Chapter 16
Globalization and Economic Geography

16.1 Introductory Remarks

"Globalization" is a much used and abused word. According to The American Heritage® Dictionary of the English Language (copyright © 2009 Houghton Mifflin Company), to globalize means "To make global or worldwide in scope or application." In the field of international economics, globalization means different things to different people (see, for example, Gupta ed., 1997; Stern, 2009). Some authors (see, for example, Dreher, 2006; Dreher, Gaston, & Martens, 2008) have also suggested indexes to measure the degree of globalization of the various countries, taking into account the three main dimensions of globalization (economic, social, and political). These indexes are available at http://globalization.kof.ethz.ch/

A by no means exhaustive list of the elements that make up globalization is:

(a) The increase in the share of international and transnational transactions, as measured for example by the share of world trade and world direct investment (carried out by multinational corporations) in world GNP;
(b) The integration of world markets, as measured for example by the convergence of prices and the consequent elimination of arbitrage opportunities;
(c) The growth of international transactions and organizations having a non-economic but political, cultural, social nature;
(d) An increasing awareness of the importance of common global problems (the environment, infectious diseases, the presence of international markets which are beyond the control of any single nation, etc.,)
(e) The tendency to eliminate national differences and to an increasing uniformity of cultures and institutions.

The debate on globalization usually considers the following aspects:

1. The actual degree of integration of markets;
2. Globalization as a process that undermines the sovereignty of the single states, reducing their autonomy in policy making and increasing the power of multinational corporations;

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3. The effects of globalization on world income distribution, both within and across countries;
4. The possible development of an international government to cope with global problems.

The aspects of globalization concerning multinational corporations and their foreign direct investment have been treated in Sect. 6.8.4. Here we shall take "globalization", as referred to international trade, to mean the closer integration of world markets for commodities, services, and factors, partly due to the decrease in transport and communication costs (so called "*annihilation of distance*").

The importance of transport costs and location was already stressed by Ohlin himself: the title of the 12th chapter of his treatise (Ohlin 1933) is "Interregional Trade Theory as Location Theory", where he considers the role of location and transport costs in both domestic and international trade. An early attempt at integrating location theory and international trade theory was Lösch (1954).

The topic was taken up again by Paul Krugman (1991a, p. 1), who defined *economic geography* as "the location of production in space; that is, that branch of economics that worries about where things happen in relation to one another". Under this definition, location theory is part of the much broader field of economic geography, a field that would also include international trade theory as a special case. It would then seem quite natural to observe a close integration between international trade theory and location theory in the broader context of economic geography, but this has not been the case, for several reasons examined for example by Krugman (1991a, 1993a).

The present chapter examines the relations between location of production, cost of transport, and international trade in the context of both the traditional and the new theories of international trade.

16.2 Transport Cost, Location Theory, and Comparative Advantage

Location theorists classify industries into "materials (or resource) oriented" and "market oriented" according as to whether transportation costs impose location close to the source of raw materials or to the final consumer (see, for example, Beckmann, 1987).

The original sites of the heavy industry (Pittsburgh in the United States, Birmingham in England, the Ruhr in Germany), illustrate the need for the production of iron and steel to be carried out close to the iron-ore and coal fields. Hence it is no surprise that the heavy industry arose in those countries that were well endowed with the necessary mineral resources, countries which then became exporters of the products of the heavy industry. This is perfectly in line with the standard factor proportions theory, as transport costs caused those mineral resources to be almost immobile factors.

However, after the second world war the transport revolution involving giant bulk carriers has drastically altered the situation. This has created a pool of primary resources on which all countries can draw: the most striking example is Japan, that became a top industrialized country using imported raw materials from far-away locations. Thus the relevant factor endowments are again capital (including technology and human capital), and labour rather than the endowment of primary resources, which is due to geological accidents.

These ideas have been modelled by Findlay (1995, chap. 6, sect. 6.3), who considers a three-commodity, three-factor model with constant-returns-to-scale technology. The commodities are:

1. An "all purpose" commodity (A), that can be either consumed or invested, namely added to the stock of capital, and is taken to be the *numéraire*;
2. A pure consumer good (B);
3. A raw material (Z) that is used in fixed proportions in the production of A.

The factors are:

(i) Land, or natural resources (N), specific to the production of Z;
(ii) Labour (L), used in the production of all three commodities;
(iii) Capital (K) used only for A and B.

While both N and L are in fixed supply, the supply of capital is endogenous. Commodity A is assumed to be capital-intensive with respect to B, and turns out to be also resource-intensive. To show this, we observe that commodity A—apart from the amount of N directly used to produce Z which is specific to A—indirectly requires more N with respect to B. In fact, since K embodies the part of A that has been invested (hence K indirectly embodies N), it follows that A, being capital-intensive with respect to B, indirectly requires more N.

Consider now two identical countries except for the endowment of natural resources, which is larger in country 1. Since N_1/L_1 is greater than N_2/L_2, we speak of 1 and 2 as the resource-rich and resource-poor country, respectively.

The first step is the introduction of international trade in final goods only. The raw material Z is assumed to be non traded due to prohibitive transport costs when it is in unprocessed form; these costs disappear when it is embodied in the capital-intensive final good A. With these assumptions the model behaves like the standard 2×2 Heckscher-Ohlin model, hence country 1 will export the resource-intensive commodity A and import commodity B, while country 2 will export commodity B and import commodity A. In country 1 the A sector will expand and the B sector will contract, while the opposite will take place in country 2.

Thus, when there is free trade in final goods only, what happens is a higher extraction of the raw material input in the resource-rich country; this entails an increase in the capital stock to meet the needs of the higher output of the capital-intensive exportable commodity A. In the other country the opposite will happen: the resource sector shrinks because of the reduction in the output of the import-competing commodity A, with a corresponding decrease in the long-run capital stock. As Findlay (1995, p. 168) notes, "free trade clearly *enhances* the initial difference in wealth between the two countries based on the difference in natural resource endowment."

The second step is to allow free trade in all commodities, because a transport revolution takes place so that the resource input Z can be traded at zero transport cost like the two final goods. We now have a model with three traded goods (one of which is a factor of production), and three factors (one of which is traded). Given the assumption of internationally identical technologies with constant returns to scale, if we further assume that all three commodities are produced in both countries, factor prices will be equalized.

In the long-run equilibrium, agents must have the same per capita utility level in both countries; this implies that per capita income and per capita wealth (and hence total wealth, given the assumption of identical labour force), must also be equal. Total wealth is made up of two components, the capital stock and the capitalized value of the rents from the natural resources N used to produce Z.

Commodity- and factor-price equalization implies that the price of Z increases (with respect to the pre-trade situation), in the resource-abundant country 1 (where before trade it was lower than in the resource-scarce country), and decreases in the resource-scarce country 2. The resource sector shrinks in country 2 and expands in country 1, which implies that, in the long run equilibrium, the natural-resource component of wealth is greater in country 1 than in country 2. This in turn entails a greater long-run equilibrium capital stock in country 2 than in country 1, as total wealth must be equal in both countries.

