outlined in Damijan, Kostevc (2002).

$$(2) \qquad M = \left[\int_0^n m(i)^\rho \, di \right]^{\frac{1}{\rho}}, \qquad 0 < \rho < 1$$

where parameter ρ represents the intensity of the preference for any given variety of manufactured goods. When ρ is closer to 1, differentiated goods are nearly perfect substitutes for each other, while as ρ gets closer to 0, the desire to consume a greater variety of manufactured goods increases, due to the fact that the varieties are less than perfect substitutes and consumers wishing to satisfy their preference for variety will be spending more of the available varieties. ρ can be expressed in the form of the elasticity of substitution:

$$(3) \qquad \sigma \equiv \frac{1}{1-\rho} \qquad \rho \equiv \frac{\sigma - 1}{\sigma} \quad ,$$

where σ represents the elasticity of substitution that is equal between any two varieties. Due to the constraints placed on ρ, σ can only assume values between 1 and ∞.

Given that income is Y and prices are p^A and $p(i)$ for agricultural products, and for each variety of manufacturing goods, respectively, the consumer is maximizing his utility (1) according to the budget constraint:

$$(4) \qquad Y = p^A A + \int_0^n p(i) m(i) di \quad .$$

According to the value of the manufacturing composite (M), each $m(i)$ has to be chosen so as to minimize the cost of attaining M. This can be achieved by solving the following minimization problem:

$$(5) \qquad \min \int_0^n p(i) m(i) di \qquad \text{subject to} \qquad M = \left[\int_0^n m(i)^\rho \, di \right]^{\frac{1}{\rho}} .$$

The first order condition for this expenditure minimization problem gives the equality of marginal rates of substitution to price ratios (6). A consumer will maximize his utility by consuming such quantities of manufacturing varieties that his utility curves will be tangent to the relative price curve:

$$(6) \qquad \frac{m(i)^{\rho-1}}{m(j)^{\rho-1}} = \frac{p(i)}{p(j)} \quad .$$

Expressing $m(i)$ and using the original constraint (2), as well as bringing the common term $m(j) p(j)^{1/(1-\rho)}$ outside the integral, then for any pair i, j (6), it leads to:

$$(7) \qquad m(j) = \frac{p(j)^{1/(\rho-1)}}{\left[\int_0^n p(i)^{\rho/(\rho-1)} di\right]^{1/\rho}} M \quad .$$

Equation (7) is simply a compensated demand function for the *j*-th variety of manufactured goods.

An expression for the minimum cost of attaining *M* can also be derived considering that the expenditure on the *j*-th variety is *p(j)m(j)*, so using (7) and integrating over all *j* ($j = 0,...,n$) gives:

$$(8) \qquad \int_0^n p(j)m(j)dj = \left[\int_0^n p(i)^{\rho/(\rho-1)} di\right]^{(\rho-1)/\rho} M \ .$$

The term multiplying *M* on the right hand side of (8) can be defined as a price index, so that the price index times the quantity consumed equals total expenditure. Denoting the price index for manufacturing goods as *G*, we get:

$$(9) \qquad G \equiv \left[\int_0^n p(i)^{\rho/(\rho-1)} di\right]^{(\rho-1)/\rho} = \left[\int_0^n p(i)^{1-\sigma} di\right]^{1/(1-\sigma)} ,$$

where *G* measures the minimum cost of purchasing a unit of composite index *M* of manufacturing products. If we consider *M* to be a utility function, then *G* could be thought of as an expenditure function. Using (7) and (9), the demand for *m(j)* can be written more compactly as:

$$(10) \qquad m(j) = \left(\frac{p(j)}{G}\right)^{1/(\rho-1)} M = \left(\frac{p(j)}{G}\right)^{-\sigma} M \ .$$

Consumer satisfies his utility in two steps. In the first step he divides total income between agriculture and manufactures in aggregate, that is, to choose *A* and *M* so as to:

$$(11) \qquad \max U = M^{\mu} A^{1-\mu} \quad \text{subject to} \quad GM + p^A A = Y \ ,$$

which yields a familiar result that $M = \mu Y/G$ and $A = (1-\mu)Y/p^A$. The second step involves choosing the desired quantities of manufacturing goods as presented earlier. Joining individual stages together, the following compensated demand functions can be obtained. For agriculture, the demand function yields:

$$(12) \qquad A = (1-\mu)Y / p^A \ ,$$

and for each variety of manufactures the demand function is:

$$(13) \qquad m(j) = \mu Y \frac{p(j)^{-\sigma}}{G^{-(\sigma-1)}} \quad \text{for} \quad j \in [0, n] \ .$$

Holding G constant, we can notice that the price elasticity for every available variety is constant and equal to σ.

Maximized utility as a function of income, the price of agricultural output, and the manufacturers' price index, gives an indirect utility function:

$$(14) \qquad U = \mu^{\mu}(1-\mu)^{1-\mu} Y G^{-\mu} (p^{A})^{-(1-\mu)} \ .$$

The term $G^{\mu}(p^{A})^{(1-\mu)}$ is the cost of living index in the economy.
As opposed to the standard DS models, the *FKV* model (1999, p. 48) endogenizes the range of manufactures supplied. This makes it crucially important to understand the effects of changes in n (number of varieties) on the consumer.
Increasing the number of varieties on offer will act towards reducing the manufacturers' price index G (because consumers value variety[27]) and subsequently reduce the costs of attaining a given level of utility. This can be seen more clearly if we assume that all manufacturers' prices are the same, p^M . This turns (9) into:

$$(15) \qquad G \equiv \left[\int_0^n p(i)^{1-\sigma} di \right]^{1/(1-\sigma)} = p^M n^{1/(1-\sigma)} \ .$$

The price index's responsiveness to the number of varieties ($\partial G/\partial n$) depends on the elasticity of substitution between varieties (σ), with the lower σ (more differentiated product varieties) leading to the greater reduction in the price index caused by an increase in the number of varieties. The effect of a larger number of varieties on welfare is given represented by (14).

4.2. MULTIPLE LOCATIONS AND TRANSPORT COSTS

In this section, I intend to introduce spatial aspects into the model with multiple locations in production and consumption by introducing transport costs between different locations. Until now, perfect mobility of goods was assumed, meaning that no costs incurred during transport of goods. The lack of transport costs assumed thus far, implies either that all production and consumption took place at a single location, which would imply that there is no international trade (and no trade between any locations) or, on the other hand, that all goods traded are

[27] The consumers' preference for variety leads to the consumption of all available varieties, while the budget constraint limits the consumption of a single variety. An increase in the number of varieties consumed should lead to a decrease of demand for a single variety (basically a downward shift of the demand curve for a single variety should occur), which would ultimately cause a fall in the price of this variety.

perfectly mobile between locations[28]. Once we allow for the existence of transport cost in trade the decisions of individual consumers and producers with regards to their consumption (production) choices will be affected, and these changed decisions will in turn shape the spatial distribution of economic activity.

4.2.1. Modeling iceberg transport costs

In principle transport costs could be modeled by adding a transport sector to the model, which would supply transportation services to other sectors, but this would unnecessarily complicate the model. The transportation costs of the manufacturing and agricultural sectors would present revenue for the transportation sector. Issues of the transportation sector spending, as well as location decisions made by the transportation sector, would also have to be dealt with in the model.

Instead, we model transportation costs by using the simplifying "iceberg" assumption, which is commonly attributed to Samuelson[29] (1952), although his notion of real transport costs, which use up the product in shipping, gets only a slight mention in his discussion on the transfer problem (Samuelson, 1952, p. 294). The term "iceberg" form transportation costs, implying that a part of the good melts away during transport, was coined later by other authors.

In the context of the core model of geographical economics, iceberg transport costs imply that out of a unit of good shipped from location r to location s only a fraction $1/T_{rs}$ of the original unit arrives with the rest melting away en route. The rest of the unit $1-(1/T_{rs})$ represents the cost of transportation. T_{rs} is therefore a parameter representing transportation costs; defined as the number of goods that need to be shipped in order to ensure that one unit of good arrives at the destination. Supposing, for example, that 107 flowers are sent from Holland to France with only 100 arriving in Paris unharmed. Then T = 1,07 and cost of transport is 0,07/1,07 (6,5%) (Brakman, Garretsen, Marrewijk, 2001, p. 81).

The iceberg transport technology implies that if a manufacturing variety produced at location r is sold at price p_r (f.o.b.), then the delivered (c.i.f.) price p_{rs} of that variety at each consumption location s is given by:

$$(16) \qquad p_{rs}^M = p_r^M T_{rs}^M \ .$$

[28] This would have to imply that transport of goods occurs instantaneously incurring no costs regardless of the actual distance traveled. In international trade there are also no other trade impediments.
[29] Von Thünen (1828) is considered by many to be the originator of the "iceberg" assumption transport costs, when he proposed that the cost of grain transportation consists largely of the grain consumed on the way by the horses pulling the wagon and of the wages paid to the driver in kind (Fujita, Krugman, Venables, 1999, p. 59).

4.2.2. Implications of multiple locations on consumption and production

Iceberg transport costs combined with the assumption that all varieties produced in a particular location have the same price means that, using (5), the price index G can be written as:

$$(17)\qquad G_s = \left[\sum_{r=1}^{R} n_r (p_r^M T_{rs}^M)^{1-\sigma}\right]^{1/(1-\sigma)},\ s = 1,\ldots,R\ .$$

Aggregate consumption demanded by consumers in location s for a product produced in r now follows from (13):

$$(18)\qquad m(j) = \mu Y_s (p_r^M T_{rs}^M)^{-\sigma} G_s^{(\sigma-1)},$$

where Y_s is income for location s. To supply this level of consumption, T_{rs}^M times this amount has to be shipped. I assume that no transport costs can be incurred within each location (each region). Summing the consumption across all locations in which that product is sold, the total sales of a single location r variety, denoted q_r^M, therefore amount to:

$$(19)\qquad q_r^M = \mu \sum_{s=1}^{R} Y_s (p_r^M T_{rs}^M)^{-\sigma} G_s^{\sigma-1} T_{rs}^M\ .$$

Sales of each firm depend on income in each location, the price index at that location, transport costs, and the production price. The elasticity of the aggregate demand for each variety with respect to the production price is σ because the delivered price ($p_r T_{rs}$) of the same variety at all consumption locations changes proportionally to the production price, and because each consumer's demand for a variety has a constant price elasticity σ.

4.3. PRODUCER BEHAVIOR

The assumption is that the agricultural good is produced using constant-returns technology under conditions of perfect competition in the markets. Manufacturing, however, is assumed to involve economies of scale arising at the level of variety (there are no economies of scope or of multiplant operation foreseen in the model). Technology is the same for all varieties and in all locations and involves a fixed input F and marginal input requirement c^M.

Here my model starts to differ from the *FKV* model with the inclusion of the second production input. I model the production function with both capital and labor, where economies of scale are possible in the use of both factors. The inclusion of capital as the second factor of production enables the modeling of capital flows and their effects on the location of production. My model also assumes the existence of both internal and external economies of scale, while the *FKV* model proposes that only internal economies of scale are relevant.

I use a simple cost/production function as the basis for the analysis of producer behavior:

$$(20) \qquad C = F_r^M + c_r^M q^M \quad ,$$

where C is the total cost incurred in the production of q units of manufacturing products (the cost of both labor and capital used), with F_M representing the total fixed costs and c_r^M representing the total variable costs (19). The existence of fixed costs enables me to model internal economies of scale, while external economies of scale are modeled through marginal costs[30], where we assume that the size of a region (expressed by the number of firms n_r) is negatively correlated with the size of the marginal cost in the region:

$$(21) \qquad c_r^M = n_r^{-\sigma}(\frac{w_r}{\alpha})^{\alpha}(\frac{i_r}{\beta})^{\beta} \qquad\qquad F_r^M = w_r L_f + i_r K_f \quad ,$$

where w_r and i_r are the nominal wage and interest rate in region r, and L_f and K_f the required fixed amounts of labor and capital.

Because of the increasing returns to scale, consumers' preference for variety, and the unlimited number of potential varieties of manufactured goods, no firm will choose to produce the same variety supplied by another firm. The number of manufacturing varieties will therefore ultimately equal the number of manufacturing firms.

Solving the profit maximization problem for each individual firm at a specific location facing a given nominal wage rate w_r^M for manufacturing workers there and a nominal interest rate i_r^M, the profit maximizing price is[31]:

$$(22) \qquad p_r^M(1-1/\sigma) = n_r^{-\sigma}(\frac{w_r}{\alpha})^{\alpha}(\frac{i_r}{\beta})^{\beta} \qquad \text{or} \qquad p_r^M = \frac{(\frac{w_r}{\alpha})^{\alpha}(\frac{i_r}{\beta})^{\beta}}{n_r^{\sigma}(1-1/\sigma)} \quad .$$

Assuming free entry and exit in response to profits or losses, the zero-profit condition implies that the equilibrium output of any active firm is:

[30] Modeling external economies of scale is simplified due to the complexity of the issue. External economies of scale arise due to input-output linkages, with firms using intermediate products of other firms in the assembly of final goods. For more on this issue see Damijan (1999).

[31] Considering that the price is maximized at quantity q*, where $MC = MR$ and

$$MR = \frac{d(TR)}{dq} = \frac{d(p_r^M q)}{dq} = p_r^M + \frac{q(dp_r^M)}{dq} = p_r^M\left(1 + \frac{q}{p_r^M}\frac{dp_r^M}{dq}\right) = p_r^M\left(1 - \frac{1}{\sigma}\right) = MC$$

(23) $$q*_r^M = \frac{F_r^M(\sigma-1)n_r^\sigma}{(\frac{w_r}{\alpha})^\alpha(\frac{i_r}{\beta})^\beta} \quad .$$

If we apply Shephard's lemma[32] (for the proof of Shephard's lemma see Appendix A), we can derive the demand for labor and capital when the equilibrium output is produced. Shephard's lemma states that the derivative of the cost function with respect to an input price gives the variable portion of the demand function for that factor. To attain equilibrium labor (capital) inputs we have to multiply the variable factor demand with the equilibrium output and also acknowledge fixed labor (capital) requirements.

Equations (24)-(27) derive the demand for *K* and *L*:

(24) $$l_r^* = \frac{\partial c}{\partial w}q^* + L_f$$

(25) $$l_r^* = \frac{\left[\left(\frac{w}{\alpha}\right)^\alpha\left(\frac{i}{\beta}\right)^\beta\right]\frac{\alpha}{w}}{n^\sigma}\frac{F(\sigma-1)n^\sigma}{\left[\left(\frac{w}{\alpha}\right)^\alpha\left(\frac{i}{\beta}\right)^\beta\right]} + L_f$$

(26) $$l_r^* = \frac{\alpha\left(wL_f + iK_f\right)(\sigma-1)}{w} + L_f$$

(27) $$l_r^* = L_f(\alpha\sigma - \alpha + 1) + K_f\frac{\alpha(\sigma-1)i_r}{w_r}$$

$$k_r^* = K_f(\beta\sigma - \beta + 1) + L_f\frac{\beta(\sigma-1)w_r}{i_r} \quad ,$$

both *l** and *k** are common to every active firm in the region, with the number of varieties produced in the region *r* (n_r) equaling:

(28) $$n_r = L_r^M / l* = K_r^M / k* \quad .$$

L_r^M and K_r^M represent manufacturing labor and capital endowments in region *r*. These two parameters specify the size of a certain region. The ratio of labor to capital is fixed by the production (cost) function (21) and is therefore equal for every region (home and foreign) due to

[32] For more on the validity of Shephard's lemma and the assumptions that have to be satisfied for it's validity see Fuchs-Selinger (1995,1997).

the assumption of identical production functions at all locations (no technological differences exist within a country nor between countries).

4.4. THE MANUFACTURING WAGE EQUATION

Using a demand function for a single variety (19), the firm's equilibrium level of output should satisfy:

$$(29) \qquad q^* = \mu \sum_{s=1}^{R} Y_s (p_r^M)^{-\sigma} (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \quad ,$$

where Y_s represents the nominal income of region s (the income of the region consists of labor and capital incomes, i.e. $Y_s = L_s{*}w_s{+}K_s{*}i_s$).

We can turn (29) around and express the break even price for every firm in a region:

$$(30) \qquad (p_r^M)^{\sigma} = \frac{\mu}{q^*} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \quad .$$

Using the pricing rule (22), nominal wages and nominal interest rates for region r can be expressed as:

$$(31) \qquad \left(\frac{w_r}{\alpha}\right)^{\alpha\left(\frac{\sigma-1}{\sigma}\right)} = \frac{n_r^{\sigma-1}\left(\frac{\sigma-1}{\sigma}\right)}{\left(\frac{i_r}{\beta}\right)^{\beta\left(\frac{\sigma-1}{\sigma}\right)}} \left[\frac{\mu}{(F(\sigma-1))} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1}\right]^{1/\sigma}$$

$$(32) \qquad \left(\frac{i_r}{\beta}\right)^{\beta\left(\frac{\sigma-1}{\sigma}\right)} = \frac{n_r^{\sigma-1}\left(\frac{\sigma-1}{\sigma}\right)}{\left(\frac{w_r}{\alpha}\right)^{\alpha\left(\frac{\sigma-1}{\sigma}\right)}} \left[\frac{\mu}{(F(\sigma-1))} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1}\right]^{1/\sigma} .$$

Equation (31) reveals that wages at location r increase with the rise of incomes in all regions (including region r), which represent the firms' markets. Firms' access to the markets (lower T_{rs}^M) increases nominal wages of the firms in the region. On the other hand, the more competition the firm faces in these markets, the lower the wages will be, due to the fact that the price index decreases with the number of varieties sold (with a small number of varieties sold, G_s is relatively high, therefore raising the wages in the region of origin). In addition, the augmented model with respect to the basic *FKV* model reveals that the wages depend also on the nominal interest rate in the region causing the nominal wage rates to fall with higher interest rates (Damijan, Kostevc, 2002). An important property of the wage equation is also the positive relationship between wages and the number of firms producing in a region, which can be attributed to the external economies of scale.

Expressing the nominal interest rate (32) gives the opposite relationship with the product of nominal wages and nominal interest rates being determined by (31) and (32). With the product of the two factor costs being determined endogenously by the model, one of the two factors has to be determined exogenously in order for the other one to remain endogenous. The product of wages and interest rates is determined for a single region and applies for all firms in the region and those that could enter the markets.

4.5. SOME NORMALIZATIONS

Choosing the units of measurement appropriately, we can simplify the equations and make the analysis somewhat simpler. Simplifying the equations makes the subsequent analysis somewhat more transparent and clearer, without causing any loss to the generality of the conclusions. We are free to choose the units of measurement to satisfy the following equation[33]:

$$(33) \qquad F = \mu / \sigma$$

The wage and interest rate equations then become:

$$(34) \qquad \left(\frac{w_r}{\alpha}\right)^{\alpha(\sigma-1)} = \frac{(n_r^{\sigma-1}(\rho))^{\sigma}}{\left(\frac{i_r}{\beta}\right)^{\beta(\sigma-1)}} \left[\frac{1}{\rho} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \right]$$

$$(35) \qquad \left(\frac{i_r}{\beta}\right)^{\beta(\sigma-1)} = \frac{(n_r^{\sigma-1}(\rho))^{\sigma}}{\left(\frac{w_r}{\alpha}\right)^{\alpha(\sigma-1)}} \left[\frac{1}{\rho} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \right] \quad .$$

Comparing (31) and (32) to (34) and (35) it can be seen that later equations are a simplified version of the former. The first part of the equation in the brackets has been simplified from $\mu/F(\sigma-1)$ to $1/\rho$. This makes the equations slightly less complex and easier to analyze.

4.6. THE PRICE INDEX EFFECT AND THE HOME MARKET EFFECT

Considering just the two home regions, we can apply (17) and (31) to determine some interesting conclusions of this system of equations. Price indices and wage equations (17) and (31) do not define a full economic model, which is determined by a number of equations that create a general

[33] This means that we disregard the fact that both the elasticity of substitution (σ) as well as the share of manufacturing in consumption (μ) are in per cents, while fixed costs of production (F) are in units of costs.

equilibrium model, however, they do imply some very important relationships such as the price index effect and the home market effect.

Writing the two equations out in full for the two home regions, we have the price indices (17),

$$(36) \qquad G_1^{1-\sigma} = n_1 p_1^{1-\sigma} + n_2 p_2^{1-\sigma} T^{1-\sigma}$$
$$G_2^{1-\sigma} = n_1 p_1^{1-\sigma} T^{1-\sigma} + n_2 p_2^{1-\sigma} \ ,$$

and the wage equations, (31),

$$(37) \qquad \left[(\frac{w_1}{\alpha})^{\alpha} (\frac{i_1}{\beta})^{\beta} \right]^{(\sigma-1)} = \left(n_1^{\sigma(\sigma-1)} \rho^{\sigma} \frac{\mu}{F_1(\sigma-1)} \right) \left(Y_1 G_1^{\sigma-1} + Y_2 G_2^{\sigma-1} T^{1-\sigma} \right)$$
$$\left[(\frac{w_2}{\alpha})^{\alpha} (\frac{i_2}{\beta})^{\beta} \right]^{(\sigma-1)} = \left(n_2^{\sigma(\sigma-1)} \rho^{\sigma} \frac{\mu}{F_2(\sigma-1)} \right) \left(Y_1 G_1^{\sigma-1} T^{1-\sigma} + Y_2 G_2^{\sigma-1} \right),$$

where transport costs between both home locations have been denoted by T , maintaining the assumption that no transport costs can be incurred within a region. Each region is assumed to be small enough so that no transport costs within a region occur. Both pairs of equations are symmetric due to the fact that only two regions are used and the distance effects are the same for both regions. Due to the symmetry of the above systems of equations, there is also a symmetric solution; i.e. if $n_1 = n_2$, $i_1 = i_2$ and $Y_1 = Y_2$, there is a solution with $G_1 = G_2$ and $w_1 = w_2$. Such symmetric equilibrium parameters therefore satisfy the following relationships:

$$(38) \qquad 1 + T^{1-\sigma} = \frac{G^{1-\sigma}}{\left[(\frac{w}{\alpha})^{\alpha} (\frac{i}{\beta})^{\beta} \right]^{1-\sigma} n^{\sigma(\sigma-1)+1} \rho^{\sigma-1}} = \frac{G^{1-\sigma}}{\left[(\frac{w}{\alpha})^{\alpha} (\frac{i}{\beta})^{\beta} \right]^{1-\sigma} n^{\sigma(\sigma-1)} \rho^{\sigma} \frac{\mu Y}{F(\sigma-1)}} \ .$$

The absence of subscripts in (38) denotes the fact that these are symmetric equilibrium values, equal for both regions.

The relationships between price indices and wage (interest rate) equations can be further explored by linearizing them around the symmetric equilibrium (38). Around the point of equilibrium an increase in a variable in one location is always associated with a change of opposite sign but of equal absolute magnitude (a decrease of the same magnitude) in the corresponding variable in the other country. So letting $dG = dG_1 = - dG_2$ and so on, we derive, by differentiating, the price indices and wage equations respectively (see Appendix B for details):

$$(39) \qquad (1-\sigma)\frac{dG}{G} = \frac{\left[(\frac{w}{\alpha})^{\alpha} (\frac{i}{\beta})^{\beta} \right]^{1-\sigma} n^{\sigma(\sigma-1)+1} \rho^{\sigma-1}}{G^{1-\sigma}} \left[(1-\sigma)(\alpha\frac{dw}{w} + \beta\frac{di}{i}) + (\sigma(\sigma-1)+1)\frac{dn}{n} \right] (1 - T^{1-\sigma})$$

$$(40) \qquad (\sigma-1)(\alpha\frac{dw}{w}+\beta\frac{di}{i})=\frac{n^{\sigma(\sigma-1)}\rho^{\sigma}\mu YG^{\sigma-1}}{\left[(\frac{w}{\alpha})^{\alpha}(\frac{i}{\beta})^{\beta}\right]^{\sigma-1}F(\sigma-1)}\left[\sigma(\sigma-1)\frac{dn}{n}+\frac{dY}{Y}+(\sigma-1)\frac{dG}{G}\right](1-T^{1-\sigma}) \ .$$

This set of equations enables me to examine the price index effect and the home market effect in subsections 4.6.1. and 4.6.2., respectively.

4.6.1. Price index effect

Equation (39) shows direct effects of a change in the location of manufacturing on the price index of manufactured goods:

$$(41) \qquad (1-\sigma)\frac{dG}{G}=\frac{1-T^{1-\sigma}}{1+T^{1-\sigma}}\left[(1-\sigma)(\alpha\frac{dw}{w}+\beta\frac{di}{i})+(\sigma(\sigma-1)+1)\frac{dn}{n}\right] .$$

It is convenient at this point to introduce a new variable, variable Z:

$$(42) \qquad Z=\frac{1-T^{1-\sigma}}{1+T^{1-\sigma}} \ ,$$

which is in essence an index of trade costs, with values between 0 and 1. If trade is perfectly costless ($T = 1$), then Z takes the value of 0, while, on the other hand, if trade is impossible ($T = \infty$), Z takes the value of 1.

Supposing that the supply of labor and capital are perfectly mobile[34] (meaning that both dw/w and di/i are zero, because perfect mobility of factors prevents changes in factor costs, with every increase in demand for factors met instantaneously). Bearing in mind that $(1\text{-}\sigma) < 0$ and that $T > 1$ (which leads to $Z > 0$), (38) implies that a change in the number of firms (dn/n) has a negative effect on the price index (dG/G). This has been termed the **price index effect** (Fujita, Krugman, Venables, 1999, p. 56). It means that the location with a larger manufacturing sector also has a lower price index for manufactured goods, simply because a smaller proportion of this regions consumption bears transport costs. The larger the home-region manufacturing sector compared with the other regions (locations), the larger the share of home products in consumption, which bear no transport costs. When a greater proportion of consumption is satisfied by more distant locations, this will adversely affect the price index, with prices from those locations being proportionally higher with transport costs.

[34] For an in depth discussion and a mathematical derivation of the effects of capital and labor mobility see also Bental (1985) and van Bemmelen (1985).

4.6.2. Home market effect

Having determined what effect the price index has, I now turn to the analysis of the home market effect. Using the definition of *Z* and (39) and (40) to eliminate *dG/G, dY/Y* can be expressed as follows:

$$(43) \qquad \frac{dY}{Y} = (\sigma - 1)\left[\alpha\frac{dw}{w} + \beta\frac{di}{i}\right](\frac{1}{Z} - Z) + \frac{dn}{n}\left[Z(\sigma(\sigma - 1) + 1) - \sigma(\sigma - 1)\right]$$

Supposing again that the wider economic model gives a perfectly elastic supply of labor and capital to manufacturing, so that $dw = di = 0$, this would lead to the so-called **home market effect**. A one per cent change in demand for manufacturing (*dY/Y*) causes a $1/\left[Z(\sigma(\sigma-1)+1)-\sigma(\sigma-1)\right]$ per cent change in the number of varieties, and hence production of manufactures (*dn/n*). If $Z(\sigma(\sigma-1)+1)-\sigma(\sigma-1) > 0$, which is true if:

$$(44) \qquad Z > \frac{\sigma(\sigma-1)}{\sigma(\sigma-1)+1} \quad ,$$

then an increase in demand for manufacturing (*dY/Y*) causes an increase in the number of varieties produced (*dn/n*). This, given the assumption of perfect factor mobility, also means that an increase in demand for manufacturing will lead to an increase in employment in the production of manufacturing in the observed region (see Appendix C for a detailed discussion). Other things being equal, the region with the larger home market will, therefore, have a proportionally larger manufacturing sector. Home region's demand for manufacturing (the size of the home market) will determine the size of the manufacturing sector in this region. A relatively large manufacturing sector in the larger region will also mean that this region will export manufactured goods to other regions with relatively smaller manufacturing sectors.

The importance of the home market effect has originally been introduced by Krugman (1981), but he did so in the context of a model in which relative market sizes were determined exogenously and not endogenously as in my case. In more recent empirical work, Davis and Weinstein (1997) found that the home market effect has a surprisingly strong impact on international trade.