The final result is that in the long-run equilibrium country 2 may become the *exporter* of the capital-intensive commodity A.

"In other words, the possibility of sharing on equal terms in a global pool for access to the intermediate input enables the resource-poor country to build up its capital stock per head to such an extent that it leads to a *reversal* of its former comparative advantage in the labour-intensive good. [...] It is now the less naturally well endowed countries that will have a higher proportion of physical capital per capita in their portfolios and will thus *export* the capital-intensive industrial goods on the basis of imported intermediate inputs as, for example, in the case of Japan" (Findlay 1995, pp. 170, 172).

16.3 The Core-Periphery Model

The Core-Periphery model, developed in Krugman (1991c), has sparked a new and rich stream of literature known as the new economic geography (NEG). In a way analogous to the Krugman model of Sect. 9.2.1, which showed the existence of international trade in the absence of comparative advantage, the core-periphery model shows that agglomeration may emerge even in the absence or exogenous differences between locations. This is what makes this model new with respect to the preexisting literature on economic geography.

As recalled by Krugman (1991c, p. 486), many of the ideas contained in the core-periphery model had appeared in the literature since the 1950s but were not to become formalized for long time. Indeed, one of the merits of the core-periphery model is that it embodied many of these ideas into a simple and yet rigorous model. This formalization has provided a bridge between economic geography and international trade that has been crossed by many scholars. At last, as wished by Ohlin et al. (Eds.) 1977, regional economics and international economics have begun an integration process that has shed new light on many issues in both fields.

We now move to the study of the Core-Periphery model. The objective of the model is to answer the question of why and when does manufacturing become concentrated in a few regions leaving the other regions relatively undeveloped.

16.3.1 Description of the Model

Consider a world composed of two "regions" indexed by $i = 1, 2$. Assume that there are only two factors of production represented by two distinct types of labour, "farmers" and "workers": farmers are geographically immobile while workers may move between regions.[1] For simplicity, it is assumed that the world population (the sum of farmers and workers) is constant and normalized to 1. The number of farmers and workers is assumed exogenous with $(1-\gamma)$ being the number of farmers and γ the number of workers in the world economy. Farmers do not migrate and are equally distributed between the two regions, each hosting $(1-\gamma)/2$ farmers. Workers may migrate and at any point in time there are γ_i workers in each region, naturally, $\gamma_1 + \gamma_2 = \gamma$. It is convenient to compact notation and define λ_i as the share of workers residing in region i at any point in time, i.e., $\lambda_i \equiv \gamma_i/\gamma$. The world economy produces two goods, a homogenous agricultural good, A, and a differentiated manufactured good, M. The technology is identical between regions so as to eliminate any exogenous difference between them. Good A is produced with a constant return to scale technology which requires one unit of labour input (of farmers) for one unit of output. Only farmers are used in the production of A. The market for A is perfectly competitive and A is freely traded between regions. Any variety of good M is produced by use of an increasing return to scale technology characterized by a fixed and a variable input. Specifically, the labour input (of workers) per q units of output is $l = F + cq$ where F is the fixed input and cq is the variable input.[2] The market for M is characterized by monopolistic competition (see Sect. 9.2.1). Good M is traded between regions at a cost. Trade costs are assumed to be of the iceberg type already introduced in Sect. 6.3. They consist in a deterioration of the goods transported by which only a fraction $\tau \in (0, 1)$ of each unit sent from

[1] We use the terminology adopted in the early new economic geography literature. Clearly though, "region" should be understood as a geographical unit (region, country, or else) and "farmers" and "workers" as a geographically immobile and mobile factor, respectively.

[2] See Ricci (1999) for an interesting extension where the marginal labor input, c, differs between countries.

region i arrives to region j. The costs of transporting a unit of any variety of good M is therefore $(1-\tau)$ units of the variety transported.

Consumers (farmers and workers) draw utility from the consumption of A and M. Their consumption preferences are such that they spend a share γ of their income on good M and a share $(1-\gamma)$ on good A. For simplicity, it is assumed that the expenditure share on A is exactly equal to the share of farmers in total population. Good M is differentiated and the sub-utility derived from consumption of M is given by the form already encountered in Eq. (9.2). We recall that the key feature of these preferences is the appreciation for variety per se. The consequence of this assumption is that consumers always choose to spread any given amount of aggregate consumption on the maximum possible number of varieties. Given this appreciation for variety, it is optimal for a firm to differentiate its product from that of any other firm. Product differentiation, in turn, gives to firms a market power that they exploit by setting prices above the marginal cost. Thus, the profit maximizing price for a firm located in region i applied to consumers in the same region is $p_{ii}^* = \mu c w_i$, where w is the manufacturing wage in region i and $\mu > 1$ is the mark-up over the marginal cost cw_i. The profit maximizing price of a firm located in region i and applied to consumers in region j is $p_{ij}^* = \mu(cw_i/\tau) > p_{ii}^*$. The mark-up in p_{ij}^* is μ as in p_{ii}^* but $p_{ij}^* > p_{ii}^*$ because the marginal cost of producing for the foreign market, cw_i/τ, is higher than the marginal cost of producing for the domestic market, cw_i, reflecting the fact that to sell one unit in the foreign market the firm has to produce $1/\tau$ units. Profits, π_i, are given by $\pi_i = p_{ii}q - w_i(F + cq)$, where q is the total output produced by the firm, including the fraction that is used as transport cost. Entry into the market is assumed to be free and occurs instantaneously so that profits are zero at any point in time. We apply the zero profit condition by substituting the profit maximizing price into π_i and setting $\pi_i = 0$ to give the equilibrium quantity of output produced by any firm: $q^* = \frac{F}{c(\mu-1)}$. Firm output is the same for all firms in any country, hence we have dropped the subscript. Free trade in good A leads to equalization of the price of A between regions. Let A be the numéraire good and normalize its price to 1 so that agricultural wages are also equal to 1 in both regions.

16.3.1.1 Instantaneous Equilibrium

We begin by setting the equilibrium conditions in the factor markets. The farmers' labour market is very simple. Since it takes one farmer to produce one unit of A, each country produces a quantity A equal to $(1-\gamma)/2$. Total demand for workers in a region is obtained by multiplying individual firm demand, $l = F + cq^*$, by the number of firms in the region, n_i, to obtain $n_i(F + cq^*)$. The total supply of workers in the region at any point in time is given by the share of workers in that region, λ_i, multiplied by the total number of workers in the world economy, γ. Therefore, the equilibrium conditions in the market for workers are:

$$n_i\left(F + cq^*\right) = \lambda_i \gamma; \qquad i = 1, 2. \tag{16.1}$$

Replacing equilibrium output $q^* = \frac{F}{c(\mu-1)}$ into Eq. (16.1) gives $n_i^* = \frac{\lambda_i \gamma(\mu-1)}{\mu F}$. Computing the total number of varieties in the world, $N = n_1 + n_2$, gives $N^* = \frac{\gamma(\mu-1)}{\mu F}$. Finally, computing region $i's$ share of manufacturing output in world output, $\frac{n_i}{N}$, gives:

$$\frac{n_i}{N} = \frac{\gamma_i}{\gamma} \equiv \lambda_i \tag{16.2}$$

Turning to the goods market, we begin by obtaining the demand for any single variety. We shall do this intuitively in three steps (see Sect. 23.2.1 for the formal derivation of the demand functions).

First, we compute total regional income,

$$E_i = (1-\gamma)/2 + \lambda_i \gamma w_i. \tag{16.3}$$

The first summand is the total farmers' income (recall that farmers' wage is equal to 1), and the second summand is the total workers' income. Second, we recall that expenditure on manufactures is γ times total income, γE_i. Third, quite intuitively, the expenditure share of a single variety in the total expenditure on manufactures depends on the price of that variety relative to the price of the other varieties. To see the latter point more specifically, let P_i be an index (think of it as an average) of the prices of all varieties. Note that the price index bears the regional subscript i. This is because the index contains the price of all varieties, domestic and foreign, and the price applied abroad is $(1/\tau)$ times the domestic price. Therefore, unless regions produce an equal number of varieties, the number of varieties on which residents of region 1 pay the transport cost is different from the number of varieties on which the residents of region 2 pay the transport cost; consequently, the price indices are different. Furthermore, the price index P_i is necessarily decreasing in $\left(\frac{n_i}{N}\right)$ since the larger is $\left(\frac{n_i}{N}\right)$, the smaller is the number of varieties on which residents of i pay transport costs. The price of a variety relative to the average price is (p_{ii}/P_i) or $\left(p_{ji}/P_i\right)$ for a domestic and a foreign variety, respectively. The demand for a single variety is decreasing in such a relative price. The exact functional form of the demand emanating from residents of region i is $\left(\frac{P_i}{p_{ii}}\right)^{\frac{1}{\mu-1}} \gamma E_i$ for any domestic variety and $\left(\frac{P_i}{p_{ji}}\right)^{\frac{1}{\mu-1}} \gamma E_i$ for any foreign variety.[3] It is not surprising to find the mark-up μ in the demand functions. After all, the mark-up reflects the market power of producers, which is related to the rigidity of the demand for any particular variety. Equilibrium in the goods market requires that

$$p_{11}^* q^* = \left(\frac{P_1^*}{p_{11}^*}\right)^{\frac{1}{\mu-1}} \gamma E_1 + \left(\frac{P_2^*}{p_{12}^*}\right)^{\frac{1}{\mu-1}} \gamma E_2, \tag{16.4}$$

[3]See Sect. 23.2.1 for a formal derivation of demand functions from S-D-S preferences.

$$p_{22}^{*}q^{*} = \left(\frac{P_1^*}{p_{21}^*}\right)^{\frac{1}{\mu-1}} \gamma E_1 + \left(\frac{P_2^*}{p_{22}^*}\right)^{\frac{1}{\mu-1}} \gamma E_2. \tag{16.5}$$

On the left hand side of each equation we have the supply and on the right hand side we have the demand. At first sight it seems as if there are many endogenous variables in Eqs. (16.4) and (16.5) but, in fact, there are only two. This is because prices are constant multiples of wages; the price indices contain only λ_i and all prices; the firm's output is only a function of the parameters; and expenditure contains only λ_i and wages as we see in Eq. (16.3). Therefore, for any given λ_i, after substituting the expressions for prices, price indices, output, and expenditure into Eqs. (16.4) and (16.5) we are left with only two endogenous variables, namely, w_1 and w_2 (see Eqs. (30.1)–(30.3) in Sect. 30.1 for details). It is now clear that for any given value of λ_i, Eqs. (16.4) and (16.5) determine w_1 and w_2; but λ_i varies over time as workers migrate. This is what we have to address next.

16.3.1.2 Dynamics

Migration flows give the model a dynamics represented by the evolution of λ_i over time. Let $\dot{\lambda}_i$ be the migration flow into region i at a point in time and take region 1 as the reference region. Migration into region 1 is determined by the real wage difference:

$$\dot{\lambda}_1 = \omega_1(\lambda_1) - \omega_2(\lambda_1) \tag{16.6}$$

where, ω_i, is the real wage in region i given by

$$\omega_i = \frac{w_i}{(P_A)^{1-\gamma}(P_i)^{\gamma}}. \tag{16.7}$$

The notation $\omega_1(\lambda_1)$ and $\omega_2(\lambda_1)$ refers to the fact that real wages are determined by Eqs. (16.4) and (16.5) and, therefore, depend on the value of λ_1. We can see at this point the dynamics of the system.[4,5] At any instant in time the value of λ_1 is given and Eqs. (16.4) and (16.5) determine nominal wages (w_i). Once nominal wages are determined so are prices, price indices, real wages and the real wage

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[4]This migration mechanism implies that migration decisions are taken by comparing current real wage differentials and neglecting the future evolution of real wages. For extensions of the core-periphery model that explicitly take account of expectations on future real wage differentials see Krugman (1991b), Baldwin (2001), and Ottaviano (1999, 2001).

[5]More complex functional forms may be used for Eq. (16.6) but this simple form suffices for our expositional purposes. Note also that it suffices to write only one law of motion since $\lambda_2 = 1 - \lambda_1$ at any time.

differential. The real wage differential in turn determines the migration flow ($\dot{\lambda}_i$) which leads to a new value of λ_i. This new value of λ_i will determine new values of wages via Eqs. (16.4) and (16.5). The new wages give new prices, new price indices and new real wages which in turn will determine a new migration flow and so on until either all workers have moved to one region or real wages have equalized. We refer to the case where all workers are in one region as the core-periphery geographical configuration since the region where all the workers have located hosts the world's manufacturing output (the industrial core) and the other region produces only the agricultural good (the agricultural periphery). There are, obviously, two possible core-periphery configurations, one in which region 1 has the industrial core and the other one where region 2 has it. The case of equalization of real wages is instead referred to as the dispersed geographical configuration since the manufacturing output is produced in both regions. In the remainder of the section we discuss the conditions under which one has, in the long run, the core–periphery outcome or the dispersed outcome.

To understand the economic logic of the circular causation in the model, we shall consider an initial geographical configuration where the two regions are identical, $\lambda_i = 1/2$, and refer to this geographical configuration as a "symmetric configuration". In the symmetric configuration each country is an exact replica of the other. We perturb this configuration by an exogenous change in λ_i and study the mechanisms that lead to a further, this time endogenous, change in λ_i. Consider, for instance, an exogenous increase in λ_i. The direction of the endogenous change in λ_i is determined by the relative strength of three distinct economic mechanisms which we now analyse.