On the other hand, perfect elasticity of labor and capital supply need not be the case, which would imply that the supply curves for both labor and capital are upward sloping and not perfectly horizontal as was implied by the assumption of perfect factor mobility. Some of the home market advantage will be taken out by higher wages or higher interest rates. This scenario can also be divided into two parts.

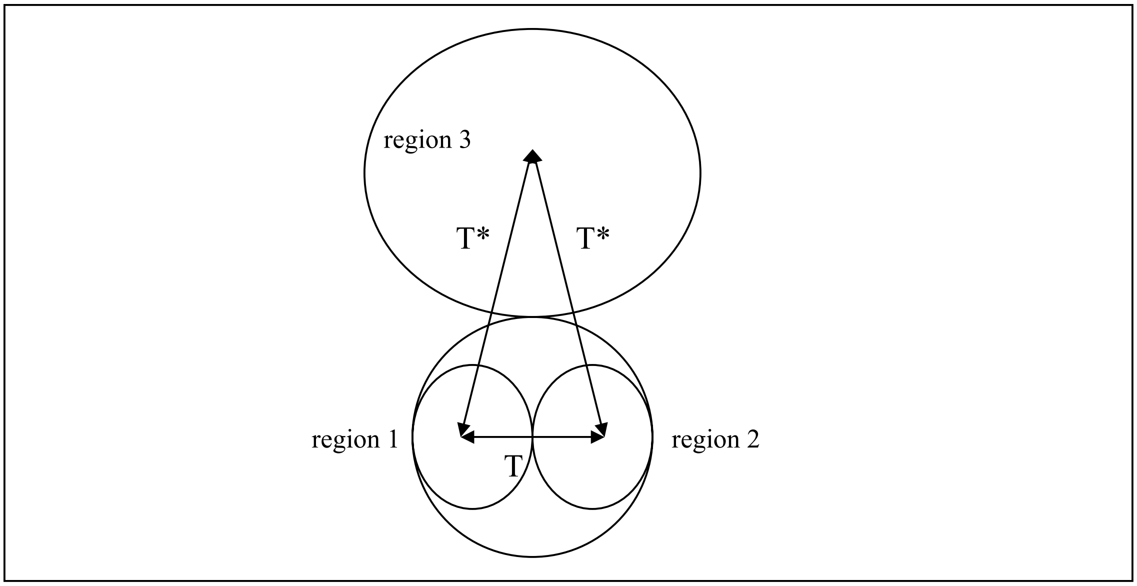
First, we can suppose that capital supply between the two home regions is perfectly elastic (di = 0), which means that locations with a higher demand for manufactures pay a higher nominal wage. I have already shown that an increase in L (labor endowment) is, other things being the same, associated with a decrease in G through an increase in n (15). A region with high Y might therefore be expected to have a relatively high real wage because the nominal wage is high and because the price index is low. Hence regions with higher demand for manufactures tend, other things being equal, to offer higher real wages to manufacturing workers.

Second, abandoning the assumption of perfect capital mobility, the conclusions cease to be as simple. I assume that the larger region (larger L and larger K) has lower interest rates than the smaller region, due to its larger absolute capital endowment. Increases in demand for manufacturing could be caused either by higher nominal wages or, on the other hand, lower nominal interest rates. The larger of the two regions will hence be confronted with higher wage rates, lower nominal interest rates, or both, while the region with smaller demand for manufactures encounters relatively smaller nominal wages and relatively higher nominal interest rates. As we can see from (31), the wage rate hike at a specific location should, other variables held constant, lead to a compensatory fall in interest rates. There is also the possibility that only one of the two will occur despite non-perfect elasticity of factor supply (the larger region could either have higher nominal wages or lower nominal interest rates, whereas the smaller region would face lower wages and higher interest rates).

4.7. BREAKING THE SYMMETRY OF THE LOCATION OF HOME REGIONS

The *FKV* model assumes that both home locations are the same distance away from the foreign location, therefore having the same transport costs to that location. I assume that one of the home locations is actually closer to the foreign location than the other, thus having a cost advantage (lower transport costs) in access to foreign markets with respect to the region further away. I represent the *FKV* model assumptions in Figure 2 and my model, i.e. non-symmetric home region location model, in Figure 3. I keep assuming that there are only three regions, one of them being a large foreign region and the other two home regions. In-country transport cost (T) are incurred in trade between the two home regions, while foreign trade transport costs (T^*), which include both transport costs as well as trade costs, incur in between country trade.

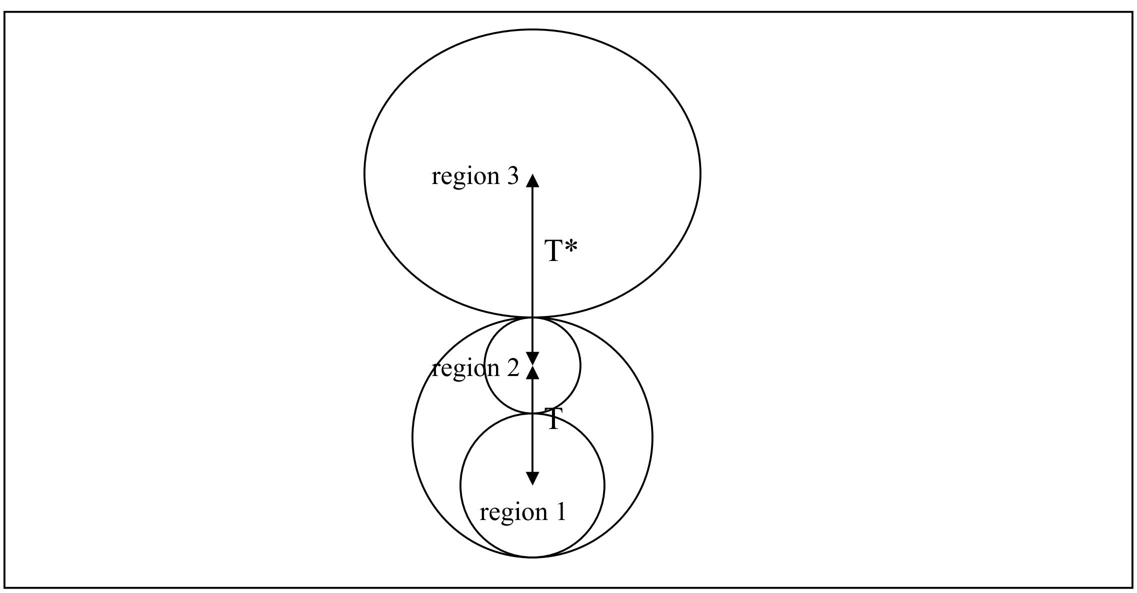
Figure 2: **Representation of the *FKV* model**



Source: Own representation, based on Fujita, Krugman, Venables (1999)

Figure 2, representing the *FKV* model, shows that foreign trade transport costs (*T**) are equal for both home country regions (region 1 and region 2), while transport costs (*T*) are incurred in trade between both home country regions. No additional assumptions are made about the size of the regions, although region 1 is commonly assumed to be larger in both labor and capital endowment.

Figure 3: **Representation of the non-symmetric model**



Source: Own representation

Figure 3, on the other hand, represents a slightly more realistic model of asymmetric home region location, whereby transport and trade costs from the larger home region (region 1) to the foreign country (region 3) include in-country transport costs (*T*) and foreign trade costs (*T**). Costs of transport from regions 1 to 3 are hence *TT**. The smaller home region's (region 2) trade with the foreign country incurs only transport/trade costs *T**.

Trade liberalization affects all three regions with the fall of foreign trade costs (*T**) in the second representation, benefiting the smaller home region more then the larger home region. Because of the fact that region 1 is further away from region 3, it will face a comparative disadvantage compared to region 3 once trade liberalization commences.

The wage and price index equations in this specific case are:

$$(45)\qquad \left[(\frac{w_1}{\alpha})^{\alpha}(\frac{i_1}{\beta})^{\beta}\right]^{(\sigma-1)} = (n_1^{\sigma}\rho)^{\sigma-1}\left[Y_1G_1^{\sigma-1}+Y_2G_2^{\sigma-1}T^{1-\sigma}+Y_3G_3^{\sigma-1}T^{1-\sigma}(T^*)^{1-\sigma}\right] \quad ,$$

$$\left[(\frac{w_2}{\alpha})^{\alpha}(\frac{i_2}{\beta})^{\beta}\right]^{(\sigma-1)} = (n_2^{\sigma}\rho)^{\sigma-1}\left[Y_1G_1^{\sigma-1}T^{1-\sigma}+Y_2G_2^{\sigma-1}+Y_3G_3^{\sigma-1}(T^*)^{1-\sigma}\right] \quad ,$$

$$\left[(\frac{w_3}{\alpha})^{\alpha}(\frac{i_3}{\beta})^{\beta}\right]^{(\sigma-1)} = (n_3^{\sigma}\rho)^{\sigma-1}\left[Y_1G_1^{\sigma-1}T^{1-\sigma}(T^*)^{1-\sigma}+Y_2G_2^{\sigma-1}(T^*)^{1-\sigma}+Y_3G_3^{\sigma-1}\right] \quad .$$

$$(46)\qquad G_1^{1-\sigma} = \frac{L_1}{l_1^*}p_1^{1-\sigma}+\frac{L_2}{l_2^*}p_2^{1-\sigma}T^{1-\sigma}+\frac{L_3}{l_3^*}p_3^{1-\sigma}(T^*)^{1-\sigma}T^{1-\sigma} \quad ,$$

$$G_2^{1-\sigma} = \frac{L_1}{l_1^*}p_1^{1-\sigma}T^{1-\sigma}+\frac{L_2}{l_2^*}p_2^{1-\sigma}+\frac{L_3}{l_3^*}p_3^{1-\sigma}(T^*)^{1-\sigma} \quad ,$$

$$G_3^{1-\sigma} = \frac{L_1}{l_1^*}p_1^{1-\sigma}T^{1-\sigma}(T^*)^{1-\sigma}+\frac{L_2}{l_2^*}p_2^{1-\sigma}(T^*)^{1-\sigma}+\frac{L_3}{l_3^*}p_3^{1-\sigma} \quad .$$

where *T** represents the transport costs (trade costs) of trade between the smaller (peripheral) region 2 and the foreign country. We assume that the central region's costs of trade with the foreign country are the product of its transport costs with region 2 and the smaller regions trade costs with the foreign country.

Equation (45) can be further simplified into:

$$(47)\qquad w_1 = \alpha\left[\left(\frac{n_1^{\sigma}\rho\beta^{\beta}}{i_1^{\beta}}\right)\left(Y_1G_1^{\sigma-1}+Y_2G_2^{\sigma-1}T^{1-\varsigma}+Y_3G_3^{\sigma-1}(TT^*)^{1-\sigma}\right)^{\frac{1}{\sigma-1}}\right]^{\frac{1}{\alpha}} \quad ,$$

$$w_2 = \alpha \left[\left(\frac{n_2^{\sigma} \rho \beta^{\beta}}{i_2^{\beta}} \right) \left(Y_1 G_1^{\sigma-1} T^{1-\sigma} + Y_2 G_2^{\sigma-1} + Y_3 G_3^{\sigma-1} (T^*)^{1-\sigma} \right)^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}} ,$$

$$w_3 = \alpha \left[\left(\frac{n_3^{\sigma} \rho \beta^{\beta}}{i_3^{\beta}} \right) \left(Y_1 G_1^{\sigma-1} (TT^*)^{1-\sigma} + Y_2 G_2^{\sigma-1} (T^*)^{1-\sigma} + Y_3 G_3^{\sigma-1} \right)^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}} .$$

Equations (47) represent the nominal wage formation in both home country regions as well as the foreign country. Due to the complexity of the equations as well as the fact that singular effects get intertwined and mutually strengthened, an analysis on the basis of a review of the above equations is fairly difficult or almost impossible for some variables. Another factor that contributes to the difficulties in analyzing the above equations is also the circular connection between (46), (47) and (22), whereby the value of one variable is always dependent on the value of the other. It is obvious that profit-maximizing prices (22) depend on nominal wages and interest rates in the region, nominal wages in turn depend on the price levels (G) in all regions. Regional price levels again depend on the regional prices and therefore on nominal wages, which completes the circle of influence. Such circularity also prevents analysis based on partial derivatives, which would enable a mathematical solution to solving the issues of the correlation of variables in the model. Due to this circular causation singular influences of elasticity of substitution (σ), share of labor in the production function (α), and a number of varieties (n) on the nominal wage rate are difficult to determine and can only be discovered by the use of numeric simulations. The results of such simulations are presented in the following section (4.8.).

On the other hand, (47) allows some simple conclusions with respect to the effects of nominal income, nominal interest rates, regional price levels, and transport costs on nominal wages. It can be easily seen that higher regional nominal incomes (Y) increase the nominal wages of the producing region, due to the fact that higher regional incomes imply higher buying power in those markets and therefore stronger demand for manufacturing products. Considering the effects of nominal regional interest rates on wages is not so simple though. There is direct negative relationship between interest rates and wages seen from (47)[35], meaning that larger interest rates at one location imply lower nominal wages. Interest rates, however, also have an indirect effect on wages through price levels, namely higher interest rates induce higher prices, which results in higher price levels and consequently higher nominal wages (46) and (47). The effects of interest rates on nominal wages remain indeterminate without the use of simulations. As already

[35] This relationship stems from the price setting equation (22).

mentioned, higher regional price levels induce higher nominal wages in the producing region, while higher transport costs and trade costs reduce nominal wages in the region of production.

4.8. NUMERICAL SIMULATIONS

In chapter 4 so far, I have presented mathematical outline of the model and while this allows for a limited scope of direct analysis, a feel for the model can hardly be obtained. Only with the use of numeric simulations can the intricate workings of the model be better understood and its implications easier foreseen. Computer simulations serve the following three goals: First, they allow us to see how certain crucial aspects of the model react to changes in important parameters of the core model. Second, they can give rise to new analytical solutions, and finally, they can be used to demonstrate that certain ideas or suggestions do not always hold, simply by producing a counter-example (Brakman et.al., 2001).

In this section, I intend to illustrate the implications of my model on the adjustment pattern of the relative regional wages under different assumptions. The relative regional wages (w_2/w_1) of the peripheral home region will serve as an indicator of whether the wage gaps between home regions are increasing or decreasing with trade liberalization. This will enable me to answer the question whether trade liberalization increases (decreases) regional wage disparities within countries and whether it leads to greater (smaller) gaps between richer and poorer regions. I will expose the model's properties by subjecting it to a sensitivity analysis aimed at testing the robustness of the model to changes in certain crucial variables. Changes in some of the exogenous variables will therefore bring about different reactions of the endogenous variables, presenting a clearer picture of the workings of the model and relations between the explained and unexplained variables. It should subsequently become clearer which of the market variables work in favor of agglomeration and which stimulate spatial dispersion of economic activity. Finally, I will compare the implications of my model with the *FKV* model, using the same base parameter values (exogenous variables) in order to determine whether the predictions of the two models differ substantially.

According to model specifications (sections 4.1. to 4.7.), there are a number of endogenous variables being determined by the model, namely the number of firms producing in a region (n_r), regional income (Y_r), product prices (p), and the ensuing price levels (G_r). The central variable being determined by the model are of course the regional nominal wages (w_r) or the relative regional wages (w_2/w_1). The rest of the variables coming into the model have to be determined exogenously and basically represent regional endowments (labor and capital), market characteristics (elasticity of substitution between varieties of manufactured goods), characteristics of the production function (labor and capital elasticities), and transport/trade costs.

4.8.1. Simulation of the changes in inter-regional transport costs

In running the simulation of my model, all the assumptions introduced in section 4.7. are maintained, however, in addition to that, I assume that the central home region (subscript *1*) is a bit larger than the peripheral home region (subscript *2*), in terms of factor endowments. The base example parameter values are presented in Table 3.

Table 3: **Base case parameter values**

Parameter	Region 1	Region 2	Region 3 (foreign country)
L	200	160	1000
K	86	68	428
α	0.7	0.7	0.7
β	0.3	0.3	0.3
σ	1.5	1.5	1.5
T	1.15	1.15	1.15

Source: Fictional values

The larger home region (region *1*) is about 25 per cent larger in its labor and capital endowments, while region 3 (foreign country) has a labor force five times the size of that in the larger home region.[36] It is obvious from the elasticities of the CD production function that a constant returns to scale production function with respect to L and K is proposed. Elasticity of substitution of manufacturing products is set fairly low at only 1.5, implying that the varieties of manufactures represent fairly poor substitutes for each other in the eyes of the consumers[37]. The inter-regional transport costs are set at 1.15, which represents a 13.04 per cent transport costs of transport between the two home regions. Fixed labor and capital requirements are set at 2 units of labor and capital each and are equal for all regions[38]. The base nominal interest rate has been set at 6% and serves as the interest rate of the biggest region (foreign country), while nominal regional interest rates in both home regions are determined by their endowments of capital relative to the foreign country. I realize that this is a gross simplification, since there are many other factors influencing the interest rates, such as demand for capital, required reserves, institutional factors etc., but for the sake of keeping the specification of the model as simple as possible I keep relative capital endowments as the only factor influencing capital costs[39]. Figure 4 shows some

[36] The large foreign country could, in the case of transition economies, represent the European Union.

[37] The assumption of a low elasticity of substitution is particularly relevant for manufactures, where products are far less homogenous than in agriculture for instance. Krugman, Venables (1996) assume a higher elasticity of substitution at 5, while Brackman et.al. (2001) base their estimates of elasticities of substitution at 1.66.

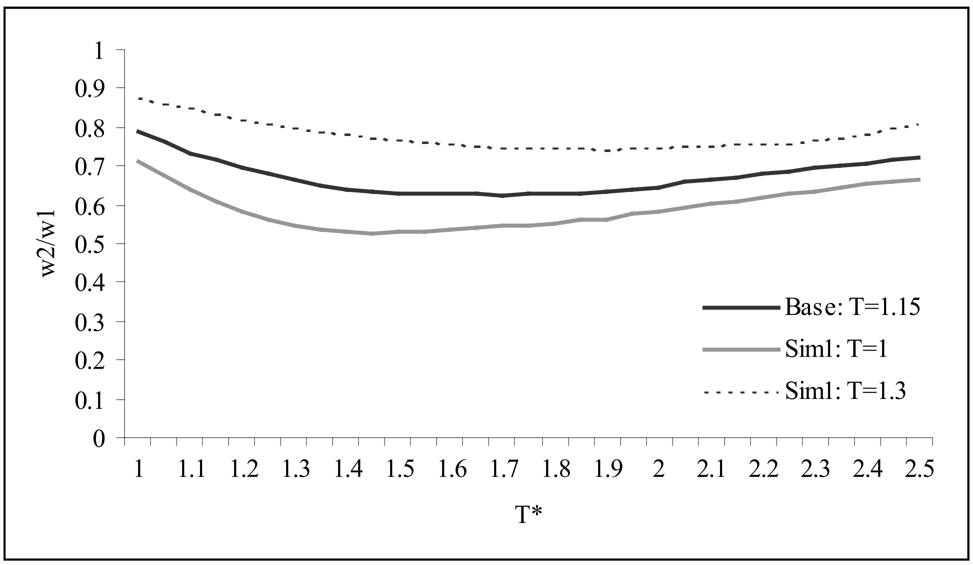
[38] This is in compliance with the equal technologies assumption made earlier. Technologies in all three regions are the same, which should not limit the conclusions of the model excessively.

[39] Capital costs equal the marginal productivity of capital at the profit-maximizing price.

basic simulations[40] with a simple sensitivity analysis of the model to changes in the transport costs between the two home regions.

Base simulations reveals a typical *U*-shaped response of home relative regional wages to a reduction of foreign trade costs, which occurs within reasonable trade costs (in the range $T^* = [1, 2.5]$).[41] The *U*-shaped curve reveals the expected firm behavior as trade gets progressively liberalized. As trade costs fall, firms tend to agglomerate in the region where more varieties are already produced (where more firms are already producing) because that would enable them to take advantage of larger economies of scale. The positive externalities of a common labor pool or input-output linkages outweigh the negative aspects of the concentration of industrial activity. The fall in trade costs allows the relocated firms to continue supplying their consumers in their region of origin and in the foreign country. Before a certain threshold of trade costs is reached, firms from the smaller home region tend to loose a large proportion of their market by moving to the larger home region.

Figure 4: **Response of home relative nominal regional wages to reduction in foreign trade costs and inter-regional transport costs**



Source: Own calculations

Since a certain threshold of trade costs has been reached, the benefits from agglomeration start to outweigh the potential loss to a firm's markets due to higher prices. If this were the whole story,

[40] Mathematica version 4.1 has been used to perform all model simulations.

[41] It should be noted though that this outcome is not general per se. First, it holds in a very limited range of low transport costs only. When transport costs exceed the value of $T = 5$ the shape of relative wage curve becomes very complex. Second, the above outcome holds only when size differential between both regions is sufficiently large. For low values of size differential the relative wage curve is subject to multiple equilibria.

the end result would be a straight core-periphery pattern with all of manufacturing concentrated in the larger home region, but this is not the case. As more and more firms move to the larger home region, the demand for labor in the region increases, causing nominal wages to increase. This is the point of the lowest regional nominal wage of the smaller home region (region 2) seen in Figure 4. At some level of trade costs[42] the increased demand for labor in the larger home region will raise the nominal wages to the extent that will affect the prices in the larger home region despite the fact that the number of varieties produced would increase (22). Once a certain level of regional wages is reached, firms will start moving back to the region with lower nominal wages. Lower nominal wages make peripheral regions more attractive to new firms despite smaller benefits from economies of scale and higher nominal return to capital[43]. The other reason, making the peripheral region more attractive, is that with decreasing trade costs the large foreign country market becomes increasingly accessible to firms operating in the peripheral region, while firms operating in the central home region have to incur inter-regional transport costs in addition to trade costs.

The importance of home inter-regional transport costs becomes apparent from Figure 4. It is evident that larger home inter-regional transport costs benefit the peripheral home region more than the central home region, which is reflected in the fact that the relative regional wages in the peripheral region are higher for all levels of trade costs.[44] The other effect of higher home inter-regional transport costs on the relative regional wage curve is that the *U*-turn occurs at higher trade costs. The *U*-turn of the upper line in Figure 4 occurs slightly to the right of the base case. This means that, given higher inter-regional transport cost, firms operating in the central-home region will move to the peripheral region at a lower level of trade costs. This occurs due to the fact that larger transport costs between the two home regions accentuate the peripheral region's advantage vis-à-vis the central home region due to its preferential geographical position. This in turn accelerates the dispersion of manufacturing activity from the central region to the more advantageous peripheral location. On the other hand, lower inter-regional transport costs have the opposite effect both on the level of relative regional wages as well as on the position of the minimum relative regional wage. Lower transport costs lessen the peripheral region's geographical advantage and, hence, delay firms' decisions to relocate to that region till a lower level of trade costs is reached.

[42] This level depends on other exogenous variables such as the size differential, inter-regional trade costs, elasticities etc.

[43] If perfect competition prevails in the markets, the cost of capital will equal capital's marginal product. In other words, that nominal interest rates will equal nominal returns to capital.

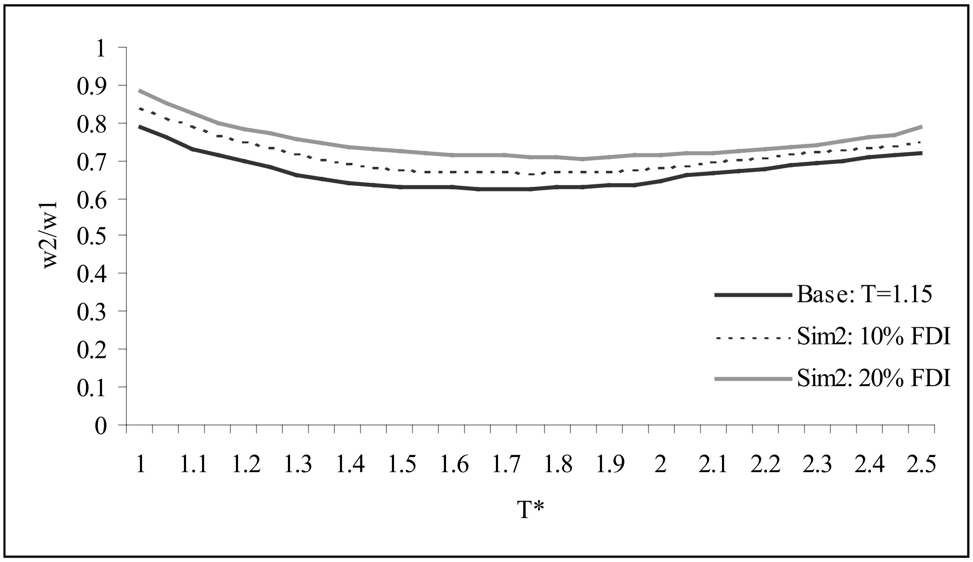
[44] In Figure 4 the line indicating relative regional wages in the simulation with higher inter-regional transport costs (T = 1.3) lies above the base scenario simulation.

4.8.2. Simulation of the effect of foreign direct investment

The second set of simulations is aimed at presenting the possible effects of foreign direct investment on firm relocation, as it manifests itself through the relative regional wage curve. The importance of foreign direct investment goes far beyond it, being a source of capital to providing employment, managerial skills, technology, and therefore accelerating growth and development in a particular region or country.[45] Foreign direct investment can work either for or against agglomeration, depending on which region succeeds in attracting a larger share of it, as capital inflows start to come into the home country in conjunction with the ongoing trade liberalization (falling trade costs). In determining the flows of direct foreign investment, I resort to implementing another simplifying assumption, in order to maintain the established structure of the model without having to add additional propositions and equations. I assume that the direction of foreign direct investment depends solely on nominal regional wages and nominal regional interest rates. Nominal regional wages should be negatively correlated with FDI inflows, causing relatively larger inflows into regions where nominal wages are lower. Lower nominal wages, other things held constant, mean lower labor costs, which should attract foreign investors into the region. On the other hand, higher nominal interest rates imply higher returns per unit of capital invested, which should stimulate foreign direct investment in the region. I fully realize that there are a number of other determinants for the location of foreign direct investment, such as real gross domestic product per capita, the quality of the infrastructure, country's openness, political stability/instability of a country, taxes and tariffs imposed in a particular country (region), underlying macroeconomic characteristics and many more.[46] Nonetheless, I will refrain from further complicating the model and use only regional nominal wages and interest rates as a determinant of foreign direct investment location. Using solely this two determinants, it can clearly be seen that the peripheral region will receive the relative majority of the foreign direct investment into the home country, due to the fact that it has both lower nominal wages as well as higher interest rates than the central home region. The third factor that may stimulate foreign direct investment into the peripheral region is its preferential geographical location closer to the foreign market, enabling a substantial reduction in transport costs compared to the central region. To simulate foreign direct investment into the smaller, peripheral home region, I increase the region's capital endowments by 10 % [47] to $K_2 = 75$ and by 20% to $K_2 = 82$. The effects of foreign direct investment are presented in Figure 5.

[45] For a more detailed look at the functions of capital and advantages of foreign direct investment see Trošt (1991).
[46] For more on the determinants of foreign direct investment see Grossman, Razin (1985) and Asiedu (2002).
[47] Due to the structure of the model, this can also be considered as a relative increase compared with the central home region.