The first mechanism is known as the *demand linkage* and works through the effect that the exogenous change in λ_i has on expenditure. As is clear by inspection of Eq. (16.3), an increase in λ_i causes an increase in total expenditure emanating from region i and a decline in the total expenditure emanating from the other region $\left(E_i \uparrow, E_j \downarrow\right)$. Although these change have the same absolute magnitude the net effect of is an increase in demand for varieties produced in region i and a decline in demand for varieties produced in j. This is easily verified by inspection of Eqs. (16.4) and (16.5) where we should recall that $p_{ij} > p_{ii}$ and that at the symmetric equilibrium $E_1 = E_2$ and $P_1 = P_2$. We have already encountered this effect in Sect. 9.2.4 where we dubbed it "home market dominance". In the present context, the circular causation between size of demand and location of firms makes that the home market dominance gives rise to the demand linkage. Indeed, since demand increases in i and declines in j, manufacturing prices increase in i and decline in j. With the wage being a constant proportion of the price that the manufacturing wage increases in i and declines in j. Therefore, ceteris paribus, the real wage differential $\left(\omega_i - \omega_j\right)$ increases inducing further migration into region i (λ_i increases endogenously).

The second mechanism is known as the *cost of living linkage* and works as follows. The initial perturbation in λ_i brings about an increase in region $i's$ share of the total number of varieties $\left(\frac{n_i}{N} \uparrow\right)$ which, in turn, causes a decline of the

Table 16.1 Agglomeration and dispersion mechanisms in the core-periphery model

Perturbation $\lambda_i \uparrow$		
Effect	Result	Channel
$E_i \uparrow, E_j \downarrow$	$\lambda_i \uparrow$	*Demand linkage*
$\frac{n_i}{N} \uparrow \rightarrow \left(P_i \downarrow, P_j \uparrow\right)$	$\lambda_i \uparrow$	*Cost of living linkage*
$\frac{n_i}{N} \uparrow$	$\lambda_i \downarrow$	*Market crowding*

price index in region i and an increase of the price index in the other region $\left(P_i \downarrow, P_j \uparrow\right)$. Therefore, other things equal, the real wage differential $\left(\omega_i - \omega_j\right)$ increases inducing further migration into region i (λ_i increases).

The third mechanism is known as *market crowding* and works through the competition among firms for regional demand. The increase $\left(\frac{n_i}{N} \uparrow\right)$ brought about by the perturbation ($\lambda_i \uparrow$) intensifies the competition for a given amount of expenditure in region i while relaxing it in region j. Therefore, prices tend to fall in region i and tend to increase in region j. Given that the wage is a constant proportion of prices, the real wage differential $\left(\omega_i - \omega_j\right)$ declines which induces migration into region j (λ_i decreases endogenously).

The schematic representation given in Table 16.1 summarizes the causal chain of the three mechanisms.

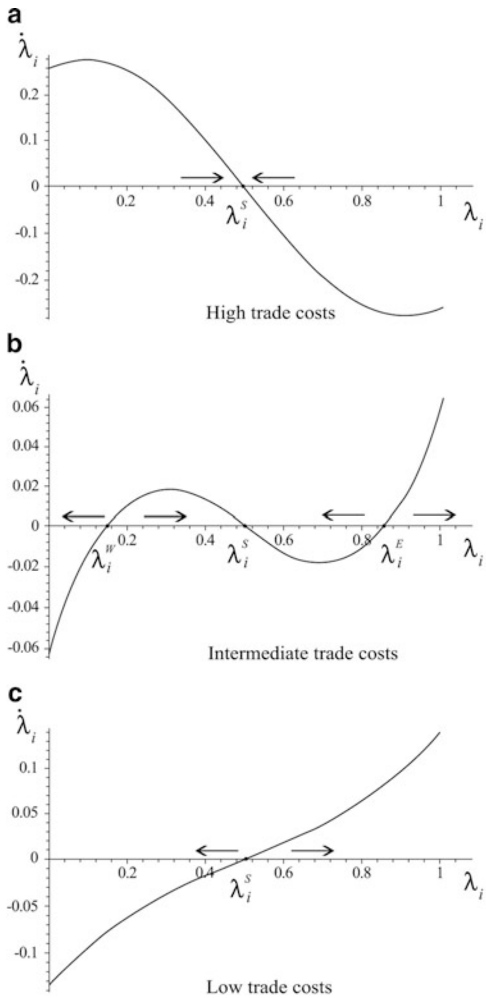
The demand linkage and the cost of living linkage push λ_i in the same direction of the perturbation. They are agglomeration mechanisms since they push the economy towards either of the core-periphery configurations. The market crowding effect pushes λ_i in the opposite direction from the perturbation. This is a dispersion mechanism since it pushes the economy towards the symmetric configuration.

The relative strength of these three mechanisms determines the actual direction taken by λ_i after the perturbation. Whether agglomeration or dispersion prevails in the long run depends on the value of three key parameters in the model: the transport cost (represented by $1 - \tau$), the intensity of appreciation for variety per se (reflected by μ), and the share of the manufacturing sector in world output (represented by γ). In the next sub-section we shall focus on the effect of transport costs. The reason for this interest is that changes in trade costs may be taken to represent changes in the degree of market integration, which is one of the principal subjects of investigation in international trade and regional economics and is a matter of great policy relevance.

16.3.1.3 Market Integration and Industrial Localization

We now discuss the principal result of the core-periphery model. For sufficiently high trade costs, the agglomeration mechanisms are weaker than the dispersion mechanism and the dispersed configuration emerges in the long run. For sufficiently low trade costs, the balance is reversed and one of the core-periphery configurations emerges in the long run. For intermediate levels of trade costs, there exist multiple possible long run configurations. Figure 16.1 shows three representative situations.

Fig. 16.1 Phase diagram of the core-periphery model



The figure plots $\dot{\lambda}_i$ against λ_i in the three cases of "high" trade costs (panel *a*), "intermediate" trade costs (panel *b*), and "low" trade costs (panel *c*).[6] The diagram in each panel is called the phase diagram, the line in the diagram is called the phase line and the arrows above the abscissa indicate the directions of motion of λ_i over time. Note that Eq. (16.6) tells us that $\dot{\lambda}_i$ is equal to the real wage difference. Therefore, the phase line also represents the real wage difference plotted

[6]The model determines the two values of τ that divide the set $(0, 1)$ into the three segments corresponding to 'high', 'intermediate' and 'low' trade costs. See Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud (2003) for an exhaustive treatment of this matter.

against λ_i. Since the non-linearity of the model does not allow solving explicitly for the endogenous variables the phase line is obtained by numerical solutions. [7] Whenever the phase line is above the horizontal axis, the real wage is higher in region i and therefore workers will move towards that region (λ_i increases). Conversely whenever the phase line is below the horizontal axis the real wage is lower in region i and workers move towards region j (λ_i decreases).[8]

Consider first the case of high trade costs. The economy is initially in the symmetric configuration (λ_i^S) and is perturbed by an exogenous change in λ_i. No matter the direction and the size of the exogenous perturbation, the dynamics of the economy will bring λ_i back to the symmetric configuration. We conclude that for high trade costs the symmetric configuration is the only stable spatial configuration and, therefore, the world economy will be one where economic activity is dispersed.

Consider now the case of intermediate trade costs (panel b). Now the size of the exogenous perturbation matters. If the perturbation puts λ_i somewhere between λ_i^W and λ_i^S or between λ_i^S and λ_i^E, the dynamics of the economy will bring λ_i back to the symmetric configuration (the superscripts stand for East and West). If, instead, the exogenous perturbation is large such as to put λ_i between 0 and λ_i^W or between λ_i^E and 1, the dynamics of the economy will bring λ_i to 0 or 1, respectively. We conclude that, for intermediate trade cost, there are three stable spatial configurations: the two core-periphery configurations ($\lambda_i = 0$ and $\lambda_i = 1$) and the symmetric configuration ($\lambda_i = \lambda_i^S$).

Lastly, consider the case of low trade cost. In such a case the size of the perturbation does not matter. Any perturbation will bring the economy to one of the core-periphery configurations.

16.3.2 Conclusion

The core-periphery model is indeed very simple. Its simplicity has the merit of highlighting the key mechanisms that determine whether an industry agglomerates. All the mechanisms are endogenous and driven by the effect of migration on aggregate regional demand, on the price indices and on the demand for variety.

In the following sections we shall review some of the theoretical developments that have followed the core-periphery model.

[7] This is typical of many new economic geography models. See Ottaviano (2001) and Forslid and Ottaviano (2003) for explicitly solvable models. The appendix to this chapter provides an elementary guide to numerical solutions and calibrations.

[8] We are informally using a topological method for stability analysis. For a formal treatment of such a method see Gandolfo (2009, chap. 21, sect. 21.3.1).

16.4 Other Models

In this section, we review four variants of the core-periphery model. The first assumes the presence of a congestion force driven by the price of housing, the second introduces input-output linkages, the third highlights the role of diminishing returns to labour input in the agricultural sector and in the fourth the fixed cost is represented by a fixed input of mobile capital.

16.4.1 Housing Congestion

In this section we present the model developed by Helpman (1998) where the availability of a fixed stock of housing in each region gives rise to an additional force of dispersion. As people move into a region, housing becomes scarcer and its price increases thereby discouraging further inflow of migrants. Housing in this model stands in fact for any fixed stock of a non-tradeable resource. For clarity of exposition we refer to such a resource as housing.

16.4.1.1 Description of the Model

The world economy is composed of two regions indexed by $i = 1, 2$. Labour is the only one factor of production and the world endowment of labour is $\overline{L}$. Labour may migrate and $\lambda_i \equiv L_i/\overline{L}$ is the percentage of the world labour stock located in region i at any point in time. Consumers derive utility from consumption of a manufactured good, M, and from housing services (H). They spend a fraction γ of their income on good M and the remaining fraction on H. Profit-maximizing prices, equilibrium output, and demand functions in industry M are exactly as in the core-periphery model. So is the equilibrium condition in the labour market, $L_i = n_i\,(F + cq^*)$, from which we obtain

$$\frac{n_i}{N} = \frac{L_i}{\overline{L}} \equiv \lambda_i. \tag{16.8}$$

The only difference with the core-periphery model so far is that housing replaces good A and that there is no immobile factor of production. Each region is endowed with a constant stock of "Housing", labelled H_i. Given that consumers spend a proportion $(1-\gamma)$ of total expenditure on housing, the equilibrium price of H is given by

$$P_i^H = \frac{(1-\gamma)\,E_i}{H_i}. \tag{16.9}$$

Total expenditure is the sum of labour income and income from local housing services $E_i = w_i \lambda_i \overline{L} + P_i^H H_i$. Replacing P_i^H in this expression gives

$$E_i = \frac{w_i \lambda_i \overline{L}}{\gamma}. \tag{16.10}$$

Equilibrium in the goods market gives conditions identical to Eqs. (16.4) and (16.5).

16.4.1.2 Dynamics

Migration flows are determined by real wage differences between regions and the real wage is

$$\frac{w_i}{\left(P_i^H\right)^{1-\gamma} (P_i)^{\gamma}}. \tag{16.11}$$

The main difference between the core-periphery model and the present model is apparent by comparing expression (16.11) with expression (16.7). In the core-periphery model, since the price of A is constant, only the price of manufactures matters for the purchasing power. In the present model the price of housing is not constant and therefore both prices matter. This gives rise to an additional circular causation mechanism since the price of housing in a region depends on the expenditure emanating from that region, as shown by expression (16.9). To understand this mechanism, consider again an exogenous perturbation that increases λ_i starting from the symmetric geographic configuration. Such a change in λ_i causes an increase in total expenditure emanating from region i and a decline in that of region j as shown by expression (16.10). Since expenditure on housing is $(1 - \gamma)$ times total expenditure, the demand for housing in region i increases and decreases in region j. Therefore, P_i^H increases and P_j^H decreases, as shown by expression (16.9). As a result, ceteris paribus, we see from expression (16.11) that the real wage increases in j and declines in i, thus pushing labour to return in region i. This mechanism, which we may label the *cost of housing linkage*, is clearly a dispersion mechanism since it pushes λ_i in the opposite direction to that of the exogenous change.[9] The three mechanisms of the core-periphery model are in action in the present model too. Table 16.2 summarizes the causal chain of the four mechanisms.

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[9]Since housing services are part of total consumption the cost of housing is part of the total cost of living. To keep terminology close to the literature, however, we continue to refer to the cost of living linkage as to the linkage driven by the price index of manufactures, P_i. We refer instead to the cost of housing linkage as to the linkage driven by the price of housing, P_i^H.

Table 16.2 Agglomeration and dispersion mechanisms in the housing congestion model

Perturbation $\lambda_i \uparrow$		
Effect	Result	Channel
$E_i \uparrow, E_j \downarrow$	$\lambda_i \uparrow$	*Demand linkage*
$E_i \uparrow, E_j \downarrow \rightarrow \left(P_i^H \uparrow, P_j^H \downarrow\right)$	$\lambda_i \downarrow$	*Cost of housing linkage*
$\frac{n_i}{N} \uparrow \rightarrow (P_i \downarrow, P_j \uparrow)$	$\lambda_i \uparrow$	*Cost of living linkage*
$\frac{n_i}{N} \uparrow$	$\lambda_i \downarrow$	*Market crowding*

16.4.1.3 Market Integration and Industrial Localization

Market integration gives different results from those of the core periphery model. First, if the expenditure share on housing is large, the cost of housing linkage is so strong that dispersion mechanisms always prevail on agglomeration mechanisms. In this case, the symmetric configuration ($\lambda_i = 1/2$) is the only stable spatial configuration for any value of trade costs. This means that market integration has no impact on localization of industries. If the expenditure share on housing is not very strong, agglomeration mechanisms prevail on dispersion mechanism for values of λ_i near the symmetric equilibrium, but the opposite occurs for values of λ_i far from the symmetric configuration. Another way of stating this result is that when the expenditure share on housing is small, agglomeration mechanisms prevail for low levels of agglomeration while dispersion mechanisms prevail for high degrees of agglomeration. This result is quite intuitive: as agglomeration progresses, the cost of housing linkage becomes stronger and eventually prevails on agglomeration mechanisms. The increase in the strength of the cost of housing linkage can be seen from Eqs. (16.10), (16.9), and (16.11) in the following way. Consider increasing levels of agglomeration towards region j. That means that λ_i decreases and approaches zero. Then, as we see from Eq. (16.10) expenditure in region i approaches zero and so does the price of housing as we see from Eq. (16.9). Consequently, as we see from Eq. (16.11) the real wage in i approaches infinity eventually attracting workers back to region i.