Figure 5: **Response of home relative regional wages to a reduction in foreign trade costs and foreign direct investment to the “peripheral” home region**



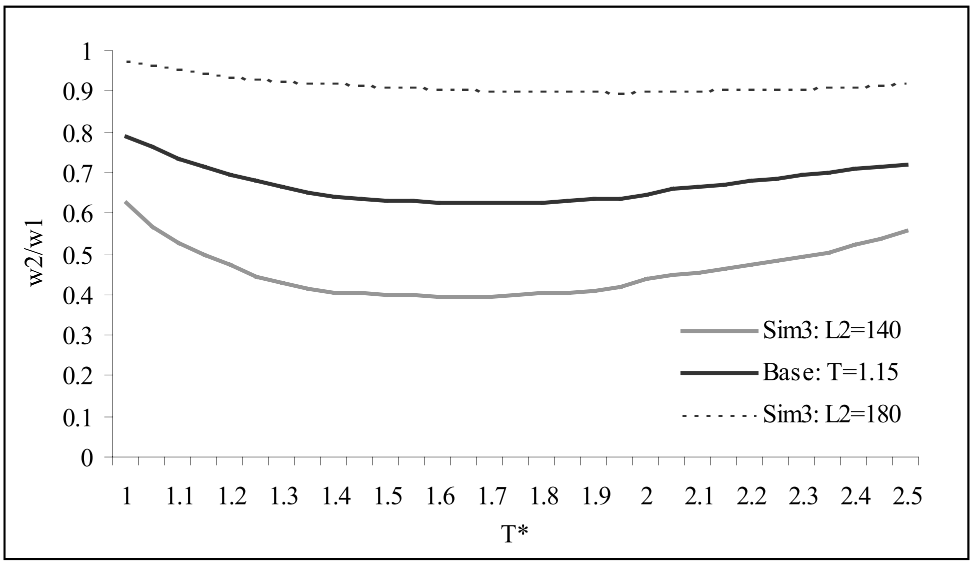
Source: Own calculations

It is obvious, from Figure 5, that capital inflows into the peripheral home region lessen the wage differential between the two home regions (that is evident from the fact that both relative wage curves with foreign direct investment lie above the base scenario curve) by working in two ways. First, the additional inflows of capital cause a fall in interest rates in the smaller home region, which has the net effect of increasing the nominal wage in the region and subsequently also increasing its the relative wage. That lessens the initial disparity between the two home regions, which negatively affects the strength of the relocation process. Firms initially have less incentive to relocate, which makes the *U*-curve slightly less pronounced than in the base case. Second, the fall in interest rates also lessens the equilibrium labor requirement (27), which, combined with unchanged labor endowments, serves to increase the number of firms that are able to produce in the region, which also infers higher regional wages. Both effects combine to lessen the strength of firm relocation as trade costs fall, simultaneously maintaining higher regional relative wages for the entire range of trade costs.

4.8.3. Simulation of the effects of changes in initial endowments of home regions

The third set of simulations is intended to represent the effects of size differentials between the two home regions, whereby Figure 6 shows the implications of a smaller difference in size between the two home regions (the endowments of the central home region remain unchanged, whereas the peripheral regions labor and capital endowments increase to L_2 = 180 and K_2 = 77) and similarly the effects of a larger inter-regional difference in endowments (L_2 = 140 and K_2 = 60).

Figure 6: **Response of home relative regional wages to the reduction in foreign trade costs and different inter-regional endowment differences**



Source: Own calculations

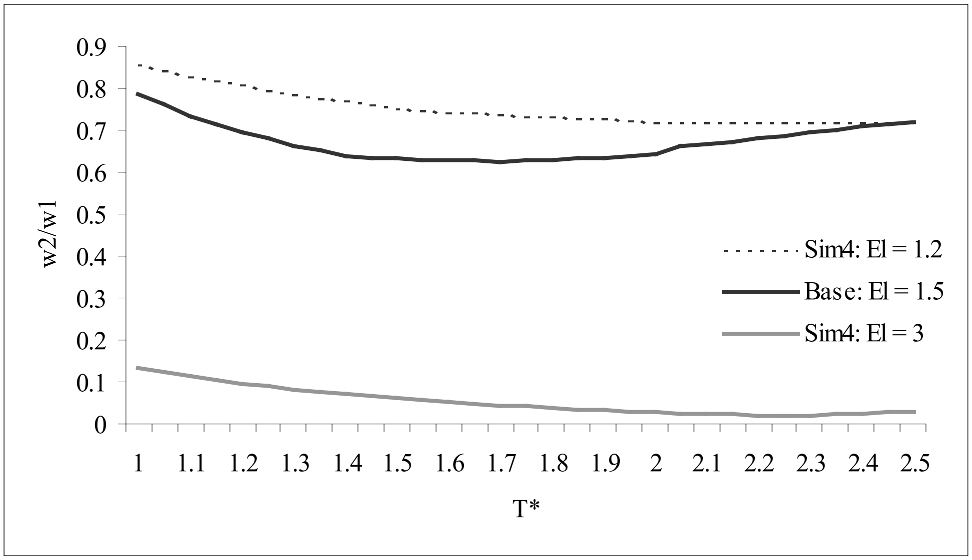
The results are in line with expectations, with the relative regional wages depending heavily on regional labor and capital endowments. Smaller regional differences in endowments increase the peripheral region's relative wage above that of the base case scenario for all levels of trade costs. This is in line with the fact that the larger the region's labor and capital endowments (more varieties produced and more firms operating in a region), the higher the regional nominal wage (the proof has been derived in subsection 4.6.2). The opposite holds for the scenario with lower endowments of the peripheral region vis-à-vis the base scenario, where the relative wage line lies bellow the base case line. There is, however, another difference in all three scenarios, namely with increased similarity between the two regions the relative wage line becomes substantially flatter, eluding to the fact that once both home regions are similar enough, the incentives for relocation become less pronounced, which subsequently reflects in smaller changes in the relative regional wages as trade costs decrease. With similar initial conditions between regions, the relocation between regions is driven exclusively by the peripheral region's proximity to the large foreign market. In the case of completely equal home regions' endowments, divergence between the two regions would occur with the peripheral region gaining by firm relocation. This is the case for all reasonable low levels of trade costs, while at higher levels of trade costs the relative wage curve becomes very complex. On the other hand, if the endowment differences between the two home regions increase, this results in a more pronounced pattern of firm relocation, which is also reflected in the relative wage curve being deeper than in the base case. Figure 6 shows the relative wage curve of the scenario with larger endowment differences (L_2 = 140) lying beneath the base case scenario, whereby the minimum value of relative regional wages occurs only slightly to the left of the base scenario.

4.8.4. Simulation of the effects of changes in the elasticity of substitution

The final set of simulations deals with the effects of the elasticity of substitution on relocation of economic activity with trade liberalization. This set of simulations serves to test the robustness of the model to changes in the elasticity of substitution between manufacturing products. Lower elasticities of substitution between varieties of manufacturing products mean that the consumers are better able to differentiate between particular varieties and no longer consider them as substitutes. This also enables firms to function more as monopolies in the production of their own varieties than as perfect competitors. Larger elasticities of substitution, on the other hand, bring the market structure closer to perfect competition than multiple monopolies, with consumers considering varieties as more or less perfect substitutes. This increases the competition between firms. The effects of changes in the elasticity of substitution on the relocation of economic activity are presented in Figure 7, where in addition to the base scenario (σ = 1.5), the case with increased elasticity (σ = 3) and decreased elasticity (σ = 1.2) is presented as well.[48]

[48] It should be noted that given the condition for intensity of the preference for manufacturing variety (equation 2), the elasticity of substitution must be higher than 1.

Figure 7: **Response of home relative regional wages to a reduction in foreign trade costs with different elasticities of substitution**



Source: Own calculations

Figure 7 shows that changes in elasticity of substitution induce very volatile reactions of the model, with an increase in elasticity causing a huge drop in relative regional wages. While the *U*-shape of the relative wage curve remains present, it is far less pronounced. This can be explained by the fact that the strength of external economies increases with elasticity of substitution (21), which in turn works in favor of agglomeration. Since the strength of agglomeration effects increases substantially, this decreases the relative regional wage of the peripheral region by allowing for agglomeration effects to concentrate manufacturing activity in the central home region. Trade cost reduction does not effect the spatial distribution of manufacturing activity to the extent visible in the base case. A decrease in elasticity of substitution decreases the effects of external economies, which has two possible implications. Lower elasticity of substitution, namely, decreases the agglomeration effects by reducing the influence of external economies, which both increases the relative regional wage as well as enables convergence to occur at a higher level of trade costs as visible from Figure 7.

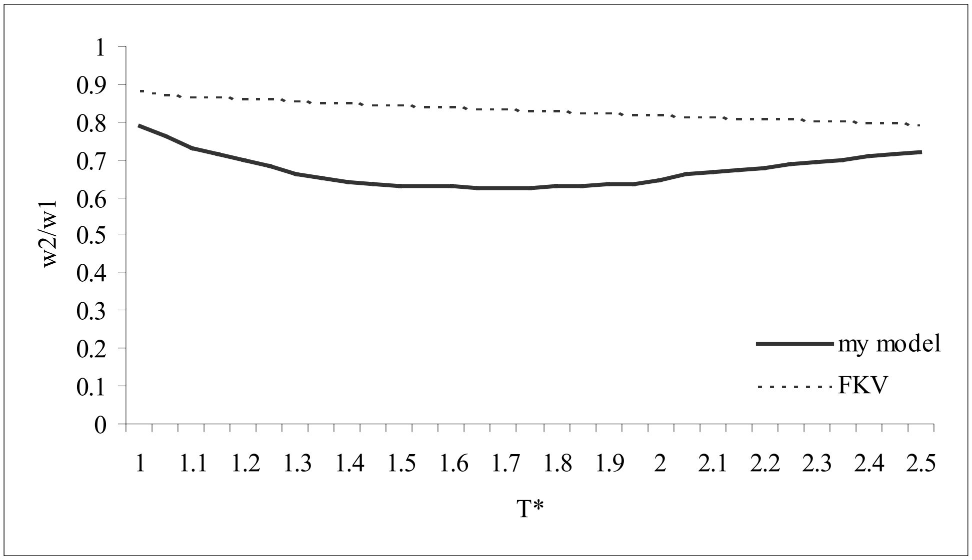
4.8.5. Comparison of the *FKV* and my model using numerical simulations

The main differences between the two models have already been outlined in sections 4.1. to 4.7., i.e. major differences being the inclusion of capital as the second factor of production, the explicit modeling of scale economies, modeling of demand for labor and capital, the breaking of the home region symmetry. Figure 8 presents a comparison of the simulations of both models using equal values for the included external variables. Labor endowments in both models are therefore

$L_1 = 200$, $L_2 = 160$, $L_3 = 1000$, with capital endowments in my model amounting to $K_1 = 86$, $K_2 = 68$ and $K_3 = 428$. The crucial elasticities are $\alpha = 0.7$, $\beta = 0.3$ and $\sigma = 1.5$, whereby the elasticities of the Cobb-Douglas production function are relevant only for my model. The inter-regional transport costs remain 1.15 for both models. Fixed labor costs for the *FKV* model amount to 2 units, while proportion of consumer expenditure spent on manufactures is 70 per cent (the rest of the consumer incomes are spent on agricultural products). Figure 8 shows that the *FKV* curve lies substantially higher than the (base) curve of my model and exhibits only a monotonically increasing trend in the relevant region of trade costs. This implies that the *FKV* model in this form with symmetrically positioned home regions predicts that trade liberalization will lead to a dispersion of economic activity and a convergence in relative regional wages. This points to the conclusion that the initial agglomeration effects are much stronger in my model, due to the explicit modeling of external economies of scale. The *FKV* model's higher relative wages are to a large extent the result of the fact that there is a strong negative influence of nominal interest rates on the wages in peripheral region (higher interest rates decrease the nominal regional wage in the peripheral region). Since labor is the only production factor in the *FKV* model, the initial wage difference between the two regions is much smaller, whereby higher nominal wages in the central region continuously drive firms to the smaller region as trade costs decline. The agglomeration effects that work against the dispersion of economic activity in my model are therefore much weaker in the *FKV* model.

Despite the fact that the *FKV* relative regional wage curve in Figure 8 looks like a straight line, it is actually a *U*-shaped curve, although the minimum relative wage occurs at enormous (unrealistic) trade costs. This in fact means that the *FKV* model predicts a monotonic relationship between trade costs and relative regional wages. Decreasing trade costs lead to a convergence in wages between the peripheral home region and the central home region.

Figure 8: **The comparison between the *FKV* and my model's responses to the reduction in trade costs**



Source: Own calculations

Given the specification of regional endowments and elasticities, the effects of the FKV model seem very similar to Krugman's (1991) model. It should be noted though that the FKV model is extremely sensitive to changes in elasticity of substitution and that an increase in the elasticity would deepen the bend of the curve substantially.

5. PREVIOUS EMPIRICAL STUDIES OF ECONOMIC GEOGRAPHY MODELS

Having presented the theoretical model of the spatial relocation of economic activity in the previous chapter (Chapter 4), my aim is to present some of the empirical work dealing with economic geography in this chapter. In chapter 6 I intend to present my own empirical research on the effects of trade liberalization on the allocation of production on a sample of five transition countries. Despite a relatively short history of modern spatial economics, there is an ever increasing and diverse body of empirical work undertaken on the subject of geographical economics, mainly in the last five years, while an even greater expansion of empirical research has been halted by the non-linearities and multiple equlibria, which makes the empirical validation of the spatial aspects of production relatively difficult.

Empirical literature gives some, although not conclusive, support to the theoretical predictions of geographical economics. A large number of studies dealing with the spatial implications of factor reallocation can be divided into two groups. The first group of papers studies the impact of trade liberalization between countries on international as well as interregional relocations of manufacturing activities. The majority of the studies are concerned with the implications of the theory of geographical economics on the specialization and agglomeration patterns in the European Union. Arguably the most famous empirical paper, however, is probably Hanson's (1997) study on Mexican trade liberalization. The second group of papers studies the impact of within-country (inter-regional) transport costs on the structure of wages, location costs, etc. In the remainder of this chapter I provide an overview of both groups mentioned above.

5.1. EMPIRICAL STUDIES OF THE IMPACT OF TRADE LIBERALIZATION ON THE RELOCATION OF ECONOMIC ACTIVITY

Brülhart and Torstensson (1996) study the implications of trade liberalization on the European Union. They examine the implications of geographical economics on the specialization patterns in the European Union and propose a non-monotonic relationship between regional integration and geographical concentration of increasing-returns industry. However, they prove this hypothesis only indirectly and find some support for it in intra-industry trade (IIT) flows among European Union countries in the period from 1961-1991. The authors refer to a link between production localization of industries and the pattern of trade flows. In industries characterized by significant IRS[49] internal to the firm, production is likely to be concentrated in one location near center, and the pattern of trade between countries will be of inter-industry type. In industries with

[49] IRS - increasing returns to scale

less pronounced IRS production will be more dispersed, and intra-industry trade is the likely outcome. In fact, Brülhart and Torstensson provide evidence that IRS industries are subject to relatively low IIT and that IIT flows increase at the early stages of integration but decrease when intra-union trade costs fall below a certain threshold. The empirical analysis on data for European Union states from 1961 to 1991 appears to confirm the authors' predictions with the Spearman rank correlation and the Pearson correlation showing statistically significant relationship (at 1% level of significance) in support of the theoretical predictions (Brülhart and Torstensson, 1996, pp. 19-21).

Hanson (1997) tests the hypothesis that due to the presence of increasing returns to scale the employment concentrates in industry centers and regional nominal wages decrease in transport costs to industry centers. The paper attempts to verify the hypothesis on the case of Mexican regions from 1965 to 1988, the period of the Mexican trade liberalization.

(1) $$\ln\left(\frac{w_{ijt}}{w_{cjt}}\right) = \beta_0 + \beta_1 \ln MX_i + \beta_2 \ln US_i + \delta\theta \ln MX_i + \delta\phi \ln US_i + \varepsilon_{ijt} ,$$

where w_{ijt} is the nominal wage for the two-digit industry *j* and state *i* at time *t*; w_{cjt} an average nominal wage in Mexico city in industry *j* at time *t*; MX_i are unit transport costs form state *i* to Mexico city; US_i unit transport costs from state *i* to the border with the United States; and δ is a dummy variable for trade liberalization.

The empirical results with panel data verify a statistically significant negative correlation between the distances from the industry center and the nominal wages of the region (the correlation is shown to be significantly negative at 1 per cent level of significance for all versions of the model tested). An added feature of the empirical results is a deconcentration of economic activity in Mexico City (the only pre-trade liberalization economic center) and a shift of economic activity to border regions after trade being liberalized. The empirical results are consistent with two motivations for industry agglomeration in regions: increasing returns to scale in production and the location bias in government policy.

Davis and Weinstein (1999) analyze several possible causes of regional specialization in Japan using data for 1985 and employing a combination of the Heckscher-Ohlin model with economic geography models, where the "home market effects" play a major role.[50] They estimate the following function:

(2) $$X_g^{nr} = \alpha_g^n + \beta_1 SHARE_g^{nr} + \beta_2 IDIODEM_g^{nr} + \Omega_g^n V^r + \varepsilon_g^{nr} ,$$

[50] The "home market effect" was introduced by Paul Krugman (1980, 1981).

where X_g^{nr} is the output for region *r* of good *g* in industry *n*; $SHARE_q^{nr}$ represents the base level of production of good *g* of industry *n* in region *r*, representing the region's overall commitment to the encompassing industry and the importance of good *g* in the industry in the aggregate, assuming there are no idiosyncratic components of demand. $IDIODEM_g^{nr}$ represents the relative importance of good *g* for region *r*, relative to other regions. V^r represents the vector of factor endowments and Ω_g^n the corresponding row for industry *n* and good *g* of the technology matrix.

They find statistically significant effects, proving the existence of economic geography in eight of the nineteen manufacturing sectors (mainly sectors with high potential for scale economies and high product differentiation such as transport equipment, iron and steel, electrical machinery…). The home market effect is significantly present in trade and industrial specialization between regions, according to empirical findings, which was not the case in international trade, to a great extent due to the increased importance of trade costs. The second likely factor emphasized in the paper is the greater factor mobility exhibited between regions as opposed to international trade, which tends to reinforce the economic geography effects with the compensation of economic scarcity for production of particular goods.

Hallet (2000) investigates the occurrence and the development of regional specialization and concentration in the European Union without analyzing the causes of such changes. The paper instead focuses on documenting the development of regional specialization and concentration in the European Union from 1980 to 1995, with data limitations sometimes causing the observed period to shorten to ten years only. The author uses simple indexes of specialization and concentration (concentration, clustering measure, centrality measure and income measure) to show the trends of specialization and concentration for 199 European regions and 17 industries. The empirical results point to an increasingly similar specialization of regions from manufacturing into services, which could work towards reducing the probability of region specific shocks. The concentration measures show a dispersion of agriculture and processing of its products (as well as other day-to-day services), following patterns of arable land and settlements while manufacturing industries with high economies of scale concentrate in fewer regions.

Midelfart-Knarvik, Overman, Venables (2000) develop and econometrically estimate a model combining comparative advantage and spatial forces in order to determine the location of industries across countries. The model serves to determine whether factor endowments and geographical considerations alone in interaction with industry and country characteristics suffice in establishing the location of production.

(3) $$\ln(r_i^r) = \alpha + \sum_j \beta[j](x_i[j] - \bar{x}[j])(y^k[j] - \bar{y}[j]) + \varepsilon_i^k$$

and the expanded function:

(4) $$\ln(r_i^k) = \xi + \sum_j (\beta[j]x_i[j]y^k[j] - \beta[j]\bar{y}[j]x_i[j] - \beta[j]\bar{x}[j]y^k[j]) + \varepsilon_i^k \ ,$$

where r_i^k (dependent variable) is the output of each industry in each country relative to to the size of the industry and the country, while $\beta[j]$ measures the importance of the interaction, $\beta[j]\bar{y}[j]$ and $\beta[j]\bar{x}[j]$ give level effects in the interaction, and constant, ξ, contains the sum (over *j*) of the products of all the level effects. $x_i[j]$ and $y_i[j]$ are country and industry characteristics, as denoted in Table 4.

Table 4: **Interactions in the Midelfart-Knarvik, Overman, Venables (2000) model**

	Country characteristics: x_i [j]		**Industry characteristic: y_i [j]**	
j=1	Agricultural endowment	log	Agricultural intensity	elasticity
j=2	Skilled labor endowment	log	Skill intensity	elasticity
j=3	Researchers and scientists	log	R&D intensity	elasticity
j=4	Intermediate price	log	Intermediate intensity	elasticity
j=5	Elasticity of market potential with respect to transport intensity	elasticity	Transport intensity	log
j=6	Relative market potential	elasticity	Share of output to industry	log

Source: Midelfart-Knarvik et. al. (2001)

The above characteristics are used in order to establish the effects of four main interactions: (1) the effects of primary factors and endowments, (2) the supply of intermediate goods (forward linkages), (3) market potential and transport costs, and (4) intermediate goods demand (backward linkages).

The model was estimated on the sectoral data for European Union member countries over the period from 1980 to 1997. The implementation of the model on the data shows that a very substantial part of the EU's cross-country variation in the industrial structure can in fact be explained by the forces captured in the model (determination coefficients are around 15% both in pooled OLS regression and in fixed effects estimation). In particular, countries' endowments of highly skilled labor appear to be the most important factor in attracting high skill intensive industries, while geography is also important, as industries dependent on backward and forward linkages to locate close to centers of manufacturing supply and demand (Midelfart-Knarvik et. al., 2000). The paper offers a very comprehensive structural model for justification of the included (tested) variables, but maintains an unrealistic assumption of perfect competition in all sectors of the economy, which detracts from the paper's overall contribution. This empirical analysis also serves as proof of the strong connections between the (neo)classical trade theory and the theory of the spatial allocation of production.

Forslid, Haaland and Midelfart-Knarvik (2002) use a large scale CGE model to simulate the effects of economic integration[51] on the location of industrial production. Their model bases on the input-output structures of specific industries, where downstream firms use an aggregate of upstream varieties as an intermediate input. This creates forward and backward linkages between firms as a strong agglomeration force. The authors simulate the interactions on the basis of a two-country, three-sector, two-factor economy with countries having identical relative endowments, although differing in size.[52] They discover a non-monotonic relationship between trade liberalization and concentration of production (inverted *U*-shape) for industries driven by economies of scale, while a monotonic relationship is observed for comparative advantage driven industries.

Redding and Venables (2001) estimate a structural model of economic geography, using cross-country data on per capita income, bilateral trade, and the relative price of manufacturing goods. They use data on 101 countries in the year 1996 to estimate the intermediate goods model with forward and backward linkages, keeping both incomes as well as firm number exogenous. They use a gravity equation to obtain predicted values for market and supplier access to estimate the wage equation, whereby they determine that more than 70% of variation in per capita income can in fact be explained by the geography of access to markets and sources of supply of intermediate inputs. They also find the effects of distance, access to coasts, and openness on level of per capita income to be very important.

5.2. EMPIRICAL STUDIES OF THE IMPACT OF INTER-REGIONAL TRANSPORT COST REDUCTION ON THE RELOCATION OF ECONOMIC ACTIVITY

De la Fuente (2000) investigates the sources of productivity convergence between Spanish regions in the period from 1955 to 1991. The paper argues that the high conversion rates observed for the Spanish regions in the given period are, in large part, due to the technological diffusion (to the so-called catch-up effect) and reallocation of resources across regions. The empirical results of a panel data analysis indicate significant by positive correlation between capital deepening variables (which include gross capital formation and employment growth), human capital investment variable (as measured by the share of employees who started secondary

[51] The economic integration occurring is meant as trade liberalization and partial market integration. For further effects of economic integration see Balassa (1961).
[52] Of the three sectors two are imperfectly competitive sectors, producing under increasing returns to scale, while the remaining sector is a perfectly competitive sector producing under constant returns.

education), technological diffusion (residual term of the estimated growth equation) and the dependent variable (the growth rate of relative productivity of a region compared with the “average region”). The empirical results support the proposed correlation only when fixed effects estimator is used, while random effects estimator shows the importance of the omitted region specific variables (the error factor captures all of the unobserved regional characteristics that have affected the productivity differentials).

Hanson (2000a) examines the spatial correlation between wages and consumer purchasing power across the U.S. countries, thereby seeing how regional product-market linkages contribute to spatial agglomeration. The structural model of this paper is heavily based on Krugman’s “home market effect” (Krugman, 1980). The paper first examines a simple market potential function where the proximity to consumer markets is the prime determinant of nominal wages for a given location as seen in the following estimated equation:

$$(5) \qquad \Delta \log(w_{jt}) = \alpha_1 \left[\sum_k Y_{kt} e^{\alpha_2 d_{jk}} - \sum_k Y_{kt-1} e^{\alpha_2 d_{jk}} \right] + \varepsilon_{ijt} ,$$

where w_{jt} represents nominal wages in region j at time t ; Y_{kt} income in region k at time t; and d_{jk} distance between regions j and k.

The data for the U.S. countries from 1970 to 1990 confirms the predicted negative relationship of nominal wages to transport costs to demand markets and a positive relationship to consumer income in demand markets at one per cent significance level, where this simple market potential function explains around 20 per cent of the nominal wage variation in the observed period. The paper also examines an augmented market potential function, whose parameters reflect the importance of scale economies and transport costs, the stability of spatial agglomeration patterns and their evolution over time. The data conform somewhat better to this function with the R-square rising in all estimated variants of the function. The inclusion of the two new dependent variables, wages and housing stock, lessens the importance of market potential, while enlarging the effect of distance. The effects of personal income and wages in surrounding locations on nominal wages in the given location are expectedly positive, while the housing stock in surrounding locations variable in contrast to theoretical predictions has a positive effect on nominal wages (Hanson, 2000, pp. 22-28).

Brakman, Garretsen and Schramm (2002) estimate a Helpman-Hanson[53] type of the empirical model, using data for Germany. An advantage of the Helpman-Hanson model is that it incorporates the fact that agglomeration of economic activity increases the prices of local (non-tradable) services like housing. The authors further complicate the Helpman-Hanson model by

[53] See also Helpman (1998), Hanson (2000).

introducing some country characteristics for Germany such as labor immobility and transfer of capital. The model thus provides a powerful spreading force, which leads to less extreme outcomes than the basic model of the new economic geography by Krugman (1991). Using specific data for 151 districts for 1994, the authors succeed in supporting the idea of a spatial nominal wage structure in Germany, but fail to find any conclusive evidence of real wage equalization. They also find evidence that a reduction of trade costs might lead to a more even spreading of economic activity, which could be good news for the “peripheral” East-German districts.

Overman, Redding, Venables (2001) present a survey of empirics as pertaining to the field of economic geography. The paper focuses on the general effects that the economic geography has on the volume of trade, income levels and structure of production, and offers a structural model to provide the basis for research work in this paper as well as research work of other authors. The authors first estimate (relating to the gravity model of trade) the elasticity of trade volumes with respect to distance at around –1 and the elasticity of trade volumes with respect to transport cost at around –3, indicating the importance of location for the competitiveness of firms in foreign markets[54]. The other important implications of the research are the effects of the access of a country (firms) to the world markets and it’s access to foreign suppliers on GDP per capita of that country. The effects appear to be very strong (positive and statistically significant at the 1% significance level) and explain around 35% of cross-country variation of gross domestic product per capita. The final part of the analysis focuses on the effects of economic geography and factor endowments as determinants of industrial structure in a given location, whereby the results imply that increasing returns manufacturing is disproportionately drawn into larger markets as opposed to smaller markets (Overman et. al., 2001).

Finally, a comprehensive overview of some of the recent empirical literature and some of the issues involved in estimating the effects of scale economies and the occurrence of geographic concentration of industry is also given in *Hanson (2000b)*. Hanson identifies three issues that might cause trouble in the estimation of economic geography effects: (1) unobserved regional characteristics, (2) simultaneity in regional data and (3) multiple sources of externalities, and additionally offers some solutions for this problem as well.

[54] The estimates are given on the basis of research work of other authors. See Hummels (1999a, 1999b, 2001).

6. EMPIRICAL VERIFICATION OF ECONOMIC GEOGRAPHY EFFECTS IN TRANSITION COUNTRIES

In the preceding chapter, I gave a very brief overview of the empirical work done on the spatial implications of the reallocation of economic activity as a repercussion of trade liberalization or a decrease of intra-country transport costs. The focus of the majority of research work has been limited to the analysis of the processes of market unification in the European Union, with the rest of the work dealing with the United States and Mexico. So far, I am not aware of any comparative studies on economic geography in transition countries or spatial repercussions of recent trade liberalization in transition countries. Thus, in this chapter, I will try to fill this void by attempting the empirical verification of some of the most basic implications of the Krugman (1991), *FKV* (1999) and my economic geography model, using a panel of regional data for five accession countries. The second reason for choosing transition countries is that the transition of the former Eastern bloc countries into market economies presents a very obvious candidate for a kind of controlled or natural experiment to test the effects of trade liberalization. In the subsequent sections I will first discuss the empirical model used, and explore some of the predictions ensuing from the competitive models of economic geography (section 6.1.). The following section 6.2. deals with the data employed as well as the pattern of relative regional wages and FDI inflows in each of the transition countries. Some characteristics of the transition process in the former Eastern bloc countries, which clearly differentiate this process from plain trade liberalization, are also presented. Finally, after a short discussion about some of the methodological issues involved in testing the model, this chapter offers some results of econometric estimation in the empirical model.

6.1. THE EMPIRICAL MODEL

There are clear implications for transition countries of the Krugman, *FKV* and my model discussed above. The Krugman (1991) model predicts a monotonic decline in relative regional wages throughout the period after trade liberalization has been initiated. This implies that trade liberalization will bring forth a core-periphery formation of economic activity with the larger region[55] gradually assuming ever larger shares of the manufacturing industry. *FKV* model predicts a *U*-shaped response of relative regional wages to the reduced foreign trade barriers in transition countries. In the first years after trade liberalization, relative wages will decline, while after some threshold of foreign trade costs being reached, the wages in peripheral regions will start catching up with the central region, due to the increasing attractiveness of those regions for

[55] In the case of Krugman (1991), the regions mentioned here are actually countries.

firms on account of lower wages. My model predicts that after a country liberalizes its trade with the EU, its pattern of inter-regional manufacturing relocation will be determined by a trade off between agglomeration effects, remaining trade costs and existing differences in relative factor costs. With the unchanged inter-regional transport costs, regions that are located closer to the EU border (western and/or northern regions, *W/N regions* henceforth) will benefit from trade liberalization through larger inflows of FDI due to lower trade costs with the EU and due to lower wages and higher returns to capital relative to the central home region. Some domestic resources might also relocate to border regions.[56] As a result, after the initial downturn, border regions will converge to the home capital region in terms of relative wages (and returns to capital) and relative manufacturing output.[57] In non-border regions, this adjustment pattern might be less pronounced. Hence, regional data for transition countries should exhibit a *U*-shaped curve of relative wages. The crucial differences relative to the *FKV* model, however, are in the speed of convergence, the importance of FDI factor, and a faster convergence of the W/N border regions, as seen in the simulations (see section 4.8.).

In order to examine the spatial repercussions of trade liberalization in transition countries and to search for differences between the three competitive models, the following empirical model of relative regional wages has been estimated:

$$(1)\quad \ln \mathbf{rW} = \alpha + \nu\, \mathbf{t} + \omega\, \mathbf{t}^2 + \delta \ln \mathbf{irVAe} + \phi \ln \mathbf{rFDI} + \beta \ln\mathbf{DIST} + \gamma\, \mathbf{BORD} + \lambda\, \mathbf{FTA} + \mu \ln\mathbf{DIST{*}FTA} + \kappa \ln\mathbf{DIST{*}BORD} + \sigma\, \mathbf{BORD{*}FTA} + \rho\, \Sigma\mathbf{R} + \tau\, \Sigma\mathbf{T} + \varepsilon_{it}$$

where:

rW	relative regional wage (i.e. wage ratio of region *r* to the capital region)
t, t^2	time effects
irVAe	initial regional efficiency differential
rFDI	relative regional output of foreign firms (as compared to domestic firms)
DIST	distance to capital
BORD	dummy for western/northern border regions
FTA	dummy for enforcement of trade liberalization with the EU
ΣR	broader regional dummies
ΣT	time dummies
ε_{it}	error term

[56] So far, my model does not enable explicit modeling of labor mobility, but this is an interesting direction for its further development.
[57] It should be noted though that complete convergence is very unlikely.

According to the model specification (1), one can interpret predictions of the three competitive models in the way as summarized in Table 5. In general, no firm conclusions can be made upon the initial regional conditions in all of the transition countries (hence, distance and border effects can be of either sign). Initial relative regional wages might to a large extent depend on the past specific regional policies in each of the former socialist countries and on the extent of the initial openness to trade.

Table 5: **Parameter predictions of competitive EG models**

	Krugman	*FKV*	*my model*
t	-	ambiguous (+, -)	ambiguous (+, -)
t^2	insignificant	+	+
rFDI	insignificant	insignificant	+
DIST	ambiguous (+, -)	ambiguous (+, -)	ambiguous (+, -)
BORD	ambiguous (+, -)	ambiguous (+, -)	ambiguous (+, -)
FTA	-	+	+
DIST*FTA	-	+	+
DIST*BORD	-	ambiguous (+, -)	+
BORD*FTA	-	ambiguous (+, -)	+

Source: Own conclusions based on Krugman (1991), Fujita, Krugman, Venables (1999) and Damijan, Kostevc (2002)

More conclusive answers can be given for the period after trade liberalization (FTA) has been initiated. If the *Krugman* model applies to transition countries, one may expect a monotonic negative time pattern of relative wages (a negative sign of t) and negative distance and border effects becoming more pronounced over time, since peripheral regions will start lagging behind the central region as trade gets liberalized. In the *FKV* setting, a *U*-shaped time pattern of relative wages is expected (hence, a positive sign of t^2) and, in general, positive distance and trade liberalization effects on relative regional wages will prevail over time. The question that arises here is whether the time period chosen for the transition countries in our sample is long enough for the completion of the transition process or not. If the time period was in fact too short and trade liberalization not yet complete, the implications of lower trade barriers would be difficult to determine in a static model. Similarly, if my model is to work in transition countries in the 1990s, one may expect a *U*-shaped time pattern of relative wages and positive distance and trade liberalization effects on relative regional wages. In addition to that, positive impact of FDI and an upward trend of relative regional wages in the W/N border regions are expected.

6.2. TIME PATTERN OF RELATIVE WAGES AND FOREIGN DIRECT INVESTMENT INFLOWS IN TRANSITION COUNTRIES

My aim in this section is to present the data employed in the empirical analysis with its advantages and limitations. Given the nature of the data, the process of sample selection was governed solely by data availability, which also to some extent affected the compatibility of the data gathered. In subsections 6.2.2. and 6.2.3. I analyze some aspects of the evolution of relative regional wages and regional foreign direct investment during the process of transition. Finally, I outline some of the main characteristics of the transition process witnessed in the former Eastern bloc countries that might affect further analysis of the spatial distribution of economic activity.

6.2.1. The data

In this subsection, the propositions of the competitive EG models are analyzed by using regional data for five transition countries that are eligible for accession to the EU after 2004. These countries are Bulgaria, Estonia, Hungary, Romania and Slovenia.[58] As already mentioned above, the choice of countries was not arbitral; it was simply subject to availability of the data. Countries examined in the study are quite heterogeneous, both in terms of their level of development and advancement of transition process as well as in terms of their distance to the core of the EU. One may thus expect that the distance and border effects in more distant countries like Bulgaria and Romania, which are also less advanced, will be less pronounced, compared to the EU bordering transition countries like Estonia, Hungary and Slovenia.

The data have been collected during the Phare ACE project on regional pattern of production relocation in transition countries.[59] The data has been gathered on the basis of the NUTS (Nomenclature for Territorial Units for Statistics) classification.[60] The data for Bulgaria, Estonia, Hungary and Romania have been collected at the NUTS-2 and NUTS-3 levels and covers the period from 1990-1999 (Bulgaria and Hungary) and the period from 1992-1999 (Estonia and Romania). For Slovenia, which lacks the official regional statistics, the data have been aggregated from individual firm level data to the desired level of regional aggregation (NUTS-3 and NUTS-5 levels) and covers the period from 1994-2000. Slovenia is yet to establish self-governing regions at the NUTS 3 level and those regions remain a purely statistical construct, which poses additional problems with regard to relevance of conclusions based on the data

[58] I am well aware that the sample ought to be expanded to include other transition countries (or at least to include the remaining Central European transition countries), but at the time the data was collected, this was unfortunately not possible.

[59] I am grateful to Mary Redei, Julia Spiridonova, Carmen Pauna, Laura Resmini and Grigory Fainsthein for sharing their data with me.

[60] For a more detailed look at the NUTS classification see Appendix F.

gathered. All the data have been recalculated into 1994 constant prices using PPI indices. All the distances used (distances of regional capitals to the country capital and distances of regional capitals to the closest western/northern border region) have been measured as road distances between two locations. The data in my database comprises many aspects of regional performance; however I explore only a small part of it. I take account only of the data for the manufacturing sector, as other sectors are far less subject to trade liberalization.

As it follows from the previous discussion and from the empirical model discussed above, in all of the subsequent analyses and empirical estimations we use relative regional indicators in order to capture inter-regional relocation patterns in particular transition country. Relative regional indicators for wages and FDI are thus calculated as a ratio of *r*-th region performance to the capital (*c*) region performance. In the empirical estimations, regional data at the NUTS-3 (NUTS-5 for Slovenia) level is taken for individual observations, while NUTS-2 (NUTS-3 for Slovenia) regional dummies are taken in order to control for broader regional effects.

Table 6: **Descriptive statistics of regional data by countries**

	BG	EST	HU	RO	SLO
Data coverage	1990-99	1992-99	1990-99	1992-99	1994-00
Enforcement of FTA	1994	1994	1992	1993	1997
No. of NUTS-2 regions*	6	5	7	8	12
No. of NUTS-3 regions**	28	15	20	41	170

* NUTS-3 regions in Slovenia** NUTS-5 regions in Slovenia

While wage data does not need more discussion, some clarifications should be made with regard to the FDI data. With the exception of Slovenia, the data on relative importance of FDI in terms of output at the regional level for the other four countries in the sample were not at my disposal. What I do have, is the data on the number of foreign owned and domestic firms by regions. The ratio of foreign firms to domestic firms in each region has been taken to proxy for relative importance of FDI in each region. Of course, this is a very rough approximation, since the study for ten transition countries by Damijan et al. (2001) demonstrated that foreign owned firms were much larger in terms of output and employment, more capital intensive, etc. relative to their domestic owned counterparts in the same sectors. The role of FDI in inter-regional manufacturing relocation in the present study, hence, is by default underestimated.

Similarly, with the exception of Slovenia, there is a lack of data for the evolution of foreign trade barriers over the specified period, both at the country level as well as at the regional level. Ideally, one should take the time pattern of the actual foreign trade barriers (tariffs, non-tariff barriers) at the regional level and estimate the impact of their reduction on the spatial repercussions in each country. Instead, I all I have is the data on the date of enforcement of the free trade agreement (FTA) with the EU. This, however, imposes several problems. First, in some of the countries, FTA has been enforced at the beginning of the period under examination, which of course eliminates the reference period needed for comparison of the EG effects before and after trade liberalization. Second, some of the examined countries have unilaterally liberalized their trade even before the enforcement of FTA. Third, FTAs, enforced by the EU, were designed asymmetrically in favor of transition countries. Hence, the enforcement date of the FTA does not imply that trade barriers have been reduced linearly from that point on. In all of the countries, trade barriers for most sensitive goods have been eliminated at the end of the examined period. However, there is little one can do about it. What remains is to be cautious when discussing the results. On the other hand, I have separately estimated the model with Slovenian data by using either the FTA dummy variable or the data on actual tariffs applied by regions. Both estimations, however, do not differ significantly in terms of the signs and significance of the parameters for trade liberalization.

6.2.2. Evolution of relative regional wages

In this subsection, the evolution of relative regional wages in individual countries is examined. The graphic analysis comprised in Figure 9, combined with some descriptive statistics given in Table 7, gives a very clear insight into the pattern of relative wages during the 1990s. Table 7 reveals that, with the exception of Slovenia, at the beginning of trade liberalization in the early 1990s, there was little dispersion of regional wages in the examined countries. The average relative regional wages in all of the countries exceeded 80 per cent of that in the central region, and the coefficient of variation of relative wages was well below 10 per cent. The exception is Slovenia, where average relative wage amounted to 66 per cent of the central region's wage and the coefficient of variation exceeded 35 per cent. One can think of two possible reasons for these divergent initial positions between Slovenia and other transition countries. The first and most obvious explanation lies in the fact that before 1990 Slovenia was relatively more open to international trade than other transition countries. Exposure to trade and a kind of semi-market economy had been affecting Slovenia's regional development well before 1990, while other transition countries have additionally sheltered their respective economies by preventing large regional disparities through special regional policies. Another explanation stems from the level of aggregation used in the calculations. For Slovenia, data at the NUTS-5 (community) level is used while for other countries, the NUTS-3 data is used, which of course levels out a lot of variation. This is confirmed when we apply a coefficient of variation normalized by square root of the number of observations. In this case, variation of relative regional wages in Slovenia becomes very similar to that of other transition countries.

More important, however, is how trade liberalization affected regional development in individual countries. Again, with the exception of Slovenia, relative wages in all of the countries were declining substantially until the end of the 1990s. On average, relative regional wages diminished by 15-20 percentage points relative to the central region and the variation has increased to almost 15 per cent, which implies increased regional disparities. On the other hand, in Slovenia, relative regional wages increased slightly (on average by some 3 percentage points) and the variation fell. It is interesting to note that according to the suggestions of my model, the drop in the relative regional wages in all countries was much smaller (in Slovenia, the increase was higher) in the W/N border regions, implying that economic geography might be at work there. The economic geography effects on a dispersion of economic activity could in fact be slowing down the process of agglomeration, thus allowing for a smaller decrease in the relative regional wages observed in other non-W/N border regions.

Table 7: **Changes in relative regional wages in transition countries in the 1990s**

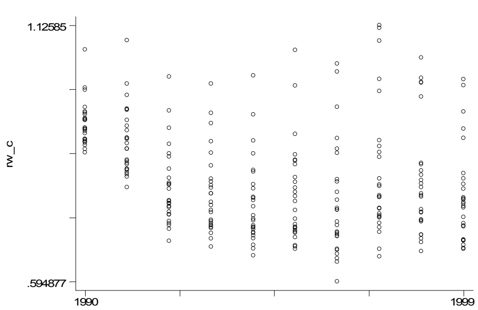
	BG (1990)	BG (1999)	EST (1992)	EST (1999)	HU (1990)	HU (1999)	RO (1992)	RO (1999)	SLO (1994)	SLO (2000)
All regions										
Mean	0.924	0.786	0.840	0.667	0.820	0.706	0.957	0.706	0.660	0.692
Std. Error	0.009	0.020	0.031	0.026	0.018	0.024	0.015	0.014	0.019	0.016
Std. Deviation	0.047	0.106	0.119	0.099	0.081	0.107	0.096	0.090	0.246	0.213
Coef. of variation	5.1%	13.5%	14.2%	14.9%	9.8%	15.2%	10.0%	12.7%	37.3%	30.8%
Norm. coef. of variation[61]	1.0%	2.5%	3.7%	3.8%	2.2%	3.4%	1.6%	2.0%	2.9%	2.4%
N	28	28	15	15	20	20	41	41	170	170
W/N border regions										
Mean	0.906	0.817	0.849	0.732	0.854	0.759	1.010	0.736	0.667	0.752
Std. Error	0.013	0.042	0.040	0.070	0.032	0.029	0.043	0.027	0.042	0.051
Std. Deviation	0.040	0.127	0.089	0.156	0.078	0.072	0.137	0.085	0.222	0.270
Coef. of variation	4.4%	15.6%	10.5%	21.3%	9.2%	9.4%	13.6%	11.5%	33.3%	35.9%
Norm. coef. of variation	1.5%	5.2%	4.7%	9.5%	3.8%	3.9%	4.3%	3.6%	6.3%	6.8%
N	9	9	5	5	6	6	10	10	28	28
Non-W/N border regions										
Mean	0.932	0.771	0.836	0.635	0.805	0.683	0.940	0.696	0.659	0.680
Std. Error	0.011	0.022	0.043	0.010	0.021	0.030	0.013	0.016	0.021	0.017
Std. Deviation	0.049	0.094	0.136	0.032	0.080	0.114	0.074	0.090	0.251	0.199
Coef. of variation	5.3%	12.2%	16.3%	5.0%	9.9%	16.7%	7.8%	13.0%	38.2%	29.2%
Norm. coef. of variation	1.2%	2.8%	5.2%	1.6%	2.7%	4.5%	1.4%	2.3%	3.2%	2.5%
N	19	19	10	10	14	14	31	31	142	142

Source: Own calculations.

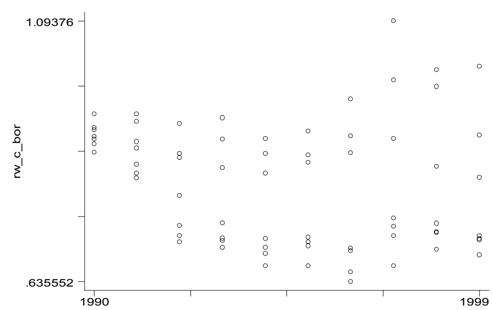
[61] Normalized coefficient of variation is a coefficient of variation normalized by a square root of the number of observations (N). This is to ensure a better comparability of variation across countries. As the variation of data for countries with the more disaggregated data is biased upward, one should take this into account.

Let us now turn to the pattern of changes in relative regional wages throughout the 1990s. Figure 9 shows clearly that only in the case of Bulgaria a clear U-shaped adjustment pattern of regional wages can be observed. This pattern better is even more pronounced in the W/N border regions, where a two-tier regional development can be distinguished (one set of regions is displaying higher relative nominal wages than the other, while both sets display a *U*-shaped pattern of regional wage adjustment). In Hungary, a clear negative trend of relative wages is evident, but the data suggest that a downturn had been reached by 1998 and that afterwards a steady rise in regional wages can be noted. For Bulgaria and Hungary, hence, one might expect the *FKV* and my model to be at work. In Romania, on the other hand, significant negative trend of relative regional wages is revealed implying the *Krugman* type of divergence. The same applies also for Romanian W/N border regions. In Slovenia, no clear adjustment pattern for all regions is visible, but a weak upward trend can be observed for the W/N regions after 1997. The latter might speak in favor of my explanation of the regional adjustment. In contrast to the above four countries, Estonia exhibits a clear picture of an inverted U-shaped pattern of regional adjustment. An explanation for this might lie in the fact that the core manufacturing production is based around Tallinn in the W/N border regions. Since the early 1990s, these regions have benefited enormously from large FDI inflows, especially in non-manufacturing sectors, which triggered off a steep rise in wages. Recently, regions that are more distant from the capital, can no longer keep pace anymore with a rapidly expanding capital region of Tallinn. Strong migrations of qualified labor to the central region are apparent, which implies that a typical *Krugman* type of regional polarization might take place in Estonia. The usual agglomeration effects of scale economies, labor pooling and others, are amplified by labor mobility to the central region.

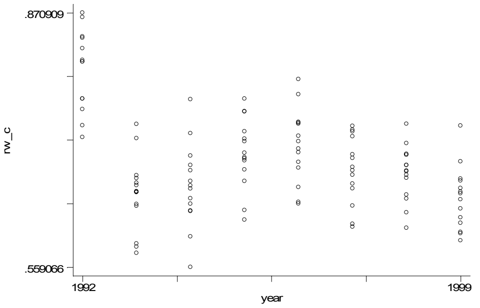
Figure 9: **Evolution of relative regional wages in transition countries**



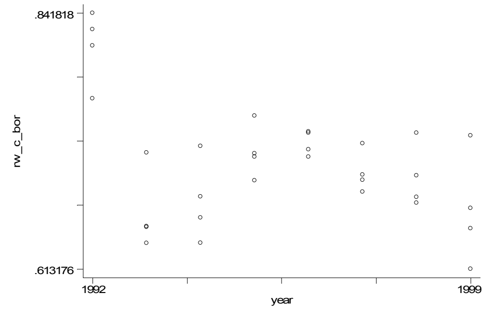
Bulgaria, 1990-99 – All regions



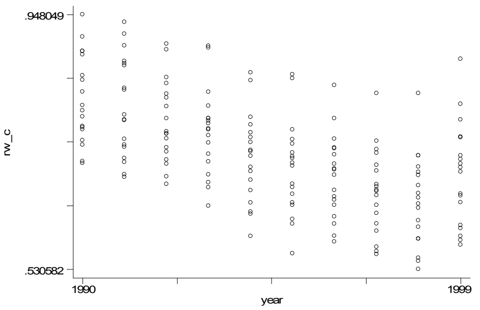
Bulgaria, 1990-99 – W/N regions



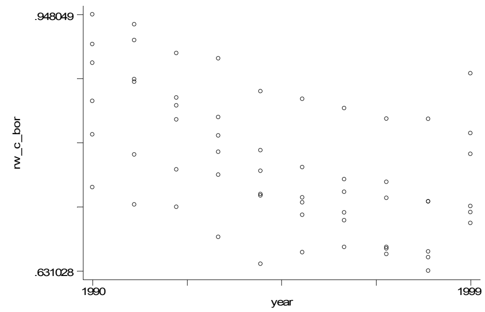
Estonia, 1992-99 – All regions



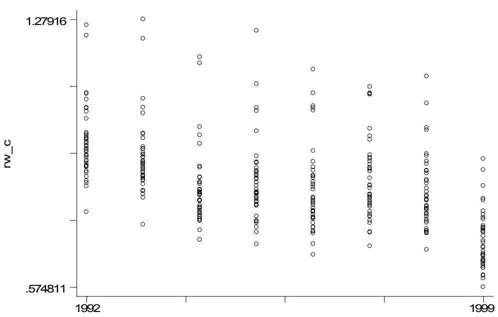
Estonia, 1992-99 – W/N regions



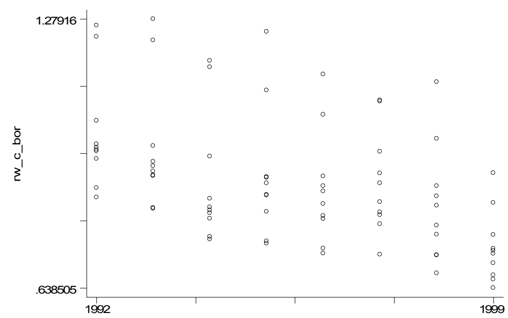
Hungary, 1990-99 – All regions



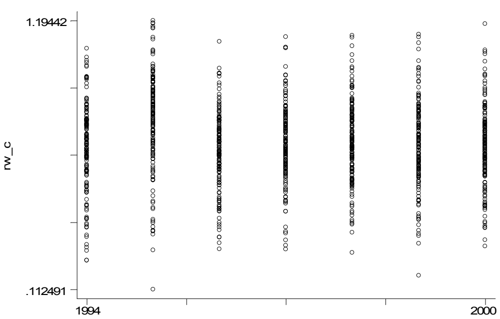
Hungary, 1990-99 – W/N regions



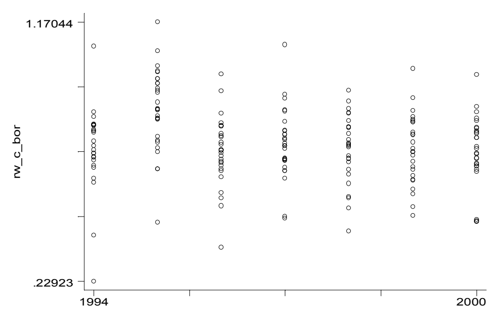
Romania, 1992-99 – All regions



Romania, 1992-99 – W/N regions



Slovenia, 1994-2000 – All regions



Slovenia, 1994-2000 – W/N regions

6.2.3. Evolution of relative regional FDI

As revealed in Table 8, selected transition countries have been subject to substantial FDI inflows during the 1990s. The share of all transition countries in the world FDI flows increased from 0.2 per cent in 1991 to some 2.3 per cent in 2000. In countries under examination the stock of FDI throughout the 1990s accumulated to some 15-50 per cent of GDP. The major recipient of FDI, in absolute terms among selected countries, is Hungary, while in relative terms (as a share of GDP), FDI plays the most important role in Estonia.

Table 8: **Pattern of FDI inflows to transition countries, 1990-2000 (in mill. $)**

Country	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**1990-2000 (as % of GDP)**
Bulgaria	4	56	42	40	105	90	109	498	537	819	1,002	19.9
Estonia	…	…	58	160	225	205	150	262	581	305	398	47.9
Hungary	311	1,459	1,471	2,339	1,146	4,453	1,983	2,085	2,036	1,944	1,957	39.9
Romania	-18	37	73	94	341	419	263	1,224	2,031	1,041	998	16.1
Slovenia	4	65	111	113	128	176	185	321	165	181	181	13.0

Source: UNCTAD, World investment report 2001.

As suggested in my model, the regional pattern of FDI inflows is determined by (i) differences in relative factor costs, (ii) trade costs between home country and foreign country as well as trade costs between home regions, and (iii) agglomeration effects. Table 8 shows the pattern of a relative regional presence of foreign investment firms (FIEs). Here, in absence of more appropriate data, the number of FIEs relative to the number of domestic firms serves as an effective measure of regional importance of FDI. As discussed earlier, these indicators should be interpreted with a large portion of cautiousness. As I only deal with the data on number of firms and not with the data on their output, this may bias the findings in an important way. Nonetheless, with some exception of Bulgaria and Estonia, the regional pattern of FDI does not correspond to that suggested by my model. In general, the importance of FDI by regions is quite low. On average, the share of FIEs by regions is well below 10 per cent and this did not change much throughout the 1990s. In Bulgaria and Estonia, these shares in the W/N border regions are substantially higher and amount to 13 and 23 per cent in 1999, respectively. In Hungary, Romania and Slovenia, the opposite is true as non-W/N border regions account for substantially higher shares of FDI. This evidence is in line with findings of Altomonte and Resmini (2001), who found that a vast majority of FDI inflows in transition countries have been directed into the central regions and traditional economic centers. To sum up, with the exception of Bulgaria and Estonia, little evidence, at least using this rough method, has been found in favor of the suggestions of my model, which proposes the majority of FDI to flow into the W/N border regions. The exact impact of regional FDI on the regional wage structure remains to be seen in formal tests what is.

Table 9: **Regional pattern of FDI by countries, 1990-2000 (relative share of firms with FDI compared with all firms in the region)**

	BG (1990)	BG (1999)	EST (1992)	EST (1999)	HU (1990)	HU (1999)	RO (1992)	RO (1999)	SLO (1994)	SLO (2000)
All regions										
Mean	0.073	0.068	0.076	0.090	0.084	0.095	0.042	0.047	0.041	0.030
Std. Error	0.037	0.036	0.066	0.065	0.049	0.048	0.024	0.024	0.017	0.011
Std. Deviation	0.197	0.189	0.256	0.253	0.218	0.215	0.155	0.154	0.221	0.141
Coef. of variation	271.3%	279.1%	338.4%	279.7%	260.6%	225.5%	366.9%	330.4%	542.8%	466.9%
Norm. coef. of variation	51.3%	52.7%	87.4%	72.2%	58.3%	50.4%	57.3%	51.6%	41.6%	35.8%
N	28	28	15	15	20	20	41	41	170	170
W/N border regions										
Mean	0.128	0.129	0.211	0.227	0.037	0.057	0.029	0.034	0.041	0.033
Std. Error	0.109	0.109	0.197	0.193	0.008	0.010	0.012	0.008	0.019	0.018
Std. Deviation	0.327	0.327	0.441	0.433	0.021	0.024	0.039	0.025	0.100	0.096
Coef. of variation	254.9%	253.4%	209.7%	190.9%	56.2%	41.4%	134.9%	74.1%	245.9%	291.7%
Norm. coef. of variation	85.0%	84.5%	93.8%	85.4%	22.9%	16.9%	42.7%	23.4%	46.5%	55.1%
N	9	9	5	5	6	6	10	10	28	28
Non-W/N border regions										
Mean	0.046	0.039	0.008	0.022	0.104	0.112	0.047	0.051	0.041	0.030
Std. Error	0.021	0.013	0.004	0.007	0.070	0.069	0.032	0.032	0.020	0.013
Std. Deviation	0.092	0.057	0.013	0.023	0.260	0.258	0.178	0.177	0.238	0.149
Coef. of variation	199.1%	147.0%	158.9%	106.1%	250.9%	230.3%	380.7%	348.8%	584.1%	500.8%
Norm. coef. of variation	45.7%	33.7%	50.2%	33.6%	67.1%	61.6%	68.4%	62.7%	49.0%	42.0%
N	19	19	10	10	14	14	31	31	142	142

Source: Own calculations

In the cases of Hungary, Romania and Slovenia, the shares of FDI in non-W/N border are higher or similar to those achieved in the W/N border regions, which implies that determinants of FDI inflows might be at work (such as the infrastructure, government development policies and many others). Another factor in the case of Slovenia might also be that, due to its small size, the within country (inter-regional) transport costs do not present an important dispersion factor in location decisions of foreign firms, which allows firms to locate in non-W/N border regions and still maintain most of the benefits from such a location. This in fact works towards weakening the strength of dispersion forces and may favor agglomeration or relocation to other non-W/N border regions. The next important contributor to the location of foreign direct investment might also be the initial location of economic activity, which in this case is closely connected with the idiosyncrasies of the former system of central planning and its transition process. Some of the characteristics of this process are discussed in the following subsection.