Market integration in this model has a reversed effect with respect to the core-periphery model. When trade costs are very low or zero, the cost of housing linkage prevails. Thus, for low trade cost, the symmetric configuration is the only stable spatial configuration. For high trade cost and if the expenditure share on housing is not too large, the symmetric configuration is unstable but there is one stable spatial configuration characterized by partial agglomeration on either side of the symmetric configuration (λ_i^W and λ_i^E).

These results are summarized in Fig. 16.2. Panel (a) shows the phase line in the case of high expenditure share on housing or low trade cost. Panel (b) shows instead the case of low expenditure share on housing and high trade costs. In either case the phase line approaches infinity when λ_i approaches 0 and approaches minus infinity when λ_i approaches 1. In the case depicted in Panel (b), the lateral configurations, λ_i^W and λ_i^E, are stable while the symmetric equilibrium λ_i^S is unstable and partial

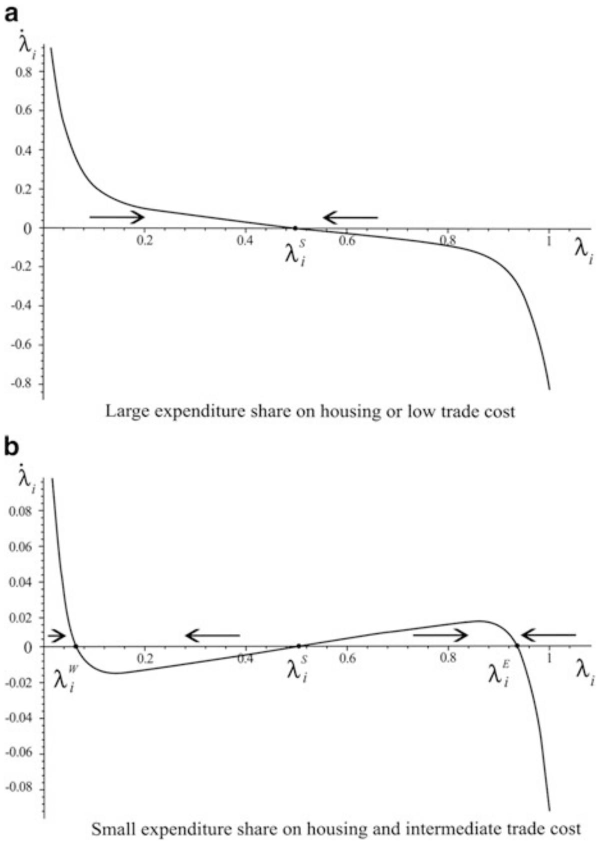

Fig. 16.2 Phase diagram under different expenditure shares on housing: Panel (**a**) high expenditure share; panel (**b**) low expenditure share

agglomeration occurs. Interestingly, the partial agglomeration configuration is one where population is unevenly distributed between regions despite the fact that the same amount of housing is available in both. As trade costs increase, the two lateral stable configurations λ_i^W and λ_i^E approach 0 and 1, respectively.

16.4.2 Input-Output Linkages

So far we have studied models where agglomeration and dispersion mechanisms were driven by migration. This may give the wrong impression that migration is a necessary assumption. We present here the model developed by Krugman and Venables (1995) where the assumption of factors migration is replaced by the presence of input-output linkages.

16.4.2.1 Description of the Model

The world is composed by two regions indexed by $i = 1, 2$. Labour (L) is immobile between regions and is used in both sectors. Production of A requires only labour and industry A is the same as in the core-periphery model. The production of any variety of good M requires instead a composite input Z produced by use of L and an aggregate of all varieties of M. Thus, part of the output of M is used as an intermediate input in the production of each variety of M.[10] To simplify matters we assume that each region is endowed with enough labour to potentially produce the world output of M and also some A. The convenience of this assumption is that both countries produce A in any geographic configuration. Thus, the price of A equalizes between countries and so does the wage in the A industry which we then normalize to unity, i.e., $w_{A1} = w_{A2} = 1$. The technology of production in M exhibits increasing returns to scale; specifically, it requires a fixed input (of Z) equal to F and c units of Z per unit of output. The requirement of Z per q units of output is therefore $F + cq$. The intermediate input Z is produced inside the firm and its technology is such γ_F is the optimal fraction of total cost represented by purchase of M and $(1 - \gamma_F)$ is the fraction representing the cost of L. The marginal cost of producing any variety increases with the wage paid in the M industry, w_{Mi}, and with the price index of manufactures, P_i. Any variety of M is traded internationally at iceberg costs. Let L_{Ai} and L_{Mi} denote employment in the A and M industry, respectively. National income is $I_i = w_{Ai}L_{Ai} + w_{Mi}L_{Mi}$. Consumers spend a fraction γ of their income on manufactures and the remaining fraction on good A. Firms spent a proportion γ_F of total cost on M but since profits are zero total costs equal total revenues. Aggregate revenue in the economy is $n_i p_{ii} q_i$. Thus, aggregate regional expenditure on M emanating from region i is

$$E_{Mi} = \gamma I_i + \gamma_F n_i p_{ii} q_i. \tag{16.12}$$

16.4.2.2 Dynamics

We begin by noting that world employment in the manufacturing industry, L_M, is constant, since world expenditure on the manufacturing industry is a constant fraction of total income, the latter being constant too. Since individual firm output is constant the total number of varieties, N, is constant too and in fixed proportion to L_M. We denote region i's share of the total employment in manufactures by $\lambda_{Mi} \equiv L_{Mi}/L_M$ and region i's share of the total number of varieties by $\eta_i = n_i/N$. Clearly, $\lambda_{Mi} = \eta_i$. Labour is assumed to move to the industry where the wage is the highest. We can therefore write the intersectoral labour flows as $\dot{\lambda}_{Mi} = w_{Mi} - w_{Ai}$, with

[10] See Alonso-Villar (2005) for an extension to this model where there are input-output linkages between two manufacturing industries and trade costs differ between industries.