6.2.4. Some characteristics of the transition process

The dramatic political events of the late 1980s and early 1990s culminated in a marked economic slowdown experienced by the Eastern bloc countries over the preceding three decades. Since the transition process affected some 1,65 billion people (China included), it has been termed by many as one of the most important economic events of the twentieth century (Roland, 2000). The resulting transition from central planned economy to market economy has been difficult for several reasons[62] as the economic performance failed to live up to some lofty expectations.

Diversity of strategies for transition

The aim of the transition was to ensure macroeconomic stability and microeconomic restructuring, along with institutional and political reforms, with the majority of the countries opting for the "big bang" rapid style reform. According to Svejnar (2002), two types of reforms were carried out. Type I reforms focused on macroeconomic stabilization, price liberalization and dismantling of the communist system institutions. Restrictive monetary and fiscal policies were emphasized, combined with wage controls and, more often than not, a fixed exchange rate[63]. The microeconomic policy moved toward price liberalization, although keeping a number of key prices such as energy, housing and some basic consumption goods, fixed. Many of the barriers to firm creation were also abolished, which led to an exaggerated growth of small firms and banks in most of the countries, many of which quickly collapsed. This type of reforms proved very successful for many of the transition countries. Type II reforms, which were not carried out by all of the transition countries, involved the development and enforcement of laws, regulations and institutions that would ensure a successful market oriented economy. This primarily involved large-scale privatization, development of market institutions and an in-depth development of a viable commercial banking system as well as institutions related to public unemployment and retirement systems.

Enormous differences exist between transition economies in strategies undertaken in privatization as well as some aspects of market reform, which helps create very heterogeneous market conditions among transition economies. The greatest differences have become apparent in the formation of a market conducive legislature, with virtually no transition country succeeding in rapidly developing a legal system and institutions that would ensure a preservation of private property and the functioning of the market economy.

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[62] Most importantly, the economic problems associated with transition were widely underestimated, while the western economies did very well, which raised the bar for a perception of economic success. The final reason for a less than expected growth rate were also some dubious decisions by policy makers.

[63] Slovenia is a noted exception with a managed floating exchange rate.

Differences in economic performance

A common characteristic of the former socialist countries at the outset of the transition process was that the prices did not reflect scarcity, consumer demand nor the productivity of producers. [64] Besides the obvious problems of unrealistic pricing, this also made market valuations very difficult, which, combined with substantial effects of the underground economy, caused precise estimations of the pre-transition gross domestic product to be almost impossible.

All transition countries experienced an early transition depression, whose length and depth was a surprise for many countries.[65] A number of explanations for this occurrence have been offered: tight macroeconomic policies, credit crunch stemming from the reduction of state subsidies to firms and the subsequent rise in interest rates, disorganization among suppliers, producers and consumers associated with the collapse of central planning, a switch from controlled to uncontrolled monopolistic structures in these economies, etc. (Blanchard, 1997, Rolland and Verdier, 1999, Polanec, 2002). In addition to the already mentioned changes, most of the transition countries strongly devalued their currencies in order to promote exports and were also forced to redirect their trade away from the old Council for Mutual Economic Assistance towards market economies. Due to high domestic inflation, the exchange rates often became overvalued quickly leading to current account deficits. Large differences between transition countries occurred also on account of the differences in the speed of trade liberalization. The economic performance was also affected by differences in the initial external debt, which was higher in Bulgaria and Hungary and substantially lower in Romania and Slovenia. Foreign direct investment inflows until 1997 were significant only in the case of Hungary, while other countries in the sample, with a possible exception of Estonia, remained less attractive to foreign direct investment. Finally, with the demise in state owned enterprises, employment and/or real wages declined in the early 1990s, with the largest initial reduction in industrial employment occurring in Hungary[66], Slovakia and Poland.

All the factors mentioned above lead to the fact that the sample of countries used for the empirical verification of economic geography hypothesis is very heterogeneous. The five transition economies differ greatly in the level of reforms implemented, market conditions and openness to foreign trade, which makes it very difficult to draw general conclusions solely on the basis of the sample data.

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[64] According to Blanchard and Kremer (1997), this is due to the decentralization of bargaining between suppliers and buyers, which under incomplete contracts or asymmetric information, bargaining could break down, which may negatively affect output as well.
[65] Some of the countries still have not reached the pre-depression gross domestic product levels.
[66] Hungarian real wages actually rose by 17 per cent at the time.

6.3. METHODOLOGY AND RESULTS

In the following section my aim is to present the results of the empirical analysis of the economic geography effects model (1) on the sample of five transition countries using panel data estimation techniques as well as some conclusions based on these tests.

6.3.1. Methodology

Before turning to the estimation results of our empirical model (1), few words need to be said about the methodology of the estimations. The data is structured as regional panel data for a time span of 7 to 10 years, which requires an explicit account of the region specific effects[67]. Without explicit control for this one might get biased estimates of coefficients, since FDI inflows, output growth and changes in relative wages might be correlated over time or subject to random shocks. Using static specification of the model (1), there are two well-known ways of controlling this bias. First obvious option is employing the fixed effects (FE) estimator, which assumes fixed (constant) region specific effects over time. On the other hand, random effects (RE) estimator assumes that region specific effects are random and only reflected in the error term; i.e. uncorrelated over time. The FE estimator is usually more robust but quite inaccurate, while the RE estimator is sensitive to the assumptions but more accurate[68]. From an analytical point of view, I am interested in observing pattern of changes in a relative regional performance over time induced by external shocks such as trade liberalization. Of course, it is straightforward to assume that an individual region will respond homogenously to external shocks throughout the period. Hence, in this case, the FE estimator is a natural choice. An important drawback of the FE estimator in the present case, however, is that some of the crucial variables in the empirical model are time invariant (such as border dummies, transport costs proxied by road distances in kilometers or the trade liberalization dummy for countries that liberalized their trade with the EU already in the beginning of the period that is covered in our data). When performing regular FE estimations, these variables are dropped from the estimation procedure. In order to avoid this, I employed a trivial trick - all of the time invariant variables have been multiplied by time trend. After differentiating, which is the underlying procedure in the FE estimations, this gives normal, time varying values of the parameters under consideration. Of course, one needs to be cautious with the interpretations, since the regression coefficients obtained through this modification are to be interpreted in terms of rates of growth. Yet, all that matters in our estimations is the sign and significance of the parameters, which are not altered by the above modifications. Irrespective of

[67] The effects that are specific to only a certain region. These effects influence the estimations and have to be accounted for.

[68] For a more detailed look at panel data estimation see Greene (2000) and Hsiao (1999).

the superiority of the FE estimator in the present case, the formal Hausman tests in order to test the validity of the model specification was conducted.

6.3.2. Results

Table 10 provides basic estimation results of our empirical model (1) using the FE estimator. F-tests performed confirm the presence of strong individual (regional) effects and justify the use of panel data techniques instead of OLS. However, irrespectively of the superiority of the FE estimator over the RE estimator, the Hausman specification tests in cases of Bulgaria, Estonia and Hungary cannot reject the null hypothesis that individual effects are random[69]. In this cases, therefore, the RE specification of the model is more appropriate. Close examination of coefficients obtained, using both estimators, however, does not reveal any reversals in the sign and significance of coefficients. The interpretation of the results that follows, therefore, does not suffer under the misspecification of the model.

The expected U-shaped (i.e. a positive sign of t^2) adjustment pattern of relative wages is revealed only in the case of Hungary, while for Bulgaria, contrary to graphic representation (Figure 6), such adjustment pattern is not confirmed. For both countries, a strong catching up of the W/N border regions is evident, which has not been strongly affected by trade liberalization. On average, wages in the W/N border regions in both countries grow annually approximately 4 per cent faster than in the central region.[70] The distance from the capital does not seem to have affected regional wages significantly, either before (DISTANCE variable) or after trade liberalization (DIST*FTA), but it has some impact on slower growth of wages in more distant W/N border regions. Only in the case of Estonia, statistically significant positive effects of distance on relative wages are evident. The dummy variable for the moment when free trade agreements came into effect, shows a statistically significant positive correlation only in the case of Estonia and Slovenia, implying that relative wages have been higher since the free trade agreements came into place. Similarly, FDI inflows in most countries do not seem to affect the manufacturing relocation and adjustment pattern of regional wages. The exceptions here are Estonia and Romania, where in the latter case, relative FDI inflows negatively affect relative regional wages. When compared to the predicted signs of parameters, according to the three competitive EG models, one may conclude that the adjustment pattern of regional wages in Bulgaria and Hungary is much in line with the *FKV* model.[71]

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[69] The Hausman test tests the null hypothesis that there is no difference in partial regression coefficients estimated with the fixed effects estimator and the random effects estimator.

[70] This is evident in the case of Bulgaria and Hungary, whereby Estonia's case shows that wages grow by 8 per cent higher.

[71] To a large extent it is also in line with my model, although the effect of FDI on the regional relative wages of the transition countries seem to have been overemphasized by the theoretical model.

Table 10: **Impact of trade liberalization on relative regional wage structure in transition countries***

	BG	EST	HU	RO	SLO
t	-0.021	**-0.301**	-0.031	-	0.013
	(-0.81)	(-2.90)	(-0.62)		(0.64)
t^2	-0.001	**-0.004**	**0.001**	0.002	**-0.004**
	(-1.10)	(-7.72)	(7.57)	(0.64)	(-2.70)
irVA/emp	**0.024**	**-0.164**	0.000	**-0.033**	**-0.019**
	(2.76)	(-3.10)	(-0.03)	(-2.56)	(-6.01)
rFDI	-0.089	**0.581**	0.180	**-0.377**	-0.086
	(-0.62)	(1.51)	(0.97)	(-2.18)	(-0.97)
DISTANCE	-0.0029	**0.058**	0.005	-0.003	0.004
	(-0.63)	(3.15)	(0.54)	(-0.74)	(0.84)
BORDER	**0.042**	**0.086**	**0.046**	-0.009	0.003
	(2.02)	(2.18)	(2.64)	(-0.36)	(0.08)
FTA	0.015	**0.503**	0.006	0.0001	**0.071**
	(0.51)	(4.96)	(0.11)	(0.01)	(2.58)
DIST*FTA	0.005	**-0.070**	-0.006	0.0003	**-0.014**
	(0.91)	(-3.60)	(-0.59)	(0.68)	(-2.35)
DIST*BORD	**-0.007**	-0.006	**-0.010**	0.002	-0.001
	(-2.01)	(-0.84)	(-3.51)	(0.39)	(-0.17)
BORD*FTA	-0.002	**-0.070**	0.011	-0.0003	0.009
	(-0.30)	(-3.92)	(1.20)	(-0.43)	(0.80)
Broad region dummies	Yes	Yes	Yes	Yes	Yes
Number of obs.	260	112	180	320	1169
Adj R^2	0.615	0.862	0.858	0.812	0.185
F test for individual effects	22.2	15.66	33.4	14.1	14.0
Hausman chi^2 test	12.2	2.6	11.0	243.5	114.1
Prob>chi^2	0.6676	0.9996	0.6876	0.0000	0.0000

* Dependent variable: relative regional wage, i.e. wage in the *r*-th region relative to the capital region
t-statistics in parentheses. Statistically significant values in bold letters.

Source: Own calculations

For Estonia, as expected according to the preliminary analysis of the data, an inverted *U*-shaped (i.e. a negative sign of t^2) adjustment of relative wages is found. Additionally, initially positive distance and border effects became negative after trade liberalization, as already mentioned above. It simply indicates that, after the initially favorable regional development of the peripheral regions later on those individual regions more distant from the capital, could not keep pace with the rapidly expanding capital region of Tallinn anymore. The impact of FDI is found to be positive, but it seems that it is directed mainly towards the central region. In fact, strong migrations of qualified labor to the central region are apparent and a typical *Krugman* type of regional polarization might be at work.

Surprisingly, similar results in terms of the coefficient of the long run adjustment pattern of regional wages (i.e. an inverted *U*-shape) are found in Slovenia. This, however, is probably a consequence of the misspecification of the model, as one of the included variables is picking up the time effects. A likely candidate for this is the initial efficiency differential (irVA/emp), which shows that regions initially found to be less efficient do catch up, in terms of wages with the central region. Trade liberalization is shown to have a strong positive impact on relative regional wages, as non-central regions after 1997 grow annually by some 7 per cent faster than the central region. In more distant regions, this process of catching up is slowed down by 1.5 per cent annually. Similarly to Bulgaria and Hungary, FDI inflows in Slovenia do not seem to affect the manufacturing relocation and adjustment pattern of regional wages. Finally, the results for Slovenia do not seem to conform to any of the three competitive EG models.

Although the preliminary analysis for Romania has shown a clear negative trend of relative regional wages, this was not confirmed in our empirical estimations. After serious economic problems in Romania in the mid 1990s, the initial negative trend in regional wages has been stopped by the newly elected socialist government. This, however, was a temporary effect, since at the end of the 1990s the trend of relative wages turned downward again. In effect, external policy shocks in Romania that caused a substantial divergence in economic performance of regions have probably prevented the occurrence of strong regional polarization effects of the *Krugman* type initiated by trade liberalization.

7. CONCLUSIONS

Economic science has neglected all mention of spatial features in its view of the world for a very long time, assuming instead, rather unrealistically, that production and consumption always occur at a single point. The basic assumption of perfect mobility of goods and factors has long been a mainstay in economic theory, despite some noted efforts of the contrary. Parallel to the development of modern economic theory, and largely overlooked by it, classical spatial economics developed a long tradition of theoretical work on the spatial dynamics of the relocation of economic activity. "New economic geography" resurrected the classical tradition of spatial economics but used a mathematical rather than simply a descriptive approach to modeling the forces that shape the location of economic activity. This approach combines the basic framework of traditional comparative advantage based trade theory, with modern theories based on increasing returns to scale as well as the existence of transport costs. The new strain of theory dealing with the spatial implications of factor relocation has managed to reintroduce the effects of distance and area into mainstream economics.

My aim in this master's thesis was to analyze the effects of trade liberalization with the European Union on interregional relocation of manufacturing and inter-regional adjustment of relative wages in transition countries. To this aim, I developed my own model of geographical economics model in order to estimate the effects of trade liberalization on the relocation of economic activity, following the tradition of the Krugman, Krugman-Venables, Fujita-Krugman-Venables and other models. Whereby the Krugman model predicts a monotonic response of relative regional wages to a reduction in foreign trade costs, strong migration flows of labor towards the core region, and thus a typical core-periphery regional polarization, both the Fujita-Krugman-Venables as well as my model argue that labor is imperfectly mobile between regions, which combined with the increasing wages in the core region prevents the complete agglomeration in the home country. Both models therefore result in a non-monotonic, U-shaped response of relative regional wages to trade liberalization. Falling trade costs would, according to both the Fujita-Krugman-Venables and my model, cause a reduction in the relative regional wage of the peripheral regions in the first instance, only to reverse the trend and increase relative regional wages once a certain threshold of trade costs is reached. The major difference between the two approaches is that my model introduces a second factor of production, capital, allowing for foreign direct investment flows between both countries to be modeled. Foreign direct investment inflows are shown to accelerate the regional adjustment process in the home country, as they are initially attracted to poorer border regions characterized by lower wages and higher returns to capital as well as a closer proximity to the large foreign markets[72], which is the second augmentation to the Fujita-Krugman-Venables model. This breaks the assumption of symmetric home region location made by most of the models so far. My model with the inclusion of foreign direct investment, hence, results in a faster convergence of relative regional wages, i.e. compared to the Fujita-Krugman-Venables approach, in a more upward and to the right shifted *U*-shaped response to relative wages. Simulations done it Chapter 4 show that foreign direct investment has a strong effect on the speed as well as the size of the adjustment of wages in the peripheral home region. The simulations also show the model to be extremely sensitive to changes in the elasticity of substitution of manufacturing products, which also serves as an indicator of the strength of external economies of scale. A lower elasticity of substitution increases the difference between manufacturing products, lowering the similarity between firms and hence lowering the effects of external economies of scale. This increases the relative wage and diminishes the agglomeration effects, with the *U*-shape being less pronounced. Similarly large are the effects of a change in inter-regional trade costs as well as the effects of changes in regional capital and labor endowments. The model has many interesting implications with respect to the effects of trade liberalization on the relocation of economic activity and those implications lend themselves well to an empirical verification.

Empirical testing of the effects of spreading and agglomeration forces in an economy, however, is relatively difficult. Not only because the core models are characterized by multiple equlibria, but also because the lack of specific regional data makes approximation inevitable. The other possible problem might be caused by the non-linearities in the model, which makes certain relationships difficult to estimate accurately enough. Here, I try to find evidence whether or not new economic geography models are in principle able to describe the spatial characteristics in a set of transition countries as they gradually liberalized their trade with the European Union. I study which of the three competitive EG models is a more appropriate approximation of the actual regional adjustment pattern in the selected transition countries. More specifically, I examine whether the response of relative regional wages to trade liberalization is monotonic and leading to strong regional polarization, as suggested by the first Krugman approach, or non-monotonic and associated with lesser regional polarization, as suggested by more recent economic geography approaches. In addition, in case of a non-monotonic response I test the suggestions of the Fujita-Krugman-Venables model against the predictions made by my approach. In doing so, impacts of FDI, inter-regional transport costs and western/northern region dummies on the adjustment pattern of relative regional wages are examined. Implications of the

[72] This emphasizes the so-called home market effect, where production is dependent on the size of demand in the nearby market. A larger home market will enable relatively larger production of local firms, whereby those will not have to incur transport costs.

three competitive EG approaches are tested using a unique regional panel data for five transition countries (Bulgaria, Estonia, Hungary, Romania and Slovenia) in the period from 1990-2000.

Summing up some of the empirical findings, one can speculate that a Krugman type of divergence of relative regional wages and increased regional polarization might be at work in the cases of Estonia and Romania. The peripheral regions seem to be loosing their share of manufacturing to the central region, which has been mirrored in the decrease of relative regional wages in those regions. On the other hand, one might conclude that the adjustment pattern of regional wages in Bulgaria and Hungary is much in line with the Fujita-Krugman-Venables model indicating that market forces by themselves have brought about the upward trend of initially declining relative regional wages. Here, Slovenia looks like a special case, since its regional development pattern does not correspond closely to any of the examined models of economic geography. In general, there is evidence of a clear catching up process in most of the regions in Slovenia after trade liberalization, while some polarization of the more distant regions is evident evident.

Despite the fact that a lot of work has been done primarily in the theory of spatial economics, there are still possibilities for future research. The models still remain only just an acceptable substitute for reality, and many of the assumptions will still have to be abandoned to make these models a closer depiction of real life mechanisms. One obvious direction for future research could be the modeling of imperfect labor mobility, which could, combined with the already mentioned effects of capital mobility, add new adjustment processes to the model, altering the predicted patterns of production allocation and regional specialization. There are, of course, many other aspects and relationships in the model that could be specified differently, such as the input-output linkages as well as the pure external economies to scale. The possibilities for further empirical research, on the other hand, seem limitless, largely due to the difficulties that are associated with the empirical verification of the economic geography models. In the case of my empirical analysis, the priority remains to assemble a broader sample of countries as well as obtain data of better quality in order to more accurately test the proposed relationships in transition countries. An additional possibility remains to respecify the model in order to achieve a better reflection of the reality in transition economies, where the economic framework still largely differs from those in market economies.

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Appendices

Appendix A

Proof of Shephard's lemma

First derivative of the cost function with respect to labor costs (*w*) is the conditional demand for labor:

$$\frac{\partial C}{\partial w}(w,i) = L^*(w,i)$$

where L* is the labor demanded.

Given a cost function C, such that

$$C = w * L^*(w,i) + i * K^*(i,w)$$

, first derivative with respect to wages is

$$\frac{\partial C}{\partial w} = L^*(w,i) + w * \frac{\partial L^*}{\partial w} + i * \frac{\partial K^*}{\partial w}$$

at cost minimization behavior

$$\frac{w}{i} = \frac{-\partial K^*}{\partial L^*} \Rightarrow w = -i\frac{\partial K^*}{\partial L^*}$$

Making the substitution for *w*

$$\frac{\partial C}{\partial w} = L^*(w,i) - i * \frac{\partial K^*}{\partial L^*}\frac{\partial L^*}{\partial w} + i * \frac{\partial K^*}{\partial w}$$

given that the last two terms cancel out

$$\frac{\partial C}{\partial w} = L^*(w,i)$$

Since the demand function is positive but downward sloping, we know that the cost function is increasing but concave in *w*.

Appendix B

The differentiation of price index (31) taking into account the profit-maximizing price (22)

(1) $$(1-\sigma)G^{-\sigma}dG = ((1-\sigma)\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]^{-\sigma}\left[\alpha\left(\frac{w}{\alpha}\right)^{\alpha-1}\frac{dw}{\alpha}\left(\frac{i}{\beta}\right)^{\beta}+\beta\left(\frac{i}{\beta}\right)^{\beta-1}\frac{di}{\beta}\left(\frac{w}{\alpha}\right)^{\alpha}\right]\left(n^{\sigma(\sigma-1)+1}\rho^{\sigma-1}\right)+$$

$$+\left(\sigma(\sigma-1)+1\right)n^{\sigma(\sigma-1)}dn\rho^{\sigma-1}\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]^{1-\sigma})(1-T^{1-\sigma})$$

(2) $$(1-\sigma)G^{1-\sigma}\frac{dG}{G} = ((1-\sigma)\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]^{-\sigma}\left[\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right](\alpha\frac{dw}{w}+\beta\frac{di}{i})\right]\left(n^{\sigma(\sigma-1)+1}\rho^{\sigma-1}\right)+$$

$$+\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]^{1-\sigma}(\sigma(\sigma-1)+1)n^{\sigma(\sigma-1)+1}(\frac{dn}{n})\rho^{\sigma-1})(1-T^{1-\sigma})$$

(3) $$(1-\sigma)G^{1-\sigma}\frac{dG}{G} = \left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]^{1-\sigma}(n^{\sigma(\sigma-1)+1}\rho^{\sigma-1})\left((1-\sigma)(\alpha\frac{dw}{w}+\beta\frac{di}{i})+(\sigma(\sigma-1)+1)(\frac{dn}{n})\right)(1-T^{1-\sigma})$$

(4) $$(1-\sigma)\frac{dG}{G} = Z\left[(1-\sigma)(\alpha\frac{dw}{w}+\beta\frac{di}{i})+(\sigma(\sigma-1)+1)\frac{dn}{n}\right]$$

and wage equations

(5) $$(\sigma-1)\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]^{\sigma-2}\left[\alpha\left(\frac{w}{\alpha}\right)^{\alpha-1}\frac{dw}{\alpha}\left(\frac{i}{\beta}\right)^{\beta}+\beta\left(\frac{i}{\beta}\right)^{\beta-1}\frac{di}{\beta}\left(\frac{w}{\alpha}\right)^{\alpha}\right] = (\sigma(\sigma-1)n^{\sigma(\sigma-1)-1}dn\rho^{\sigma}\frac{\mu}{F(\sigma-1)}YG^{\sigma-1}+$$

$$+n^{\sigma(\sigma-1)}\rho^{\sigma}\frac{\mu}{F(\sigma-1)}(dYG^{\sigma-1}+Y(\sigma-1)G^{\sigma}dG)(1-T^{1-\sigma})$$

(6) $$(\sigma-1)\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]^{\sigma-1}\left[\alpha\frac{dw}{w}+\beta\frac{di}{i}\right] = \left[n^{\sigma(\sigma-1)}\rho^{\sigma}\frac{\mu}{F(\sigma-1)}YG^{\sigma-1}\right]\left[(\sigma(\sigma-1)\frac{dn}{n}+\frac{dY}{Y}+(\sigma-1)\frac{dG}{G}\right](1-T^{1-\sigma})$$

(7) $$(\sigma-1)\left[\alpha\frac{dw}{w}+\beta\frac{di}{i}\right] = Z\left[\sigma(\sigma-1)\frac{dn}{n}+\frac{dY}{Y}+(\sigma-1)\frac{dG}{G}\right]$$

Appendix C

An increase in the number of varieties leads to an increase in employment, given the assumption of perfect factor mobility between the two home regions

(1) $$\frac{dn}{n} = \frac{d\left(\frac{L}{l^*}\right)}{\frac{L}{l^*}}$$

(2) $$\frac{dn}{n} = \frac{\dfrac{dL\left(L_f(\alpha(\sigma-1)+1)+K_f\dfrac{\alpha(\sigma-1)i}{w}\right)+K_f\dfrac{\alpha(\sigma-1)(di)w+(dw)i\alpha(\sigma-1)}{w^2}L}{\left(L_f(\alpha(\sigma-1)+1)+K_f\dfrac{\alpha(\sigma-1)i}{w}\right)^2}}{\dfrac{L}{\left(L_f(\alpha(\sigma-1)+1)+K_f\dfrac{\alpha(\sigma-1)i}{w}\right)}}$$

(3) $$\frac{dn}{n} = \frac{dL}{L} + \frac{K_f\alpha(\sigma-1)\left[\dfrac{di}{w}+\dfrac{dw}{w}\dfrac{i}{w}\right]}{\left[K_f\dfrac{\alpha(\sigma-1)i}{w}+L_f(\alpha(\sigma-1)+1)\right]}$$

Assuming that both wages as well as interest rates[73] remain unchanged ($dw = di = 0$), than the second part of the right hand side of equation 3 equals 0, giving equation 4,

(4) $$\frac{dn}{n} = \frac{dL}{L}$$

[73] Since I assume that interest rates depend solely on capital endowments, the assumption constant interest rates is not unreasonable.

Appendix D

NUTS (Nomenclature of Territorial Units for Statistics)

Nomenclature of Territorial Units for Statistics was established by Eurostat to provide a single uniform breakdown of territorial units for the production of regional statistics for the European Union and although the classification has no legal value per se, it has been used since 1988 in Community legislation ([http://europa.eu.int/comm/eurostat/ramon/nuts/splash_regions.html], 15.8.2002).

NUTS is a five-level hierarchical classification (three regional and two local levels). The economic territory of the European Union is divided into 78 regions at NUTS 1 level, 210 regions at NUTS 2 level and 1092 regions at NUTS 3 level. At the local level, the NUTS 4 level is defined only for Finland, Greece, Ireland, Luxembourg, Portugal and the United Kingdom. The NUTS 5 level consists of 98.433 communes or their equivalent.

The NUTS nomenclature serves as a reference:

- for the collection, development and harmonization of the regional statistics for the European Union, as it gradually replaced the specific divisions used in the various statistical domains (such as agricultural regions, transport regions, etc.) during the 1970s. It was on the basis of the NUTS that the regional economic accounts were developed and the regional sections of the Community survey defined.
- for the socio-economic analyses of the regions. The member states used NUTS 2 (basic regions) as a framework for the application of their regional policies, which was therefore deemed appropriate for analyzing regional-national problems, while NUTS 1 (major socio-economic regions) could be used for analyzing Community level problems. NUTS 3, which broadly comprises regions which are too small for complex economic analyses, may be used to establish specific diagnoses or to help pinpoint where regional measures need to be taken.
- for the framing of Community regional policies, for the appraisal of eligibility for aid from the Structural funds, regions whose development is lagging behind have been classified on the NUTS 2 level.