Table 16.3 Agglomeration and dispersion mechanisms in the I-O linkages model

Perturbation $\eta_i \uparrow$		
Effect	Result	Channel
$E_i \uparrow, E_j \downarrow$	$\eta_i \uparrow$	*I-O demand linkage*
$P_i \downarrow, P_j \uparrow$	$\eta_i \uparrow$	*I-O marginal cost linkage*
$\frac{n_i}{N} \uparrow$	$\eta_i \downarrow$	*Market crowding*

$i = 1, 2$. The symmetry of the model implies that we may write the intersectoral labour flows in a single equation as follows:

$$\dot{\lambda}_{Mi} = w_{Mi}(\lambda_{Mi}) - w_{Mj}(\lambda_{Mi}), \tag{16.13}$$

where the notation $w_{Mi}(\lambda_{Mi})$ recalls that manufacturing wages depend on λ_{Mi}. We may now analyze the three mechanisms at work. Again, for clarity of exposition, we consider an exogenous perturbation to the symmetric geographic configuration, $\lambda_{Mi} = 1/2$, and study the causal chain it triggers. A change in λ_{Mi} causes an identical change in η_i and the latter sets in motion three mechanisms.

The first is a demand linkage and is conveyed by firms' expenditures on manufactures. We refer to it as the *I-O demand linkage*. An increase in η_i brings about an increase in total demand emanating from region i due to the increase in aggregate firm expenditure (see expression (16.12) and note that $n_i = \eta_i N$). A corresponding decline in aggregate expenditure takes place in region j. The net effect is an increase in demand for any variety produced in region i due to the home market dominance already discussed above and in Sect. 9.2.4. As a result, η_i increases further.

The second mechanism is a cost linkage and we refer to it as the *I-O marginal cost linkage*. An increase in η_i causes a reduction in total cost for firms located in region i, since the number of varieties on which they pay transport costs when purchasing M declines (P_i declines). Exactly the opposite happens in region j. This makes profitability higher in i and smaller in j and causes firms to enter i and exit from j, i.e., a further increase in η_i.

The third mechanism is the same *market crowding effect* studied in the core-periphery model, pushing firms towards the smaller market. The three mechanisms are summarized in Table 16.3.

16.4.2.3 Market Integration and Industrial Localization

The I-O Demand Linkage and the I-O Cost Linkage are agglomeration mechanisms while the Market Crowding effect is a dispersion mechanism. The balance between these mechanisms depends on trade costs. Similarly to the core-periphery model, for high trade costs the symmetric equilibrium is the only stable spatial configuration; for intermediate trade cost the symmetric equilibrium and the core-periphery configurations are stable; for low trade cost only the core-periphery configurations are stable. The phase diagram for this model is qualitatively identical to that in Fig. 16.1.

Table 16.4 Agglomeration and dispersion mechanisms in the model with diminishing returns to labour in A

Perturbation: $\eta_i \uparrow$		
Effect	Result	Channel
$E_i \uparrow, E_j \downarrow$	$\eta_i \uparrow$	*I-O demand linkage*
$P_i \downarrow, P_j \uparrow$	$\eta_i \uparrow$	*I-O marginal cost of linkage*
$\frac{n_i}{N} \uparrow$	$\eta_i \downarrow$	*Market crowding*
$w_i \uparrow, w_j \downarrow$	$\eta_i \downarrow$	*Labour cost linkage*

16.4.3 Diminishing Returns to Labour in the A Sector

We present here a simplified version of the model proposed by Puga (1999) and characterized by the presence of diminishing returns to labour in the agricultural industry. Recall that in the core-periphery model, the production of A requires only labour (farmers). In the present model it is assumed instead that the A sector uses land (T) and labour (L) as inputs. Factor T is used only in industry A. Industry M uses a composite input produced by use of labour and the aggregate of all varieties of M as in the I-O linkages model of Sect. 16.4.2. Since labour is perfectly mobile between sectors the wage is the same in both industries within a region and is determined by its marginal productivity in industry A. The production technology of A is such that labour marginal productivity is increasing in the land/labour ratio, T_i/L_{Ai}. This model structure generates a new dispersion mechanism channeled by the change in the marginal productivity of labour in A whenever firms move from one region to the other.[11]

To understand this mechanism, consider again a perturbation to the symmetric geographic configuration that exogenously increases the number of firms in region i. The firm moving from region j to i releases labour in j and demands labour in i. Absent migration, the new demand for labour in i must be satisfied by drawing labour from industry A. As a result the ratio T_i/L_{Ai} increases and so does w_i. Exactly the opposite happens in region j, where the labour released by the firm is employed in industry A, the ratio T_j/L_{Aj} decreases and so does w_j. The marginal cost of producing in region i increases therefore whenever a new firm enters region i and the opposite happens in region j. This *labour cost linkage* is a dispersion mechanism since the changes in marginal cost push firms to migrate in the direction opposite to that of the exogenous perturbation. This dispersion mechanism exists even for zero trade costs. The other three mechanisms in the model are the same as those already studied in Sect. 16.4.2. The four mechanisms in this model are summarized in Table 16.4.

[11] See Nocco (2005) for an extension of this model where there are endogenous differences in technology levels due to interregional knowledge spillovers.

16.4.3.1 Market Integration and Industrial Localization

When trade costs are very high, the symmetric configuration is the only stable configuration. For intermediate trade costs, partial or complete agglomeration are stable configurations. For low trade costs, the benefit from being located in a large market is outweighed by the cost of paying high wages. Thus, firms always prefer to move to the location with smaller number of firms when trade costs are low or zero. As a result, in the early stage of economic integration (i.e., from high to intermediate trade costs) agglomeration emerges but as economic integration progresses (low trade cost) the world economy returns to its dispersed initial geographic configuration.

16.4.4 Footloose Capital

We present here the model developed in Martin and Rogers (1995). This model is known as the footloose capital model, and its central assumption is that capital may migrate but profits are repatriated. In this way, the expenditure in each region is constant with respect to the migration of capital and, therefore, there is no circular causation between migration and size of the market. The assumption of profit repatriation eliminates any agglomeration force and makes the model static in nature. This notwithstanding, the footloose capital model has been developed and used in the context of the economic geography literature and we therefore review it here.

16.4.4.1 Description of the Model

The world is composed of two regions indexed by $i = 1, 2$. Two factors, capital (K) and labour (L), produce two goods.[12] Capital may migrate between regions, labour may not. Good A is produced in perfect competition with a constant returns to scale technology which requires one unit of labour input to produce one unit of output. Furthermore A is chosen as the numéraire good and its price is set to 1. Good A is traded freely between regions and, as long as both countries produce some A (as we assume to be the case), the price of A is the same between regions.[13] Given the technology in industry A wages equalize too: $w_1 = w_2 \equiv w$. Good M is differentiated and produced in monopolistic competition with an increasing returns to scale technology which requires one unit of capital as fixed input and c

[12] Capital exists in a fixed stock and cannot be accumulated. The number of varieties is constant too. See, e.g. Martin and Ottaviano (1999, 2001) and Baldwin, Martin, and Ottaviano (2001) for interesting developments which link the new economic geography to endogenous growth theory.