EKONOMSKA FAKULTETA
UNIVERZA V LJUBLJANI

MAGISTRSKO DELO

Vpliv zunanjetrgovinske liberalizacije na regionalno realokacijo produkcijskih faktorjev

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1. UVOD

V zunanjetrgovinski literaturi se vplivi zunanjetrgovinske liberalizacije na prostorsko realokacijo produkcijskih faktorjev obravnavajo v kontekstu teorij nove ekonomske geografije (*new economic geography*) oziroma prostorske ekonomike (*spatial economics*). Noben izmed omenjenih izrazov ne predstavlja zadovoljivega opisa za to področje ekonomske teorije, saj gre na eni strani znotraj zaprtega gospodarstva za analizo vplivov transportnih stroškov oziroma trgovinskih stroškov in vplivov ekonomij obsega na geografsko koncentracijo industrije znotraj države in s tem specializacijo posameznih regij, po drugi strani pa za analizo vpliva zunanjetrgovinske liberalizacije na realokacijo produkcijskih faktorjev, ki vodi v konvergenco ali divergenco med regijami v plačah oziroma obrestnih merah.

1.1. OPIS ZNANSTVENEGA PODROČJA

Ekonomska teorija je prostorske vidike proizvodnje in trgovine dolgo časa zanemarjala implicitno upoštevajoč nerealno predpostavko, da vsa proizvodnja kot tudi celotna trgovina potekata na isti lokaciji brez transportnih oziroma trgovinskih stroškov. Sočasno so empirični podatki kazali nasprotno, namreč da je vpliv razdalj (trgovinskih stroškov) na trgovino in proizvodnjo prisoten in celo zelo močan. Šele v zadnjem desetletju prejšnjega stoletja je prišlo do obnovitve zanimanja ekonomske znanosti za prostorske implikacije ekonomije, tako teoretično kot z vidika empiričnih preverb, kar se odraža v delih Paula Krugmana, Anthonyja Venablesa in drugih avtorjev, ki so nastala v zadnjem obdobju. Osnove za takšen razcvet literature pa je pomenilo že delo von Thünena, Webra in ostalih predstavnikov tradicije nemške geometrije z začetka devetnajstega stoletja ter nekoliko novejša dela Marshalla (1876) in Ohlina (1933), ki sta kot prva opozorila na obstoj odvisnosti med industrijskim razvojem (industrijsko rastjo) in geografsko koncentracijo industrije. Novejša literatura pomeni predvsem formalizacijo njunih ugotovitev, da industrializacija posamezne lokacije pospeši koncentracijo delovne sile in kapitala na tem območju in da posledična aglomeracija tega območja omogoča temeljne pogoje za nadaljnjo rast. S teoretičnega vidika je takšno dogajanje posledica delovanja dveh učinkov. Doseganje eksternih ekonomij obsega v delovanju podjetij zahteva koncentracijo industrije in hkratno specializacijo posamezne lokacije, vendar pa razdalje in transportni stroški učinek eksternih ekonomij obsega slabijo.

1.2. CILJ IN ZNANSTVENI PRISPEVEK DELA

V magistrskem delu skušam tako teoretično kot empirično analizirati učinek zunanjetrgovinske liberalizacije na realokacijo proizvodnih dejavnikov znotraj posameznih držav iz skupine držav pridruženih članic Evropske unije. Države pridružene članice Evropske unije (z izjemo Malte in

Cipra) so v zadnjem obdobju doživele značilen prehod iz planskega socialističnega sistema v tržni sistem, pri čemer se srečujejo s problemom alokacije (oziroma realokacije) produkcijskih faktorjev. Kljub temu da je podoben proces značilen za vse tranzicijske države, sem svojo empirično analizo zaradi podatkovnih omejitev omejil na zgolj pet tranzicijskih držav (Bolgarijo, Estonijo, Madžarsko, Romunijo in Slovenijo) v obdobju od leta 1990 do 2000, pri čemer se zavedam, da bi podobni sklepi z določenimi omejitvami lahko veljali tudi za ostale države v pridruženem članstvu. Proces pridruževanja teh držav kandidatk za članstvo v Evropski uniji je v prvi fazi vodil do znatne liberalizacije zunanje trgovine med članicami in Evropsko unijo, kar bi lahko vplivalo na realokacijo produkcijskih faktorjev in konvergenco oziroma divergenco v razvoju posameznih regij znotraj teh držav, odvisno od njihove prostorske lege znotraj države.

Cilj magistrskega dela je ugotoviti vplive dejavnikov zunanjetrgovinske liberalizacije na racionalizacijo proizvodnje znotraj države ter s tem na regionalni razvoj v opazovanem vzorcu tranzicijskih držav, ki se pripravljajo na članstvo v Evropski uniji. Vpliv zunanjetrgovinske liberalizacije na razvoj posameznih regij ni enakomeren, vendar vzroki hitrejšega razvoja posameznih regij niso vedno enoznačno določljivi. V svojem magistrskem delu torej poskušam odgovoriti na vprašanje, ali ima zunanjetrgovinska liberalizacija značilne vplive na regionalno realokacijo produkcijskih faktorjev znotraj teh držav oziroma ali bodo ti vplivi vodili do konvergence ali divergence med regijami.

Znanstveni prispevek pričujočega magistrskega dela je v razvoju novega teoretičnega modela za razlago učinkov ekonomske geografije. Ta se od predhodnih razlag prostorske alokacije proizvodnih dejavnikov razlikuje v tem, da v analizo vključuje dva proizvodna dejavnika (tako delo kot kapital), v nasprotju z običajno prakso ostalih modelov, ki so omejeni zgolj na en produkcijski faktor (delo). Vključitev kapitala v model predstavlja pomemben korak k približevanju modela realnosti, saj omogoča dodatno analizo vpliva kapitalskih tokov in akumulacije kapitala na prostorsko alokacijo ekonomske aktivnosti. Pomembna sprememba v modelu je tudi opustitev nerealne predpostavke simetričnosti lege domačih regij glede na tujino, kar v svojem modelu nadomestim z modeliranjem od tujih trgov bolj oddaljene osrednje regije in manj oddaljene obrobne regije. Navedene spremembe bistveno spremenijo dinamične lastnosti modela in ponujajo nove implikacije predvsem z vidika smeri pritokov neposrednih tujih investicij v državo in hitrosti procesov, ki jih zunanjetrgovinska liberalizacija v državi sproži.

1.3. METODE DELA

Magistrsko delo v svojih teoretičnih napovedih temelji tako na dosedanjih teoretičnih spoznanjih novejših teorij mednarodne menjave kot tudi na razvoju lastnega modela splošnega ravnotežja v odprtem gospodarstvu s prostorskimi implikacijami. Z lastnim modelom odpravljam nekatere slabosti dosedanjih modelov z opustitvijo nerealnih predpostavk, ki so omejevale praktično uporabnost teh modelov. Tako odpravljam omejujočo predpostavko uporabe enega produkcijskega faktorja z uvedbo kapitala v produkcijsko funkcijo. Poleg tega opuščam tudi predpostavko simetričnosti obeh domačih regij proti tuji regiji z vidika trgovinskih stroškov in predpostavljam, da je ena izmed regij bližje tuji regiji od druge.

Dopolnjena različica modela, ki jo razvijam v magistrskem delu, temelji na interakciji transportnih stroškov z eksternimi ekonomijami obsega pri določanju smeri in dinamike realokacije produkcijskih faktorjev. Modeliranje omenjenih dveh dejavnikov, kakor tudi modeliranje predpostavk nepopolne mobilnosti delovne sile med posameznimi lokacijami znotraj države ter omejene mobilnosti kapitala tako domačega kot tudi tujega, bo omogočilo dinamičen model splošnega gospodarskega ravnotežja za odprto gospodarstvo. Na podlagi teoretičnega modela bodo mogoče implikacije tako glede realokacije delovne sile kot tudi realokacije kapitala znotraj države in predvsem realokacije tujega kapitala v domači državi. Velikega pomena je alokacija tujega kapitala (oziroma neposrednih tujih investicij), ki prinaša v primerjavi z domačim kapitalom nove razsežnosti v učinkovitosti izrabe produkcijskih faktorjev ter uspešnosti delovanja podjetij, ki so delno ali v celoti v tuji lasti.

Tako modificiran model splošnega ravnotežja testiram na vzorcu petih tranzicijskih držav (Estonija, Bolgarija, Madžarska, Romunija in Slovenija), ki so vključene v proces približevanja Evropski uniji. Tako struktura do sedaj zbranih podatkov kot tudi model sam pri empirični analizi zahtevata uporabo panelnih metod ekonometričnega ocenjevanja. Zaradi lastnosti podatkovne vrste bi bilo smiselno uporabiti tudi metode dinamičnih panelov, vendar pa mnoge izmed teh metod zaenkrat omejuje prekratka časovna vrsta do sedaj zbranih podatkov.

V magistrskem delu tako uporabljam poleg matematičnih in ekonometričnih metod tudi metode indukcije, dedukcije, analize, sinteze in komparativne statike, kar mi omogoča celovitejšo obdelavo in pregled obravnavanega znanstvenega področja.

1.4. STRUKTURA MAGISTRSKEGA DELA

V drugem poglavju magistrskega dela predstavljam pogled tradicionalnih teorij na realokacijo produkcijskih faktorjev in prostorske implikacije klasičnih in neoklasičnih teorij mednarodne trgovine, medtem ko v tretjem delu obravnavam razvoj teorij prostorske ekonomike od tradicionalne prostorske ekonomike z začetka 19. stoletja do nove ekonomske geografije, ki je prišla v ospredje v zadnjem desetletju. V četrtem poglavju predstavljam formalno matematično izpeljavo mojega modela ekonomske geografije z analizo osnovnih značilnosti modela, medtem ko v petem empirično testiram napovedi različnih modelov ekonomske geografije na primeru petih tranzicijskih držav. V šestem delu magistrske naloge predstavljam nekatere rezultate empirične analize, v zadnjem, sedmem delu, pa ponujam tudi nekaj sklepov v zvezi z delovanjem modela in ustreznostjo modela za analizo učinkov zunanjetrgovinske liberalizacije v tranzicijskih državah.

2. PROSTORSKE IMPLIKACIJE ALOKACIJE PRODUKCIJSKIH FAKTORJEV V TRADICIONALNIH TEORIJAH MEDNARODNE MENJAVE

Klasična zunanjetrgovinska teorija je postavila temelje razmišljanj o vplivu in učinkih liberalizirane zunanje trgovine na realokacijo proizvodnih dejavnikov, kljub temu da realokacija produkcijskih faktorjev ni bila nikoli osrednja tema v delih Adama Smitha (1776), Davida Ricarda (1819) in ostalih klasikov zunanjetrgovinske teorije. Realokacija produkcijskih faktorjev je služila zgolj kot sredstvo, ki v končni fazi omogoča večje koristi od mednarodne menjave.

Neoklasična zunanjetrgovinska teorija pa je težišče teorije preusmerila iz dotedanjih tehnoloških razlik na relativno obilnost produkcijskih faktorjev kot poglavitno determinanto smeri in obsega mednarodne menjave. Tako je tudi realokacija proizvodnih dejavnikov znotraj države (med sektorji in med regijami) postala eden od odločilnih vplivov na doseganje koristi s pomočjo zunanje trgovine.

2.1. KLASIČNA TEORIJA MEDNARODNE MENJAVE (RICARDO-TORRENS-MILLOV MODEL)

Klasična teorija primerjalnih prednosti predpostavlja zgolj en sam produkcijski faktor (delo) in razlike v tehnologijah med državami, ki vodijo do tega, da se mejni proizvod enote dela razlikuje med državami. Te razlike v produktivnosti dela med državami so tudi razlog, da pride do mednarodne menjave in da ta ob upoštevanju določenih pogojev lahko prinaša koristi. Klasična teorija prav tako predpostavlja konstantne donose obsega v proizvodnji in linearno transformacijsko krivuljo (zaradi uporabe zgolj enega proizvodnega dejavnika). Z vidika prostorske analize je bistvenega pomena tudi dejstvo, da teorija primerjalnih prednosti ne predvideva nobenih ovir za transport blaga, ki bi bile vidne v obstoju transportnih stroškov.

Napovedi klasične zunanjetrgovinske teorije v zvezi z realokacijo resursov so dokaj enostavne, kar je v veliki meri posledica zgoraj omenjenih predpostavk teorije primerjalnih (ali absolutnih) prednosti. Iz predpostavk klasične zunanjetrgovinske teorije izhaja dejstvo, da proizvodnja in potrošnja znotraj države potekata v isti točki, tako da medregionalna realokacija resursov v tem modelu ni mogoča. Teorija relativnih (absolutnih) prednosti predpostavlja popolno specializacijo države v blagu, kjer ima država relativno (absolutno) prednost, pri čemer do realokacije delovne sile prihaja zgolj med sektorji proizvodnje. Ricardo-Torrens-Millov model torej predvideva popolno mobilnost delovne sile med sektorji, kjer se delovna sila seli v panoge s primerjalnimi prednostmi iz panog s primerjalnimi slabostmi v trenutku in brez stroškov takšne realokacije. Po drugi strani pa prostorske realokacije resursov omenjeni modeli zaradi svoje enostavnosti niso obravnavali in so na ta način ohranjali predpostavko brezprostorske obravnave v ekonomski teoriji in teoriji mednarodne trgovine.

2.2. NEOKLASIČNA TEORIJA MEDNARODNE MENJAVE (HECKSCHER-OHLIN-SAMUELSONOV MODEL)

Zunanjetrgovinska praksa je pokazala, da so učinki mednarodne menjave redko tako enostavno določljivi kot to predvideva klasična zunanjetrgovinska teorija, saj v določenih sektorjih gospodarstva lahko prihaja tudi do izgub zaradi mednarodne trgovine, prav tako pa tudi popolna specializacije ni tako pogost pojav, kot bi kazalo na podlagi Ricardo-Torrens-Millovega modela. Pomanjkljivosti razlage posledic zunanje trgovine so pokazale potrebo po napredovanju zunanjetrgovinske teorije nad klasično teorijo in botrovale nastanku neoklasične zunanjetrgovinske teorije (Heckscher-Ohlin-Samuelsonov model).

Heckscher-Ohlin-Samuelsonov model (v nadaljevanju HOS model) predpostavlja obstoj dveh popolnoma homogenih produkcijskih faktorjev, prav tako pa, za razliko od klasičnih modelov zunanje trgovine, predvideva tudi enako tehnologijo v obeh državah. Predpostavka dveh produkcijskih dejavnikov v kombinaciji s predpostavko spremenljivih tehnoloških koeficientov v enačbi produkcijske funkcije vodi v konkavno obliko transformacijske krivulje. Takšna oblika krivulje odseva dejstvo, da oportunitetni stroški proizvodnje naraščajo z večanjem obsega proizvodnje, prav tako pa takšna oblika krivulje redkeje vodi v popolno specializacijo, značilno za Ricardo-Torrens-Millov model. HOS model prav tako predvideva redistribucijo dohodka med sektorji in posledično tudi redistribucijo dohodkov faktorjev, kljub temu pa prihaja do koristi od mednarodne trgovine na agregatnem nivoju celotnega gospodarstva.

HOS model podaja nekoliko bogatejše implikacije z vidika realokacije proizvodnih dejavnikov kot Ricardo-Torrens-Millov model. Podobno kot v omenjenem klasičnem modelu tudi HOS model predvideva popolno medsektorsko mobilnost, ki poteka brez stroškov (časovnih ali denarnih). Za razliko od klasičnih modelov zunanje trgovine HOS model predvideva tudi popolno mobilnost faktorjev med regijami v državi, kar pomeni, da se cene določenih produkcijskih faktorjev v trenutku izenačujejo po vsej državi ter torej ne prihaja do regionalnih razlik v plačah oziroma obrestnih merah. HOS model torej predpostavlja popolno medsektorsko in prostorsko mobilnost produkcijskih faktorjev, hkrati pa predpostavlja popolno nemobilnost produkcijskih faktorjev med državama. Predpostavke in samo delovanje HOS modela vodijo torej pod določenimi pogoji (reverzibilnost faktorske intenzivnosti ni mogoča) do izenačitve cen faktorjev tako znotraj države kot tudi med državami, do česar pripelje mednarodna menjava.

3. RAZVOJ EKONOMSKE GEOGRAFIJE

Klasična ekonomska teorija je dolgo časa zanemarjala prostorske vidike v proizvodnji in potrošnji in se pogosto zanašala na poenostavitvene predpostavke, kot so neobstoj transportnih stroškov ali to, da proizvodnja in potrošnja potekata v isti točki. Razvoj prostorske ekonomike je tako potekal v izolaciji od glavnih tokov ekonomske misli in le redki avtorji so opozarjali na njegov obstoj.

3.1. KLASIČNA TEORIJA LOKACIJE

Eden glavnih razlogov za relativno izoliranost in počasnejši razvoj prostorske ekonomike leži v dejstvu, da je ″oče″ teorije lokacije, Johan Heinrich von Thünen, kakor tudi večina njegovih naslednikov pisal v nemškem jeziku, kar je povzročilo slabo prenosljivost teh idej med angleško govoreče ″mainstream″ ekonomiste. Tako so njihove ideje ostale znane le ožjemu krogu teoretikov, medtem ko je širša ekonomska znanost prišla v stik z idejami ekonomike prostora šele v sredini dvajsetega stoletja.

Von Thünen je že leta 1826 objavil svojo knjigo "Izolirana država", ki predstavlja njegovo vizijo prostorskega delovanja idealne države. V tem delu predstavlja von Thünen popolnoma homogeno, izolirano področje, katerega središče je mesto s celotno predelovalno industrijo, medtem ko je vsa agrarna dejavnost razporejena okoli mesta v koncentričnih krogih. S svojim modelom idealne države je želel von Thünen razkriti principe, ki bodo v določenih razmerah določali cene za kmetijske proizvode, zemljiške rente za določeno predelovalno površino in na to navezujoče se vzorce porabe zemlje. Želel je torej določiti idealno razporeditev agrarnih proizvodov po koncentričnih pasovih v povezavi z oddaljenostjo od trga (mesta) in stroškov prevoza posameznega pridelka. Von Thünenovi sklepi so zelo podobni Ricardovim, saj namreč ugotovi, da so obdelovalne površine vse dražje s približevanjem mestu, prav tako pa je njihova cena odvisna od intenzivnosti obdelave, ki je potrebna pri določenem pridelku. Von Thünenova analiza ostane zgolj na nivoju omenjenega modela, pri čemer avtor, v skladu s tedanjim razvojem ekonomske matematike, ostaja zgolj pri enostavnem sklepanju ter grafični analizi.

S von Thünenovim delom so tako nadaljevali ostali predstavniki nemške šole prostorske analize, med katerimi zagotovo izstopa Wilhelm Launhardt (1882), ki je uspel poiskati matematične rešitve in razlage za vprašanja, ki si jih je postavljal von Thünen. Launhardtu pripisujejo zasluge za več originalnih rešitev, med katerimi velja poudariti njegove rešitve za optimizacijo lokacije za postavitev tovarne ob minimalnih transportnih stroških glede na fiksne trge, pri čemer je opisal tudi večino potencialnih vplivov, ki poleg transportnih stroškov lahko določajo lokacijo proizvodne enote.

Nekoliko pozneje sta klasično teorijo lokacije oblikovala še Alfred Weber (1909), ki je razvil tako grafično kot tudi matematično izpeljavo za optimizacijo lokacije proizvodnje, ter Walter Isard (1956). V primerjavi s von Thünenom Weber predpostavlja že več proizvodnih in potrošnih lokacij pri svojem optimizacijskem modelu. Isard pa je s svojim delom "Lokacija in prostorska ekonomika" želel povezati tradicionalno ekonomsko teorijo s klasično lokacijsko teorijo ter v ta namen ponudil bolj tradicionalno ekonomske rešitve za omenjene probleme lokacije.

Kljub vsem pomanjkljivostim klasične teorije lokacije pa so določeni koncepti in ideje pritegnile tudi nekatere avtorje tako imenovane "mainstream" ekonomske znanosti, kot sta Alfred Marshall in Bertil Ohlin. Alfred Marshall (1876) podaja razloge za lokalizacijo proizvodnje s konceptom eksternih ekonomij obsega. Pri tem kot razloge za koncentracijo industrije na posamezni lokaciji navaja zgostitev kvalificirane delovne sile na tej lokaciji, možnost za izoblikovanje trga surovin in specializiranih vmesnih izdelkov, s katerimi se običajno ne trguje, ter nenazadnje tudi možnost lažjega pretoka informacij med proizvajalci, kar jim omogoča optimizacijo proizvodne funkcije in proizvodnjo z nižjimi stroški. Bertil Ohlin (1933) generalizira neoklasični HOS model zunanje trgovine z vključitvijo večih proizvodnih lokacij, večih lokacij naravnih virov in večih potrošniških trgov. Prav tako pa je definiral večino vzrokov za aglomeracijo in razpršitev ekonomske aktivnosti v prostoru.

Klasično lokacijsko teorijo je ekonomska znanost v popolnosti spregledala in zanemarila, delno zaradi neugodnih zgodovinskih naključij ob njenem nastanku, delno pa tudi zato, ker klasična lokacijska teorija ni predstavljala nič več kot zgolj združitev nekaterih običajnih sklepov o pomenu prostorskih dejavnikov, ki še niso združeni v delujoč celotnogospodarski model splošnega ravnotežja. Nedostopnost del nemških teoretikov prostorske ekonomike je pomenila, da so bile tedaj uporabljene rešitve in metode reševanja problemov optimalne lokacije z vidika moderne ekonomske znanosti zastarele.

3.2. RAZVOJ MODERNE PROSTORSKE EKONOMIKE

Nedavni teoretični in empirični prispevki k teoriji prostorske alokacije proizvodnje so v dobršni meri spremenili poglede na vprašanja razdalje in prostora v ekonomski znanosti. Ta novi pristop temelji na mikroekonomskih konceptih monopolistične konkurence, kjer se podjetja locirajo v bližini drugih podjetij in na ta način hkrati izkoriščajo pozitivne eksterne ekonomije obsega, kar vodi do tega, da lahko z vidika koncentracije ali razpršenosti industrije popolnoma podobne države razvijejo popolnoma drugačne vzorce prostorske porazdelitve ekonomske aktivnosti. Večinoma se tako moderna prostorska ekonomika ukvarja z vzroki, zakaj na določenih mestih prihaja do aglomeracije ekonomske aktivnosti oziroma zakaj se ta na drugih mestih razprši bolj enakomerno po ekonomskem prostoru. Izhodišče razvoja prostorske ekonomike predstavljajo klasične in moderne teorije mednarodne ekonomike, pri čemer je inkorporacija prostorske ekonomike v mednarodno ekonomiko ključnega pomembna z vidika analize koristi in izgub regij oziroma držav od mednarodne trgovine. Že na podlagi neoklasične zunanjetrgovinske teorije je namreč razvidno, da mednarodna trgovina lahko vodi tudi do poslabšanja položaja (lastnikov) določenih produkcijskih faktorjev, vključitev prostorske ekonomike v zunanjetrgovinsko teorijo pa omogoča podobno analizo tudi na nivoju regij oziroma držav.

3.2.1. Nova ekonomska geografija (*New economic geography*)

Omenjeni nov pristop k reševanju vprašanj prostorske razporeditve ekonomske aktivnosti je bil, nekoliko neposrečeno poimenovan, "nova ekonomska geografija". Navkljub dejstvu, da takšno poimenovanje sicer dobro ločuje nove teorije od predhodnih klasičnih teorij lokacije ter tudi ostalih ekonomskih teorij, pa ostaja dejstvo, da takšno poimenovanje preveč namiguje na to, da gre za geografijo. Prav tako pa tudi predpona "nova" ne bo ostala večno del imena. Thisse (1996), Martin (1999) in Brackman et. al. (2001) tako kompromisno predlagajo poimenovanje geografska ekonomija, kar naj bi po mnenju omenjenih avtorjev podpiralo dejstvo, da gre za ekonomsko in ne geografsko teorijo. Morda najboljši naziv bi bil prostorska ekonomika oziroma ekonomika prostora, ki pa v določeni meri ohranja podobnost s klasično ekonomiko prostora, ki prav tako ni zaželena. Gre namreč za dva popolnoma drugačna pristopa k analizi prostorske alokacije ekonomske aktivnosti, ki ju združuje zgolj skupni cilj: poiskati vzroke in posledice koncentracije oziroma dekoncentracije proizvodnje.

3.2.2. Faktorji vpliva na prostorsko realokacijo proizvodnje

Modeli nepopolne konkurence z naraščajočimi donosi v proizvodnji in trgovinskimi (transportnimi) stroški napovedujejo, da se bodo podjetja locirala v bližini večjih trgov; večji trgi pa so tisti, kjer je lociranih več podjetij in njihovih delavcev. Nova ekonomska geografija se ukvarja prav z matematično formalizacijo takšne kumulativne kavzalnosti, z namenom prikaza aglomeracijskih učinkov. V namen formalizacije navedenih povezav je bilo razvitih več mehanizmov, ki jih predstavljam v tem delu magistrske naloge.

Povpraševanje po delovni sili

Krugman (1991) je ugotavljal, da mobilnost delovne sile sprošča pritiske, ki jih preveliko povpraševanje povzroča na povečanje plač. Mobilnost delovne sile zagotavlja takojšnjo zadovoljitev povpraševanja po delovni sili, pri čemer ne prihaja do razlik v plačah. Takšne selitve pa hkrati povzročajo nastajanje razlik med regijami in nastanek bogatih industrijskih središč, kamor delovna sila migrira, ter revnejših obrobnih regij, ki delovno silo izgubljajo. Zniževanje transportnih stroškov bo privedlo do položaja, ko bo za podjetja ugodno, da se selijo v večjo regijo navkljub dejstvu, da je tam ostrejša konkurenca, saj bodo imela v tej regiji lažji dostop do delovne sile, prav tako pa bodo lahko zadovoljila povpraševanje po svojih izdelkih v ostalih regijah zaradi dokaj nizkih transportnih stroškov.

Input-output povezave

Venables (1996) vzroke za aglomeracijske vzorce išče poleg povpraševanja po delovni sili (ter povpraševanja delovne sile) v direktnih *input-output* povezavah med podjetji samimi. Podjetja torej navzkrižno kupujejo končne izdelke drugo od drugega z namenom, da bi jih uporabili kot *inpute* za proizvodnjo svojih izdelkov. Pomembno pri povezavah takšne vrste pa je, da povečanje trga končnih proizvodov povečuje tudi povpraševanje tega podjetja po vmesnih proizvodih, kar posledično zaradi ekonomij obsega vodi k temu, da tudi dobaviteljska podjetja začnejo delovati bolj učinkovito. V takšnem modelu padec stroškov trgovine povzroči diferenciacijo regij v bogato centralno regijo in revne periferne regije, podobno kot se je zgodilo že v Krugmanovem modelu.

Endogena rast in faktorska akumulacija

Baldwin (1997) pa ugotavlja, da do agregacije ekonomske aktivnosti lahko pride tudi v primeru, ko ni mobilnosti delovne sile. Pokaže namreč, da ima lahko akumulacija faktorjev enako vlogo kot njihova migracija. Struktura samega modela je podobna Krugman-Venablesovemu (1990) modelu z dodatkom raziskovalne in razvojne dejavnosti, ki uporablja delo kot produkcijski faktor pri novih patentih. Patenti v tem modelu so nemenjalni, kar pomeni, da se patenti izkoriščajo tam, kjer nastajajo. Dobički in s tem vstop ali izstop podjetij iz določenih trgov so odvisni od ravnovesja med privlačnostjo večjih trgov in večjo konkurenco na teh trgih. V primeru nizkih trgovinskih stroškov tako formuliran model ekonomske geografije vodi v oblikovanje bogate centralne regije in revne periferne regije (core-periphery pattern).

3.2.3. Sile, ki delujejo na razpršitev ekonomske aktivnosti

Mobilnost delovne sile kot disperzijska sila

Puga (1998) dokazuje, da v kolikor ni popolne mobilnosti delovne sile in se plače v različnih regijah ne izenačujejo, postanejo razlike v plačah faktor, ki deluje na razpršitev ekonomske aktivnosti. Na večjih trgih je večje povpraševanje po delovni sili, kar vodi tudi do višjih plač na teh trgih, vendar pa zaradi nemobilnosti delovne sile povpraševanje ni zadovoljeno in razlike v plačah ostajajo. Nekatera podjetja se bodo tako zaradi višjih proizvodnih stroškov, ki jih povzročajo višje plače, selila nazaj v manjše regije z nižjimi plačami. Napoved modela, ki bi vseboval zgolj ta dejavnik, bi bila, da liberalizacija zunanje trgovine vodi v konvergenco med regijami oziroma enakomernejšo razporeditev ekonomske aktivnosti med lokacijami.

Nemenljivost kot disperzijska sila

Helpman (1997) kot eno izmed možnih centrifugalnih sil navaja tudi cene nemenjalnih proizvodov, kot so nepremičnine. Cene nepremičnin naj bi bile, podobno kot v zgornjem primeru plače, višja v večji regiji, kjer bi bilo več podjetij in posledično večje povpraševanje po nepremičninah, medtem ko bi bile v manjši regiji z nekoliko manjšim povpraševanjem cene nepremičnin nižje. Tako bi cene nepremičnin postale dejavnik, ki bi silil podjetja v selitev v cenejše regije. Na ta način bi se tudi v večjih regijah znižal pritisk na rast cen nepremičnin. Posledica nemenjalnih dobrin na prostorsko alokacijo ekonomske aktivnosti je torej v konvergiranju obeh regij v alokaciji proizvodnje.

3.2.4. Povzetek dejavnikov, ki vplivajo na prostorsko alokacijo ekonomske aktivnosti

Modeli ekonomske geografije predvidevajo obstoj večih dejavnikov, ki sooblikujejo alokacijo proizvodnje v prostoru. Od prevlade različnih izmed teh dejavnikov bo odvisno ali bo ekonomska aktivnost koncentrirana v eni večji regiji ali pa bo enakomerneje razpršena po prostoru.

Pomembnejši dejavniki aglomeracije, ki ustvarjajo težnje po koncentraciji ekonomske aktivnosti so mobilnost delovne sile, kar povzroči selitev delovne sile v regije z višjimi plačami, *input-output* povezave med podjetji, ki pomenijo večje pozitivne eksterne ekonomije obsega za podjetja v večji regiji, ter akumulacija delovne sile, specializirane v inovacijski dejavnosti. Omenjeni faktorji povzročajo močne težnje po aglomeraciji ekonomske aktivnosti, kar vodi do bipolarnega regionalnega razvoja. Takšen razvoj bi pripeljal do oblikovanja velike centralne regije, kjer bi bila koncentrirana večina ekonomske aktivnosti, in manjše periferne regije z manjšim deležem industrije.

Poleg tega pa na razpršitev ekonomske aktivnosti vplivajo tudi cena delovne sile, ko je ta nemobilna, in cene ostalih nemobilnih (nemenjalnih) dejavnikov v določeni regiji. Višje cene faktorjev v večji regiji, kjer je povpraševanje po njih večje, bodo prisilile nekatera podjetja v selitev nazaj v manjše regije z nižjimi cenami. Ti dejavniki, prav tako pa različne druge oblike negativnih eksternalij, ki se pojavljajo na večjih trgih, bodo, v kolikor prevladajo nad aglomeracijskimi dejavniki, povzročili enakomernejšo razporeditev ekonomske aktivnosti med regijami.

4. DVOFAKTORSKI MODEL EKONOMSKE GEOGRAFIJE S TREMI NESIMETRIČNIMI REGIJAMI

V tem poglavju predstavljam formalno matematično strukturo lastnega modela ekonomske geografije, s katerim skušam odpraviti nekatere pomanjkljivosti predhodnih modelov in razviti nove implikacije za modele ekonomske geografije, ki jih predhodni modeli niso omogočali.

Osnovni sestavni modul ogrodja modelov ekonomske geografije predstavlja Dixit-Stiglitzov (1977) model monopolistične konkurence, v katerega je vključena proizvodnja na večih lokacijah, pojav transportnih stroškov med lokacijami in v prejšnjem poglavju omenjeni dejavniki aglomeracije in disperzije. Osnove modelom ekonomske geografije je postavil Paul Krugman (1991), doživeli pa so tudi številne revizije, med katerimi izstopa Fujita-Krugman-Venablesov (1999) model (v nadaljevanju *FKV* model).

Podobno kot v primeru *FKV* modela in v nasprotju s Krugmanovim modelom tudi sam modeliram nemobilno delovno silo tako med državami kot tudi znotraj države (med regijami). Prav tako ostajam pri dvosektorskem gospodarstvu (agrarni sektor in sektor predelovalne industrije), pri čemer agrarni sektor proizvaja eno samo homogeno dobrino v pogojih popolne konkurence, medtem ko sektor predelovalne dejavnosti proizvaja množico diferenciranih proizvodov v pogojih monopolistične konkurence.

V nasprotju s *FKV* modelom uvajam v model kapital kot drugi produkcijski faktor, kar omogoča poleg analize drugih dejavnikov tudi analizo tokov kapitala znotraj države in predvsem med državama v obliki neposrednih tujih investicij. Vključitev kapitala v model tudi bistveno spremeni samo dinamiko modela v smislu moči agregacijskih in disperzijskih dejavnikov alokacije ekonomske aktivnosti. Druga bistvena sprememba, ki jo predstavljam v primerjavi s *FKV* modelom, je opustitev predpostavke simetričnosti lokacije obeh domačih regij v primerjavi s tujino, namesto česar predpostavljam, da je manjša od obeh domačih regij dejansko bližje tuji državi kot centralna domača regija. Takšna lega regij omogoča bistveno prednost manjši regiji, ko stroški mednarodne trgovine padejo pod določen nivo.

V tem poglavju tako predstavljam nekoliko skrajšano izpeljavo svojega modela ekonomske geografije v obliki modela splošnega gospodarskega ravnotežja, prav tako pa predstavljam numerične simulacije delovanja modela, ki omogočajo vpogled v potankosti njegovega delovanja in razkrivajo povezave med vključenimi spremenljivkami.

4.1. OBNAŠANJE POTROŠNIKOV

V razvoju potrošniških funkcij ostajam zvest *FKV* modelu, ki predvideva Cobb-Douglasovo funkcijo preferenc (1):

$$(1) \qquad U = M^{\mu} A^{1-\mu} \ ,$$

kjer M predstavlja kompozitni indeks potrošnje proizvodov predelovalne industrije, A pa potrošnjo agrarnih proizvodov. μ je konstanta, ki predstavlja delež potrošnje, namenjene za predelovalno industrijo. Potrošniki maksimirajo svoje koristi v dveh fazah, in sicer, v prvi fazi, z maksimizacijo koristi (minimacijo stroškov) izbire med proizvodi agrarnega sektorja in proizvodi predelovalne industrije, v drugi fazi pa z maksimizacijo svoje izbire med različicami predelovalne industrije.

Takšna dvostopenjska maksimizacija koristi preko večih korakov (Fujita, Krugman, Venables, 1999, str. 46-49) pripelje do oblikovanja cenovnega indeksa proizvodov predelovalne industrije (G):

$$(2) \qquad G \equiv \left[\int_0^n p(i)^{1-\sigma} di \right]^{1/(1-\sigma)} = p^M n^{1/(1-\sigma)} \ .$$

Pri tem predstavlja *p(i)* cene posamezne različice predelovalne industrije, σ elastičnost substitucije med posameznima različicama proizvodov predelovalne industrije (pri tem za stopnjo elastičnosti velja $1 < \sigma < \infty$), n pa število različic oziroma podjetij v posamezni regiji. Odzivnost indeksa cen na število različic je odvisna od elastičnosti substitucije med različicami. Višja je elastičnost substitucije (bolj podobni so si proizvodi med seboj), nižji je vpliv števila različic (n) na indeks cen (G). Enačba (2) tudi nazorno kaže, da večje število različic znižuje nivo cen na posamezni lokaciji.

4.2. VEČ LOKACIJ IN TRANSPORTNI STROŠKI

V tem delu magistrske naloge predstavljam posplošitev modela na proizvodnjo v večih lokacijah, pri čemer pri obnašanju potrošnikov, obravnavanem v prejšnjem podpoglavju, še vedno velja predpostavka ene same lokacije proizvodnje in potrošnje. Ekonomska teorija je do sedaj predpostavljala popolno mobilnost proizvodov, kar je pomenilo, da pri prevozu teh proizvodov ne prihaja do transportnih stroškov. Predpostavka, da ne prihaja do transportnih stroškov, lahko pomeni dvoje, prvič, da poteka vsa proizvodnja in potrošnja na eni sami lokaciji, kar seveda pomeni, da ne prihaja do mednarodne menjave proizvodov in menjave proizvodov na sploh, ali pa da so, po drugi strani, vsi proizvodi med dvema lokacijama popolnoma mobilni[74]. S tem pa, ko dovolimo obstoj transportnih stroškov, to vpliva tako na odločitve potrošnikov glede njihovega trošenja kot odločitve proizvajalcev glede lokacije njihove proizvodnje.

4.2.1. Modeliranje transportnih stroškov po predpostavki "ledene gore"

Transportne stroške modeliram upoštevajoč poenostavitveno predpostavko "ledene gore", ki jo večina avtorjev pripisuje Samuelsonu[75] (1952), kljub temu da je sam tovrstno oblikovanje stroškov zgolj omenil. Termin "ledena gora", ki namiguje na to, da se del blaga med potjo enostavno stopi, pa so oblikovali drugi avtorji.

V kontekstu ekonomske geografije transportni stroški s predpostavko "ledene gore" pomenijo, da pri prevozu enote proizvoda med lokacijo r in lokacijo s samo $1/T_{rs}$ začetne količine blaga prispe na cilj, medtem ko preostali del blaga predstavljajo stroški prevoza. Preostali del proizvoda $1-\left(1/T_{rs}\right)$ pomeni torej strošek transporta proizvoda. T_{rs} je tako parameter, ki predstavlja stroške prevoza. Ti so definirani kot število proizvodov, ki jih je potrebno poslati iz odpremnega kraja, da bi en sam proizvod prispel v namembni kraj. Če torej predpostavim, da smo poslali 107 vrtnic iz Nizozemske v Francijo in jih bo v Pariz nepoškodovanih prispelo zgolj 100, potem to pomeni, da so transportni stroški T = 1,07 in je dejanski strošek transporta blaga 0,07/1,07 (6,5%) (Brakman, Garretsen, Marrewijk, 2001, str. 81).

Tehnologija transportnih stroškov pod predpostavko "ledene gore" predvideva, da v kolikor je proizvod, izdelan na lokaciji r, tam prodan za p_r (f.o.b.), je cena v namembnem kraju p_{rs} (c.i.f.) podana kot:

(3) $$p_{rs}^{M} = p_{r}^{M} T_{rs}^{M} \quad .$$

4.2.2. Posledice večih lokacij na proizvodnjo in potrošnjo

Transportni stroški "ledene gore" v kombinaciji s predpostavko, da imajo vse različice proizvedene na isti lokaciji enako ceno, z uporabo enačbe za indeks cen lahko ta indeks zapišemo kot:

(4) $$G_s = \left[\sum_{r=1}^{R} n_r (p_r^M T_{rs}^M)^{1-\sigma} \right]^{1/(1-\sigma)}, s = 1,...,R \quad .$$

[74] To bi pomenilo, da se vse dobave blaga opravijo v infinitezimalno kratkem trenutku, pri čemer pa ne pride do nikakršnih stroškov neglede na dejansko razdaljo, ki jo blago prepotuje. Hkrati to tudi pomeni, da ne obstajajo nikakršne ovire za mednarodno trgovino v smislu carinskih ali drugih trgovinskih ovir.

[75] Dejansko naj bi že von Thünen podal podobno idejo transportnih stroškov, ko je v svoji idealni državi predpostavljal, da so stroški transporta žita sestavljeni iz žita, ki ga je na poti pojedel konj, in žita, ki so ga za prevoz plačali kočijažu (Fujita, Krugman, Venables, 1999, str. 59).

Skupna potrošnja potrošnikov na določeni lokaciji s za proizvode lokacije r sledi funkciji povpraševanja:

$$(5) \qquad m(j) = \mu Y_s (p_r^M T_{rs}^M)^{-\sigma} G_s^{(\sigma-1)},$$

kjer je Y_s dohodek na lokaciji s. Ponudba, ki zadosti povpraševanju po tej dobrini, mora biti T_{rs}^M - krat tolikšna, kot je povpraševanje po tem blagu. Zaradi majhnosti posamezne lokacije (regije) predpostavljam, da pri transportu znotraj posamezne regije ne prihaja do transportnih stroškov. Vsota potrošnje na vseh lokacijah, kjer se blago prodaja, pomeni, da količina skupaj prodanega blaga lokacije r, označena kot q_r^M , znaša:

$$(6) \qquad q_r^M = \mu \sum_{s=1}^{R} Y_s (p_r^M T_{rs}^M)^{-\sigma} G_s^{\sigma-1} T_{rs}^M .$$

Prodaja posameznega podjetja na določeni lokaciji je odvisna od nominalnih dohodkov na posameznih lokacijah, cenovnega indeksa teh lokacij, transportnih stroškov in seveda tudi proizvodne cene. Elastičnost agregatnega povpraševanja po posamezni različici glede na proizvodno ceno je enaka σ, ker se cene iste različice v namembnih krajih ($p_r T_{rs}$) po vseh lokacijah spreminjajo proporcionalno s proizvodno ceno ter tudi zato, ker je elastičnost povpraševanja vseh potrošnikov neglede na lokacijo enaka σ.

4.3. OBNAŠANJE PROIZVAJALCEV

Ostajam pri predpostavki, da je agrarni proizvod proizveden s pomočjo tehnologije konstantnih donosov pod pogoji popolne konkurence. Predelovalna dejavnost pa predvideva naraščajoče donose obsega na nivoju posamezne različice (predpostavljam, da ne prihaja do ekonomij sinergije, *economies of scope*, ali skupnega delovanja večih podjetij). Tehnologija je enaka za vse različice na vseh lokacijah, pri čemer produkcijska funkcija vključuje fiksne stroške F in mejne stroške c^M.

Tukaj moj model začne bistveno odstopati od *FKV* modela, saj v model vključujem drugi produkcijski faktor, kapital, pri čemer predvidevam možnost ekonomij obsega v uporabi tako dela kot kapitala. Moj model vključuje tudi tako interne kot eksterne ekonomije obsega, medtem ko *FKV* model kot relevantne obravnava le interne ekonomije obsega.

$$(7) \qquad C = F_r^M + c_r^M q^M ,$$

kjer so C skupni stroški proizvodnje q enot proizvoda predelovalne industrije (stroški uporabljenega dela in kapitala); F_M predstavlja celotne fiksne stroške (tako dela kot kapitala), c_r^M pa celotne variabilne stroške (7). Obstoj fiksnih stroškov omogoča modeliranje internih ekonomij obsega, medtem ko so eksterne ekonomije obsega modelirane s pomočjo mejnih stroškov[76], kjer predpostavljam negativno korelacijo med velikostjo regije (število podjetij, ki delujejo v določeni regiji n_r) in marginalnimi stroški podjetij v določeni regiji.

$$(8) \qquad c_r^M = n_r^{-\sigma} (\frac{w_r}{\alpha})^\alpha (\frac{i_r}{\beta})^\beta \qquad\qquad F_r^M = w_r L_f + i_r K_f \quad ,$$

kjer so w_r in i_r nominalne plače in obrestne mere v regiji r, L_f in K_f pa sta fiksna stroška dela in kapitala.

Zaradi delovanja ekonomij obsega, preference potrošnikov po raznolikosti in neomejenega števila potencialnih različic proizvodov predelovalne dejavnosti, nobeno od podjetij ne bo proizvajalo enake različice kot drugo. Število podjetij v predelovalni dejavnosti bo torej enako številu proizvedenih različic predelovalne dejavnosti.

Pri reševanje problema maksimizacije dobičkov za vsako posamezno podjetje na določeni lokaciji se podjetja srečujejo s plačami w_r^M za delavce v predelovalni dejavnosti posamezne regije in tamkajšnjimi obrestnimi merami i_r^M. Cena, pri kateri podjetja maksimirajo dobiček, je torej [77]:

$$(9) \qquad p_r^M (1 - 1/\sigma) = n_r^{-\sigma} (\frac{w_r}{\alpha})^\alpha (\frac{i_r}{\beta})^\beta \qquad \text{ali} \qquad p_r^M = \frac{(\frac{w_r}{\alpha})^\alpha (\frac{i_r}{\beta})^\beta}{n_r^\sigma (1 - 1/\sigma)} \quad .$$

V kolikor predpostavljam prost vstop in izstop podjetij iz določene lokacije kot odgovor na dobičke ali izgube, pogoj ničelnih dobičkov zagotavlja, da bo ravnotežna proizvedena količina podjetja v posamični regiji enaka:

$$(10) \qquad q*_r^M = \frac{F_r^M (\sigma - 1) n_r^\sigma}{(\frac{w_r}{\alpha})^\alpha (\frac{i_r}{\beta})^\beta} \quad .$$

Z uporabo Shephardove leme[78] lahko izpeljem povpraševanje po obeh produkcijskih faktorjih, ko je dosežena ravnotežna količina proizvodnje vsakega podjetja. Shephardova lemma pravi, da prvi odvod stroškovne funkcije glede na ceno določenega faktorja predstavlja hkrati tudi variabilni del

[76] Modeliranje eksternih ekonomij obsega je poenostavljeno zaradi njegove kompleksnosti. Do eksternih ekonomij obsega prihaja zaradi *input-output* povezav, kjer podjetja uporabljajo vmesne proizvode drugih podjetij za izdelavo svojih proizvodov. Več o tem glej Damijan (1999).

[77] Če upoštevamo, da je maksimirana cena dosežena pri količini q* in da velja MC = MR:

$$MR = \frac{d(TR)}{dq} = \frac{d(p_r^M q)}{dq} = p_r^M + \frac{q(dp_r^M)}{dq} = p_r^M (1 + \frac{q}{p_r^M}\frac{dp_r^M}{dq}) = p_r^M (1 - \frac{1}{\sigma}) = MC$$

[78] Več o veljavnosti Shephardove leme in predpostavkah, ki morajo za njeno izpolnitev veljati, glej Fuchs-Selinger (1995, 1997).

povpraševanja po tem faktorju. Variabilni del povpraševanja sem pomnožil z ravnotežno proizvodnjo ter dodal fiksno povpraševanje po obeh faktorjih, ki je enako neglede na lokacijo, da bi dobil celotno povpraševanje po določenem faktorju.

Enačbe (11)-(14) predstavljajo izpeljavo povpraševanja po posameznem produkcijskem faktorju:

$$l_r^* = \frac{\partial c}{\partial w} q^* + L_f \quad , \tag{11}$$

$$l_r^* = \frac{\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]\frac{\alpha}{w}}{n^{\sigma}} \frac{F(\sigma-1)n^{\sigma}}{\left[\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{i}{\beta}\right)^{\beta}\right]} + L_f \quad , \tag{12}$$

$$l_r^* = \frac{\alpha\left(wL_f + iK_f\right)(\sigma-1)}{w} + L_f \quad , \tag{13}$$

$$l_r^* = L_f(\alpha\sigma - \alpha + 1) + K_f \frac{\alpha(\sigma-1)i_r}{w_r} \quad , \tag{14}$$

$$k_r^* = K_f(\beta\sigma - \beta + 1) + L_f \frac{\beta(\sigma-1)w_r}{i_r} .$$

Tako ravnotežna količina dela (l^*) kot tudi ravnotežna količina kapitala (k^*) sta enaki za vsako podjetje v določeni regiji, pri čemer je število različic, proizvedenih v določeni regiji r (n_r), enako:

$$n_r = L_r^M / l^* = K_r^M / k^* \quad , \tag{15}$$

kjer L_r^M in K_r^M predstavljata opremljenost regije r z delom in kapitalom. Ta dva parametra definirata velikost posamezne regije. Razmerje med delom in kapitalom je definirano s (stroškovno) funkcijo (9) in je prav tako enako za vsako regijo (domačo in tujo) zaradi predpostavke o enakosti produkcijskih funkcij med državama in regijami (tehnološke razlike ne obstajajo niti med regijami niti med državami).

4.4. Enačba plače v predelovalnem sektorju

Z uporabo funkcije povpraševanja po posamezni različici (Fujita, Krugman, Venables, 1999, str. 50) mora ravnotežna proizvodnja posameznega podjetja zadovoljiti:

$$q^* = \mu \sum_{s=1}^{R} Y_s (p_r^M)^{-\sigma} (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \quad , \tag{16}$$

kjer Y_s predstavlja nominalni dohodek regije s (tega sestavlja dohodek dela in dohodek kapitala: $Y_s = L_s{*}w_s{+}K_s{*}i_s$).

Enačbo (17) lahko obrnem in izrazim tako imenovano "break even" ceno[79] za vsako podjetje v regiji:

$$(17)\qquad (p_r^M)^\sigma = \frac{\mu}{q*}\sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \quad .$$

Z upoštevanjem enačbe cen (9) lahko nominalne plače in nominalne obrestne mere za regijo r izrazim kot:

$$(18)\qquad \left(\frac{w_r}{\alpha}\right)^{\alpha(\frac{\sigma-1}{\sigma})} = \frac{n_r^{\sigma-1}(\dfrac{\sigma-1}{\sigma})}{\left(\dfrac{i_r}{\beta}\right)^{\beta(\frac{\sigma-1}{\sigma})}} \left[\frac{\mu}{(F(\sigma-1))}\sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1}\right]^{1/\sigma},$$

$$(19)\qquad \left(\frac{i_r}{\beta}\right)^{\beta(\frac{\sigma-1}{\sigma})} = \frac{n_r^{\sigma-1}(\dfrac{\sigma-1}{\sigma})}{\left(\dfrac{w_r}{\alpha}\right)^{\alpha(\frac{\sigma-1}{\sigma})}} \left[\frac{\mu}{(F(\sigma-1))}\sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1}\right]^{1/\sigma}.$$

Enačba (18) kaže, da so plače na lokaciji r pozitivno povezane z nominalnimi dohodki v vseh regijah (vključno z regijo r), ki predstavljajo trge posameznega podjetja. Prav tako bodo plače na določeni lokaciji višje v primeru, če bo dostopnost do trgov iz te lokacije lažja (nižji T_{rs}^M) ter bo konkurenca na teh trgih manjša, saj cenovni indeks pada z večanjem števila prodanih različic (z majhnim številom prodanih različic je G_s relativno visok, kar povišuje plače v izvorni regiji). Za razliko od *FKV* modela pa moj model pokaže tudi povezavo med plačami in obrestnimi merami. Izkaže se, da obstaja negativna povezava med višino plač in višino obrestnih mer (Damijan, Kostevc, 2002).

V primeru, ko izrazim nominalne obrestne mere (19), pomeni to obratno razmerje od tistega v enačbi (18), pri čemer produkt plač in obrestnih mer definirata enačbi (18) in (19). Glede na to, da model determinira produkt nominalnih plač in obrestnih mer endogeno, je potrebno eno od obeh spremenljivk definirati eksogeno, da bi druga ostala endogeno determinirana. Produkt plač in obrestnih mer je enak v vsaki regiji in velja za vsa podjetja, ki nastopajo v določeni regiji.

[79] Cena, pri kateri podjetje dosega ničelne dobičke.

4.5. Opustitev predpostavke o simetričnosti lokacije domačih regij

FKV model predpostavlja, da sta obe domači regiji enako oddaljeni od tujine in imata torej enake stroške pri transportu enote blaga v tujino. V svojem modelu pa predpostavljam, da je manjša domača regija bližje tuji državi kot centralna domača regija ter ima stroškovno prednost (skozi nižje transportne stroške) v dostopu do tujih trgov v primerjavi z drugo domačo regijo. V trgovini med regijama znotraj domače države nastajajo transportni stroški (T), trgovinski stroški med manjšo domačo regijo in tujo državo pa znašajo (T^*). Ti vsebujejo tako stroške transporta kot tudi stroške zunanje trgovine med manjšo domačo regijo in tujo državo. Stroški transporta med večjo domačo regijo in tujo regijo tako znašajo TT^*.

Upoštevajoč takšno razporeditev regij lahko izpeljem enačbi za nivo cen ter plače:

(20)
$$G_1^{1-\sigma} = \frac{L_1}{l_1^*} p_1^{1-\sigma} + \frac{L_2}{l_2^*} p_2^{1-\sigma} T^{1-\sigma} + \frac{L_3}{l_3^*} p_3^{1-\sigma} (T^*)^{1-\sigma} T^{1-\sigma},$$
$$G_2^{1-\sigma} = \frac{L_1}{l_1^*} p_1^{1-\sigma} T^{1-\sigma} + \frac{L_2}{l_2^*} p_2^{1-\sigma} + \frac{L_3}{l_3^*} p_3^{1-\sigma} (T^*)^{1-\sigma},$$
$$G_3^{1-\sigma} = \frac{L_1}{l_1^*} p_1^{1-\sigma} T^{1-\sigma} (T^*)^{1-\sigma} + \frac{L_2}{l_2^*} p_2^{1-\sigma} (T^*)^{1-\sigma} + \frac{L_3}{l_3^*} p_3^{1-\sigma};$$

(21)
$$w_1 = \alpha \left[\left(\frac{n_1^\sigma \rho \beta^\beta}{i_1^\beta} \right) \left(Y_1 G_1^{\sigma-1} + Y_2 G_2^{\sigma-1} T^{1-\varsigma} + Y_3 G_3^{\sigma-1} (TT^*)^{1-\sigma} \right)^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}},$$
$$w_2 = \alpha \left[\left(\frac{n_2^\sigma \rho \beta^\beta}{i_2^\beta} \right) \left(Y_1 G_1^{\sigma-1} T^{1-\sigma} + Y_2 G_2^{\sigma-1} + Y_3 G_3^{\sigma-1} (T^*)^{1-\sigma} \right)^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}},$$
$$w_3 = \alpha \left[\left(\frac{n_3^\sigma \rho \beta^\beta}{i_3^\beta} \right) \left(Y_1 G_1^{\sigma-1} (TT^*)^{1-\sigma} + Y_2 G_2^{\sigma-1} (T^*)^{1-\sigma} + Y_3 G_3^{\sigma-1} \right)^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}}.$$

Enačba (21) predstavlja formacijo nominalnih plač v obeh domačih regijah kakor tudi v tuji regiji. Glede na kompleksnost enačb in tudi prepletenost učinkov posameznih spremenljivk je analiza vpliva posameznih spremenljivk na plače težavna za nekatere spremenljivke, medtem ko je za druge spremenljivke skoraj nemogoča. Naslednji dejavnik, ki vpliva na zapletenost omenjene analize je tudi cirkularna povezanost zgornjih enačb, saj je vrednost določene spremenljivke vedno odvisna od vrednosti druge spremenljivke. Iz (9) je namreč razvidno, da so cene odvisne od plač in obrestnih mer, medtem ko so nominalne plače odvisne od nivoja cen v posamezni regiji. Krog je sklenjen s tem, da so regionalni nivoji cen odvisni od cen v posameznih regijah in posledično od plač in obrestnih mer.

4.6. NUMERIČNE SIMULACIJE

V tem poglavju sem do sedaj predstavil nekoliko skrajšano matematično izpeljavo modela, ki sicer dovoljuje enostavno analizo povezav med spremenljivkami v omejenem obsegu, vendar pa matematični model zaradi svoje kompleksnosti in prepletenosti vplivov posameznih spremenljivk ne dopušča natančnejše analize. Uporaba numeričnih simulacij zagotavlja natančnejšo analizo robustnosti modela in pomena posameznih spremenljivk za delovanje modela. Računalniške simualcije delovanja modela dovoljujejo doseganje treh ciljev: omogočajo vpogled v vpliv pomembnejših spremenljivk na obnašanje modela, spodbujajo nove analitične rešitve, ki so dosežene na podlagi analize modela, uporabne pa so tudi pri spodbijanju in potrjevanju določenih tez o delovanju modela.

V tem podpoglavju torej predstavljam rezultate dveh simulacij modela[80], in sicer vpliv neposrednih tujih investicij na alokacijo ekonomske aktivnosti in primerjavo simualcije mojega modela s simulacijo *FKV* modela. Z omenjenima simulacijama želim pokazati, kako neposredne tuje investicije vplivajo na alokacijo ekonomske aktivnosti, ki poteka zaradi zunanjetrgovinske liberalizacije. Alokacijo ekonomske aktivnosti merim z relativnimi regionalnimi plačami, saj te nazorno prikazujejo učinke liberalizacije na blagostanje v določeni regiji. Ta kazalec tudi kaže, ali so upravičene trditve, da liberalizacija trgovine koristi samo velikim državam (regijam), medtem ko manjše države (regije) izgubljajo. V kolikor namreč velja ta trditev, bi zunanjetrgovinska liberalizacija stopnjevala bipolarnost med razvitimi in manj razvitimi regijami v državi in vodila v vse večjo divergenco plač med bogato centralno in siromašnejšimi obrobnimi regijami. V simulacijah bi bil tak razvoj dogodkov razviden iz monotono naraščajoče krivulje relativnih plač (w_2/w_1) ob padajočih trgovinskih stroških (T^*).

Poleg simulacij, ki jih predstavljam, sem opravil še nekaj simulacij z namenom preizkušanja odzivnosti modela na spremembe nekaterih bistvenih spremenljivk. Na podlagi teh simulacij se je izkazalo, da povečanje notranjih transportnih stroškov (T) zmanjšuje razliko v plačah med regijama, saj se stopnjuje lokacijska prednost manjše regije v primerjavi z veliko. Podoben vpliv je zaznaven tudi v primeru zmanjšanja razlik v velikosti med obema regijama (obilnost delovne sile in kapitala), kar prav tako pozitivno vpliva na relativne regionalne plače obmejnih regij. Zelo velik vpliv na delovanje modela pa imajo tudi spremembe v elastičnosti substitucije, saj povečanje le te povzroči velik padec relativnih plač, medtem ko zmanjšanje elastičnosti kaže pozitivne vplive na relativne regionalne plače (w_2/w_1). Višje elastičnosti substitucije vplivajo

[80] Za namen simuliranja delovanja modela sem uporabil matematični program Matematica, verzija 4.1.

predvsem na moč aglomeracijskih učinkov, kar povzroča težnje po koncentraciji predelovalne industrije v centralni regiji in na ta način nižje relativne regionalne plače.

4.6.1. Simulacija vpliva neposrednih tujih investicij na alokacijo proizvodnje

Pri simulaciji delovanja mojega modela so upoštevane vse do sedaj omenjene predpostavke modela. V Tabeli 1 predstavljam osnovne (bazične) parametre simulacije, pri čemer predstavlja oznaka 1 večjo domačo regijo, oznaka 2 manjšo domačo regijo, oznaka 3 pa tujo državo. Iz tabele je razvidno, da je centralna domača regija (regija 1) za 25 odstotkov večja od manjše domače regije (regije 2) po obilnosti dela in kapitala, medtem ko je tuja država (regija 3) za 400 odstotkov večja od centralne domače regije.

Tabela 1: **Osnovne vrednosti parametrov**

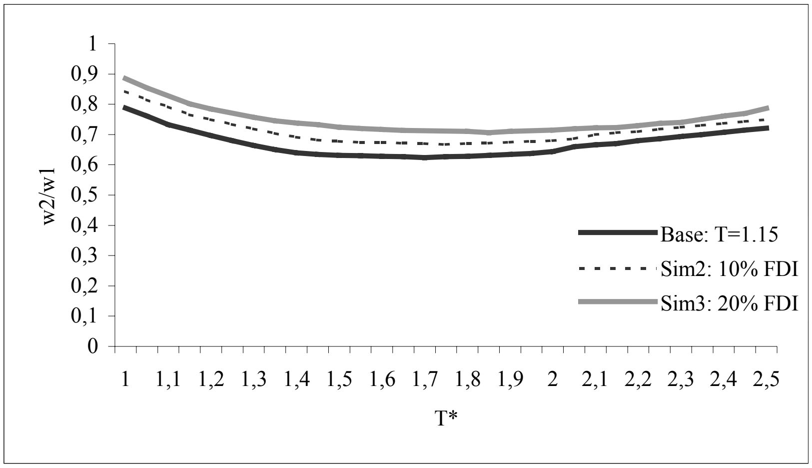
Parameter	regija 1	regija 2	regija 3 (tuja država)
L	200	160	1000
K	86	68	428
α	0.7	0.7	0.7
β	0.3	0.3	0.3
σ	1.5	1.5	1.5
T	1.15	1.15	1.15

Vir: Izmišljene vrednosti

Parametra α in β predstavljata parametra elastičnosti Cobb-Douglasove produkcijske funkcije glede na delo in kapital. Parameter T predstavlja transportne stroške prevozov znotraj države, ki naj bi znašali približno 13 odstotkov.

Pri simuliranju učinka neposrednih tujih investicij predpostavljam, da gre večji delež kapitala, ki prihaja iz tujine, v manjšo od obeh domačih regij, za kar je več razlogov. Manjša regija ima namreč tako nižje nominalne plače kakor tudi višji donos na enoto kapitala (višjo ceno enote kapitala), prav tako pa je manjša regija bližje tujim trgom, kamor se izvaža blago, proizvedeno v podjetjih manjše regije. V namen simuliranja neposrednih tujih investicij v manjšo od obeh domačih regij (regijo 2) bom tako povečal kapital te regije za 10 odstotkov na $K_2 = 75$ oziroma za 20 odstotkov na $K_2 = 82$. Učinke vplivov neposrednih tujih investicij prikazujem v Grafikonu 1.

Grafikon 1: **Reakcija relativnih regionalnih plač na zunanjetrgovinsko liberalizacijo ob neposrednih tujih investicijah**



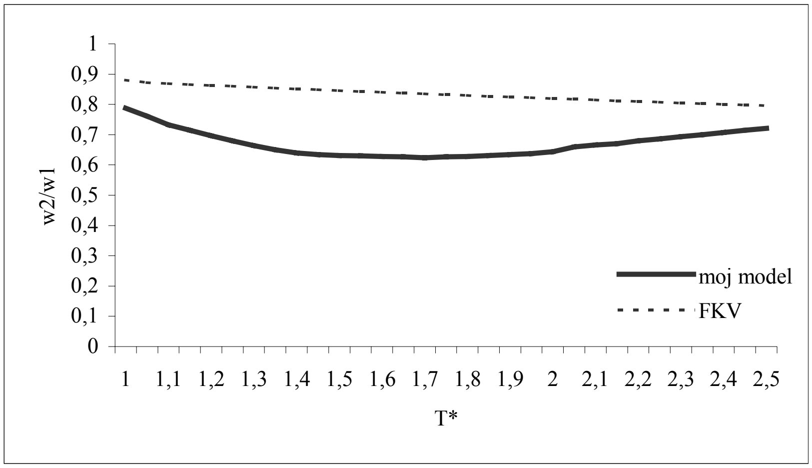
Vir: Lastni izračuni

Iz Grafikona 1 je razvidno, da tokovi kapitala v obrobno domačo regijo zmanjšujejo absolutno razliko v plačah med obema regijama (to je razvidno že iz dejstva, da krivulji relativnih regionalnih plač z vplivom neposrednih tujih investicij ležita nad bazično krivuljo relativnih regionalnih plač). Vpliv neposrednih tujih investicij deluje v dveh smereh: (i) dodatni pritok kapitala v manjši regiji povzroči padec obrestnih mer v tej regiji, kar s pomočjo enačbe plač in obrestnih mer direktno učinkuje na zvišanje nominalnih plač v tej regiji in posledično tudi poveča relativne plače v tej regiji, (ii) padec obrestnih mer pa prav tako zniža potrebe po delu ob proizvodnji ravnotežne količine, kar je razvidno iz (14), kar ob enaki količini delovne sile v regiji dovoljuje delovanje večjega števila podjetij in posledično višjih plač. Oba učinka se kombinirata in zagotavljata višje relativne plače ob neposrednih tujih investicijah. Razvidno je torej, da na podlagi obeh omenjenih učinkov neposredne tuje investicije vodijo v hitrejšo konvergenco med regijami, kar omogoča, da manjša domača regija ob zadostnem pritoku tujega kapitala hitreje dohiteva nivo plač večje regije, prav tako pa prihaja do enakomernejše razporeditve ekonomske aktivnosti med obema regijama.

4.6.2. Uporaba numerične simulacije za primerjavo med mojim modelom in *FKV* modelom

Pomembnejše razlike med svojim in FKV modelom ekonomske geografije sem opisal že pri sami izpeljavi modela, vključujejo pa predvsem vključitev drugega produkcijskega faktorja, eksplicitnejše modeliranje eksternih ekonomij obsega in opustitev predpostavke simetričnosti lege domačih regij. Za primerjavo delovanja obeh modelov sem uporabil osnovne parametre, predstavljene v Tabeli 1.[81] V Grafikonu 2 podajam rezultate simulacijske primerjave obeh modelov.

Grafikon 2: **Primerjava delovanja *FKV* in mojega modela pri zunanjetrgovinski liberalizaciji**



Vir: Lastni izračuni

Iz zgornjega grafikona je razvidno, da je krivulja relativnih regionalnih plač v *FKV* modelu bistveno nad krivuljo plač mojega modela. *FKV* model v opazovanem območju trgovinskih stroškov kaže na monoton vpliv trgovinske liberalizacije na relativne regionalne plače, saj prihaja do konvergence med regijama v relativnih plačah na celotnem območju. Grafikon 1 kaže, da so začetni aglomeracijski učinki v mojem modelu bistveno močnejši kot v *FKV* modelu, prav tako pa na višino relativnih regionalnih plač v mojem modelu negativno vplivajo še regionalne obrestne mere.

Navkljub videzu *FKV* krivulje relativnih regionalnih plač, ki nakazuje na monotono povezavo med zniževanjem trgovinskih stroškov in relativnimi regionalnimi plačami v opazovanem obsegu trgovinskih stroškov, gre dejansko za *U*-obliko krivulje relativnih plač tudi v primeru *FKV* modela. Do obrata krivulje relativnih plač v *FKV* modelu pride pri zelo visokem nivoju trgovinskih stroškov (izven opazovanega območja) in tako ta krivulja v opazovanem obsegu trgovinskih stroškov prikazuje zgolj monotono konvergenco med regionalnimi plačami.

[81] *FKV* model zahteva tudi specifikacijo deleža potrošnje, ki je namenjena za predelovalno dejavnost, ki sem ga zastavil pri 70%, in fiksne stroške delovne sile, ki znašajo 2 enoti. Poudariti je potrebno, da podatki o kapitalu ne veljajo za *FKV* model, saj gre za enofaktorski model ekonomske geografije.

5. EMPIRIČNA PREVERBA DELOVANJA MODELOV EKONOMSKE GEOGRAFIJE NA PRIMERU TRANZICIJSKIH DRŽAV

V predhodnem poglavju sem podal nekoliko skrajšano izpeljavo svojega modela ekonomske geografije, prav tako pa sem s pomočjo simulacij analiziral delovanje modela in povezanost poglavitnih spremenljivk v modelu. S pomočjo empirične analize, ki jo podajam v tem poglavju, pa skušam preveriti delovanje modelov ekonomske geografije v primeru tranzicijskih držav.

Razvoj empiričnih analiz ekonomske geografije v zadnjem desetletju ni uspel slediti razcvetu teoretičnih spoznanj na tem področju, kljub temu pa je prišlo do velikega razmika v empirični analizi ekonomske geografije. Dosedanje analize učinkov dejavnikov razdalje in prostora na ekonomsko aktivnost so bile omejene izključno na analiziranje držav Evropske Unije in ZDA, medtem ko ostale skupine držav empirične preverbe delovanja ekonomske geografije še niso doživele. V tem poglavju skušam zapolniti nastalo praznino s preizkušanjem domnev treh modelov ekonomske geografije, Krugmanovega (1991) modela, *FKV* modela in mojega modela, in sicer na primeru petih tranzicijskih držav (Bolgarije, Estonije, Madžarske, Romunije in Slovenije).

5.1. EMPIRIČNI MODEL

Implikacije zgoraj omenjenih treh modelov za tranzicijske države so dokaj jasne. Krugmanov (1991) model predvideva monotono zniževanje relativne regionalne plače manjše domače regije v primeru zniževanja trgovinskih stroškov. To posledično pomeni, da bo trgovinska liberalizacija vodila v oblikovanje vzorca centra in periferije, kjer bo glavnina ekonomske aktivnosti koncentrirana v centralni regiji, zgolj manjši delež pa bo ostal v periferni regiji. Tako *FKV* kot tudi moj model po drugi strani predvidevata, da bo krivulja relativnih regionalnih plač zavzela *U*-obliko, pri čemer bo v prvi fazi zunanjetrgovinske liberalizacije prišlo do divergence v plačah med domačima regijama, druga faza specializacije pa bo ponovno vodila v konvergenco med obema regijama. V svojem modelu lahko dodatno analiziram vpliv pritoka kapitala v obliki neposrednih tujih investicij v manjšo (periferno) domačo regijo. Pritok kapitala naj bi, kot je razvidno iz opravljene simulacije, pospešil konvergenco med regijama. Neposredne tuje investicije naj bi torej pozitivno vplivale na hitrost konvergence v regionalnih plačah med periferno in centralno domačo regijo.

V namen empirične analize delovanja omenjenih modelov ekonomske geografije preizkušam naslednji model:

$$(1)\quad \ln \boldsymbol{rW} = \alpha + \nu\, \boldsymbol{t} + \omega \boldsymbol{t}^2 + \delta \ln \boldsymbol{irVAe} + \phi \ln \boldsymbol{rFDI} + \beta \ln\boldsymbol{DIST} + \gamma\, \boldsymbol{BORD} + \lambda\, \boldsymbol{FTA} + \mu \ln\boldsymbol{DIST{*}FTA} + \kappa \ln\boldsymbol{DIST{*}BORD} + \sigma\, \boldsymbol{BORD{*}FTA} + \rho\, \boldsymbol{\Sigma R} + \tau\, \boldsymbol{\Sigma T} + \varepsilon_{it}\ ,$$

kjer je:

rW	relativna regionalna plača (relativna plača periferne regije glede na centralno regijo)
t, t²	časovni učinki
irVAe	začetna relativna produktivnost v regiji
rFDI	relativna regionalna proizvodnja podjetij s tujim kapitalom (glede na domača podjetja)
DIST	razdalja regije do glavnega mesta
BORD	dummy spremenljivka za zahodne/severne regije
FTA	dummy spremenljivka za uvedbo zunanjetrgovinske liberalizacije
ΣR	dummy spremenljivka za širše regije
ΣT	časovna dummy spremenljivka
ε_{it}	spremenljivka slučajnih napak

5.2. PODATKI

Napovedi treh modelov ekonomske geografije analiziram na regionalnih podatkih za vzorec petih tranzicijskih držav (Bolgarija, Estonija, Madžarska, Romunija in Slovenija) za obdobje od 1990-1999 (Bolgarija, Madžarska), obdobje 1992-1999 (Estonija, Romunija) ter 1994-2000 (Slovenija). Izbor držav ni bil arbitraren, temveč zgolj posledica omejitev v dostopnosti potrebnih regionalnih podatkov za tovrstno analizo. Zavedati se je potrebno, da so izbrane države izredno heterogene tako v stopnji njihovega razvoja kot tudi v napredovanju tranzicijskega procesa in zunanjetrgovinske liberalizacije. Države, zbrane v vzorec, se razlikujejo tudi po svoji stopnji integriranosti z Evropsko Unijo in oddaljenosti od nje.

Podatki so bili zbrani med Phare ACE projektom o vzorcih regionalne alokacije proizvodnje v tranzicijskih državah. Podatki so bili zbrani na podlagi NUTS klasifikacije, pri čemer so bili za vse države, z izjemo Slovenije, zbrani na nivoju NUTS-2 in NUTS-3 regij, medtem ko so podatki za Slovenijo, ki še nima uradne delujoče regionalne statistike, na nivoju NUTS-3 in NUTS-5 regij (regije in občine). Vsi vrednostni podatki so bili preračunani na cene iz leta 1994 z uporabo indeksa kupne moči. Vse uporabljene razdalje (razdalje med regionalnimi glavnimi mesti in glavnim mestom države in razdalje regionalnih glavnih mest do najbližjih severnih oziroma zahodnih mej) so merjene kot cestne razdalje v kilometrih.

6. REZULTATI

V Tabeli 2 predstavljam rezultate empirične analize modela (1) z uporabo cenilke fiksnih učinkov. F-test, prikazan v tabeli, potrjuje prisotnost močnih individualnih učinkov posamičnih regij in na ta način opravičuje uporabo panelne metode namesto metode najmanjših kvadratov. Za cenilko s fiksnimi učinki sem se odločil navkljub dejstvu, da v primeru Bolgarije, Estonije in Madžarske Hausmanov test ni pokazal značilnih razlik (tako ne moremo zavrniti ničelne domneve, da so specifični učinki posamičnih regij naključni). V teh primerih bi bila pravilnejša uporaba cenilke z naključnimi učinki (*random effects*), vendar pa pregled koeficientov ne prikaže bistvenih razlik med spremenljivkama. Razlaga rezultatov je tako zelo podobna v obeh primerih.

Pričakovana *U*-oblika (pozitiven predznak spremenljivke t^2) se je uresničila le v primeru Madžarske, medtem ko je za Estonijo in Slovenijo značilno, da so se plače prilagajale celo v obliki obrnjene *U*-krivulje, čemur pričata značilno negativna predznaka spremenljivke t^2. Začetna relativna produktivnost na zaposlenega v regiji (*irVA/emp*) je pozitivno vplivala na relativne regionalne plače le v Bolgariji, medtem ko je imela statistično značilen negativen vpliv na relativne regionalne plače v Estoniji, Romuniji in Sloveniji.[82] Tako v madžarskem, estonskem kot tudi v bolgarskem primeru je opazno, da severne in zahodne regije, ki so bližje Evropski Uniji, s procesom zunanjetrgovinske liberalizacije dohitevajo centralno regijo. Razdalja regije do glavnega mesta (spremenljivka *DISTANCE*) je značilno pozitivno vplivala na relativne regionalne plače zgolj v primeru Estonije, medtem ko je razdalja regije do glavnega mesta po zunanjetrgovinski liberalizaciji (*DIST*FTA*) imela značilen negativen vpliv v primeru Estonije in Slovenije. To pomeni, da plače v bolj oddaljenih regijah v Estoniji in Sloveniji po uvedbi sporazumov o prosti trgovini (FTA) rasle počasneje kot v centralni regiji. V primeru Bolgarije in Madžarske pa je razdalja učinkovala na počasnejšo rast nekaterih bolj oddaljenih obmejnih regij (*DIST*BORD*). Podobno v večini držav pritok neposrednih tujih investicij ni značilno vplival na realokacijo ekonomske aktivnosti. Izjemi v tem primeru sta Estonija, kjer, v skladu s pričakovanji, pritoki neposrednih tujih investicij pozitivno vplivajo na rast relativnih regionalnih plač, in Romunija, kjer pa pritoki neposrednih tujih investicij celo negativno vplivajo na relativne regionalne plače. V primeru Romunije je bila tako verjetno glavnina pritokov neposrednih tujih investicij koncentrirana v centralni regiji, kar je še poglobilo vrzel v plačah med centralno in perifernimi regijami.

[82] To pomeni, da so plače hitreje rasle v regijah z nižjo relativno produktivnostjo na zaposlenega kot v regijah z višjo produktivnostjo.

Tabela 2: **Učinki zunanjetrgovinske liberalizacije na relativne regionalne plače v tranzicijskih državah***

	BG	EST	HU	RO	SLO
t	-0.021	**-0.301**	-0.031	-	0.013
	(-0.81)	(-2.90)	(-0.62)		(0.64)
t^2	-0.001	**-0.004**	**0.001**	0.002	**-0.004**
	(-1.10)	(-7.72)	(7.57)	(0.64)	(-2.70)
irVA/emp	**0.024**	**-0.164**	0.000	**-0.033**	**-0.019**
	(2.76)	(-3.10)	(-0.03)	(-2.56)	(-6.01)
rFDI	-0.089	**0.581**	0.180	**-0.377**	-0.086
	(-0.62)	(1.51)	(0.97)	(-2.18)	(-0.97)
DISTANCE	-0.0029	**0.058**	0.005	-0.003	0.004
	(-0.63)	(3.15)	(0.54)	(-0.74)	(0.84)
BORDER	**0.042**	**0.086**	**0.046**	-0.009	0.003
	(2.02)	(2.18)	(2.64)	(-0.36)	(0.08)
FTA	0.015	**0.503**	0.006	0.0001	**0.071**
	(0.51)	(4.96)	(0.11)	(0.01)	(2.58)
DIST*FTA	0.005	**-0.070**	-0.006	0.0003	**-0.014**
	(0.91)	(-3.60)	(-0.59)	(0.68)	(-2.35)
DIST*BORD	**-0.007**	-0.006	**-0.010**	0.002	-0.001
	(-2.01)	(-0.84)	(-3.51)	(0.39)	(-0.17)
BORD*FTA	-0.002	**-0.070**	0.011	-0.0003	0.009
	(-0.30)	(-3.92)	(1.20)	(-0.43)	(0.80)
Broad region dummies	Yes	Yes	Yes	Yes	Yes
Number of obs.	260	112	180	320	1169
Adj R^2	0.615	0.862	0.858	0.812	0.185
F test for individual effects	22.2	15.66	33.4	14.1	14.0
Hausman chi^2 test	12.2	2.6	11.0	243.5	114.1
Prob>chi^2	0.6676	0.9996	0.6876	0.0000	0.0000

* Odvisna spremenljivka: relativne regionalne plače, to je plače *r*-te regije glede na centralno regijo t-statistike v oklepaju. Statistično značilne vrednosti so poudarjene.

Vir: Lastni izračuni

Ocene učinkov ekonomske geografije na vzorcu tranzicijskih držav kažejo, da so bila dogajanja v Bolgariji in na Madžarskem v skladu z napovedmi *FKV* modela, medtem ko za Estonijo in Romunijo velja, da je zunanjetrgovinska liberalizacija vodila v povečano polarizacijo med glavnim mestom in obmejnimi regijami v skladu s Krugmanovim modelom. V nasprotju s pričakovanji tokovi neposrednih tujih investicij niso vplivali na realokacijo ekonomske aktivnosti v Sloveniji, prav tako pa je trgovinska liberalizacija v Sloveniji v opazovanem obdobju vodila v konvergenco regionalnih plač. Tako slovenska zunanjetrgovinska liberalizacija ne ustreza napovedim nobenega od analiziranih modelov. Ugotavljam tudi, da moj model ne pojasnjuje realokacije produkcijskih faktorjev po zunanjetrgovinski liberalizaciji v tranzicijskih državah nič bolje od dosedanjih modelov in torej ne predstavlja ustreznejše razlage prostorske alokacije ekonomske aktivnosti v teh državah od Krugmanovega oziroma *FKV* modela.

7. SKLEP

Namen pričujoče magistrske naloge je bil v analizi učinkov zunanjetrgovinske liberalizacije (integracije z Evropsko unijo) na regionalno realokacijo predelovalne dejavnosti in posledično medregionalno prilagajanje relativnih plač v tranzicijskih državah. Glede na polemike o vplivih liberalizacije zunanje trgovine na večanje prepada med bogatimi in revnimi, je pomembno prav vprašanje učinkov proste trgovine na dinamiko razvoja posameznih regij in držav.

V ta namen sem razvil svoj lasten model ekonomske geografije, s pomočjo katerega ocenjujem učinke zunanjetrgovinske liberalizacije na večanje ali zmanjševanje regionalnih razlik. V razvoju svojega modela sledim tradiciji Krugmanovega (1991) modela, Krugman-Venablesovega (1995, 1996) in ostalih modelov, pri čemer v modele uvajam določene pomembne spremembe. Bistveni spremembi, ki sem ju vpeljal v svoj model ekonomske geografije, sta vključitev kapitala kot drugega proizvodnega faktorja in opustitev predpostavke simetričnosti lege domačih regij. Navedene spremembe so bistveno vplivale na dinamiko modela, kakor tudi na povezave med posamičnimi spremenljivkami. Med mojim in ostalimi modeli z nemobilno delovno silo ostaja podobnost v *U*-obliki krivulje relativnih plač, pri čemer začetna faza liberalizacije vodi v divergenco med regijami, medtem ko poznejše faze z nižjimi trgovinskimi stroški vodijo nazaj v konvergenco med regijami. V primerjavi z drugimi modeli pa so v mojem modelu učinki centripetalnih sil, ki povzročajo težnje po koncentraciji ekonomske aktivnosti, bistveno močnejši, prav tako pa do obrata med začetno divergenco in konvergenco pride pri bistveno nižjem nivoju trgovinskih stroškov, kar pomeni, da so tudi centrifugalne sile mojega modela nekoliko močnejše kot v drugih primerih.

V namen empirične analize pa implikacije Krugmanovega, *FKV* ter mojega modela testiram še na vzorcu petih tranzicijskih držav v zadnjem desetletju prejšnjega stoletja. Z empirično analizo želim prispevati k zapolnitvi vrzeli v empiričnih raziskavah ekonomske geografije, saj do sedaj ni bilo opravljenih analiz učinkov razdalj in prostorske razdelitve proizvodnje na tranzicijskih državah. V svoji empirični preverbi tako testiram implikacije vseh treh modelov, pri čemer iščem odgovor na vprašanje, ali so dejavniki ekonomske geografije imeli značilen vpliv na regionalni razvoj v vzorcu zajetih držav v obdobju njihove zunanjetrgovinske liberalizacije. Empirične analize s pomočjo panelne ekonometrične metode so pokazale, da je zgolj v primeru Estonije prišlo do povečevanja polarizacije med razvito centralno regijo in manj razvitimi obmejnimi regijami, kar ustreza napovedim Krugmanovega modela. Po drugi strani pa je bil razvoj dogodkov na Madžarskem v skladu z napovedmi *FKV* modela in mojega modela, saj je začetni divergenci regionalnih plač po dosegu določenega nivoja trgovinskih stroškov sledila konvergenca v regionalnih plačah med centralno in obmejnimi regijami. Zanimivo je tudi, da so empirične raziskave pokazale, da razvoj , bolgarski, romunskih in slovenskih regij ne ustreza nobeni od napovedi, ki jo ponujajo omenjeni trije modeli. Prav tako se je izkazalo, da neposredne tuje investicije, v nasprotju s pričakovanji mojega modela, niso značilno vplivale na regionalni razvoj večine držav z izjemo Estonije (in Bolgarije). Delno gre vzroke za neznačilne predznake spremenljivke neposrednih tujih investicij iskati v uporabljenem pristopu k ekonometrični analizi. Za celovitejšo analizo vpliva neposrednih tujih investicij bi bilo tako potrebno upoštevati tudi začetno stanje neposrednih tujih investicij po regijah, prav tako pa bi to vprašanje zahtevalo uporabo nekaterih novejših ekonometričnih metod (npr. dinamičnih panelnih metod).

Potencial za nadaljnje raziskave ekonomske geografije ostaja tako v teoretičnem kot empiričnem smislu, saj ostaja veliko možnosti za realnejše modele ekonomske geografije, katerih delovanje bo natančnejši odsev realokacije faktorjev znotraj države. Prav tako bo lažja dostopnost in večja kvaliteta podatkov omogočala popolnejše in ekstenzivnejše empirične preizkuse napovedi, ki jih ti modeli prinašajo.