[13] The condition for both countries being producers of A in any geographic configuration is that industry M is small enough to fit in one country.

units of labour per unit of output. Let π_i^o be the price of capital and w the price of labour. Total cost is $\pi_i^o + wcq_i$ where q_i is total firm output. As usual, we assume the presence of iceberg trade costs in M by which only a fraction $\tau \in (0, 1)$ of each unit sent from region i arrives at region j. Profit maximizing prices depend only on marginal cost (and not on fixed cost). The domestic price is $p_{ii}^* = \mu cw$ and the foreign price $p_{ij}^* = (1/\tau)\, p_{ii}^* > p_{ii}^*$. The total profit is $\Pi = pq_i - \pi_i^o - wcq_i$. Unlike the monopolistic competition models examined earlier, the presence of positive profits cannot bring about any entry since the number of firms is determined by the stock of capital. Here, any positive profit is entirely absorbed by the price of capital; that is, $\pi_i^o = p_{ii}q_i - wcq_i$, hence the price of capital coincides with the operating profits of the firm (hence the superscript ^{o}).[14] Substituting $wc = p_{ii}/\mu$ into $p_{ii}q_i - wcq_i$ gives the price of capital as function of firm total sales, $p_{ii}q$:

$$\pi_i^o = \frac{\mu - 1}{\mu} p_{ii} q_i. \tag{16.14}$$

The structure of demand is the same as in the models studied above. Consumers derive utility from consumption of both goods and spend a fraction γ of their income on good M and the remaining fraction on good A. Let s_{Li} and s_{Ki} be, respectively, the share of world stocks of L existing in i, and the share of the world stock of K owned by residents of region i. Region i's income is:

$$E_i = s_{Li}\bar{L}w + s_{Ki}\bar{K}\pi_i \tag{16.15}$$

Capital may move across regions and K_i represents the quantity of capital present in region i. The reward to capital, π_i^o, is repatriated by the capital owners. Therefore income from capital in region i is $s_{Ki}\bar{K}\pi_i$ regardless of the localization of capital.

The sub-utility derived from consumption of M takes the S-D-S form examined in Eq. (9.2). The resulting equilibrium conditions in the goods market are the same as in Eqs. (16.4) and (16.5) with expenditure given by expression (16.15).

16.4.4.2 Equilibrium

Since it takes one unit of capital to set-up a firm, the number of firms in the world, N, equals the stock of capital $\bar{K}$ and region i's share in the total number of firms, n_i/N, equals the region's share in total capital located in it, $K_i/\overline{K}$. Labour is immobile between regions and each country is endowed with L_i units of it, the world stock of labour is constant at $\overline{L} = L_1 + L_2$. The migration of capital makes that operating profits equalize, that is,

$$\pi_1^o = \pi_2^o \tag{16.16}$$

[14]Perfect competition in the labor market makes it impossible for w to rise.

Capital migration is assumed to be instantaneous so that Eq. (16.16) holds at any time. Unlike the other models in this chapter, in the footloose capital model there is no dynamic adjustment but this is not important since this model has a unique stable equilibrium. The reason for this uniqueness and stability is, as anticipated above, that the expenditure emanating from a region is independent of the migration of capital (see Eq. 16.15).

The solution of the model yields the equilibrium profit, the size of the firm, and the distribution of capital between regions.[15] It is useful to show the solution for the share of firms (equal to the share of capital) in a region using the definition $\eta_i \equiv n_i/N$. This solution is:

$$\eta_i^* = \frac{1}{2} + \frac{1+\phi}{1-\phi}\left(\frac{E_i}{E} - \frac{1}{2}\right), \tag{16.17}$$

where ϕ is a parameter related to trade cost and ranging from 0 to 1. When $\phi = 0$, trade costs are prohibitive, when $\phi = 1$ trade costs are zero. It is immediate by inspection of expression (16.17) that the footloose capital model exhibits the home market effect already encountered in Sect. 9.2.4. In fact, since $\frac{1+\phi}{1-\phi} > 1$ whenever $0 < \phi < 1$, the larger region has a more than proportionally larger share of manufactures whenever trade is costly but not prohibitively costly. This model may be seen more as a variant of the monopolistic competition model of international trade studied in Sect. 9.2.1 than as a new economic geography model, but the assumption of migration makes it suitable to study issues related to market integration and location of industries. Furthermore, the model is particularly useful to highlight some issues related to welfare and for this reason we shall use it in Sect. 16.5 below.

16.5 Too Much or Too Little Agglomeration?

We have seen above that new economic geography models give rise to a rich set of stable geographic configurations. In this section we address the question of whether these configurations are socially optimal. There are probably as many, if not more, answers to this question as there are models. The reason is that the number, positions, and stability of the geographic configurations are often sensitive even to minor model modifications. Further, the various criteria that can be used to asses whether a geographic configuration is socially optimal often give contrasting results. We therefore do not go into a taxonomy of welfare analysis. We focus instead on a

[15]To solve the model note that aggregate operating profit in the world economy is $N\pi^o$ where the subscript i is suppressed since $\pi_1^o = \pi_2^o$. By virtue expression (16.14), $N\pi^o$ is equal to the fraction $(\mu - 1)/\mu$ of world sales. World sales are equal to world expenditure which in turn is equal to world income. Furthermore, $N = \overline{K}$. Therefore we have the equation $\overline{K}\pi = \frac{\mu-1}{\mu}\gamma\left(L + \overline{K}\pi\right)$. From this equation we obtain π^* and all the other endogenous variables.

simple and insightful case where the geographic configuration determined by market forces is not socially optimal. To illustrate this case we follow Baldwin et al. (2003, sect. 11.2.4) and use the footloose capital model.

The socially optimal outcome is the one that maximizes social welfare defined here as the sum of purchasing power (indirect utility) across all individuals in the world. We assume that the "social planner", the imaginary figure who maximizes social welfare, does it by choosing η_i. The socially optimal value of η_i turns out to be

$$\eta_i^S = \frac{1}{2} + \frac{1+\phi}{1-\phi}\left(S_{Pop,i} - \frac{1}{2}\right) \tag{16.18}$$

where $S_{Pop,i} \equiv (K_i + L_i)/\left(\overline{K} + \overline{L}\right)$ is region i's share in the world population. We observe that the social planner would allocate the manufacturing industry between regions according to the regions' relative population. The larger the population in region i, the larger the share of manufacturing output allocated to that region. We also observe that the planner allocates the manufacturing activity to a region in a more than proportional relationship with the region's share of the population since $\frac{1+\phi}{1-\phi} > 1$. Baldwin et al. (2003) refer to this result as to the Social Home Market Effect paralleling the terminology used in Sect. 9.2.4.

To answer the question raised in the title of this section it suffices to compare η_i^* with η_i^S by use of expression (16.17) and (16.18):

$$\eta_i^* - \eta_i^S = \frac{1+\phi}{1-\phi}\left(\frac{E_i}{E} - S_{Pop,i}\right). \tag{16.19}$$

Expression (16.19) shows that, unless $\frac{E_i}{E} = S_{Pop,i}$, the market outcome is not optimal. There is either too much agglomeration (when $\frac{E_i}{E} > S_{Pop,i}$) or too little agglomeration (when $\frac{E_i}{E} < S_{Pop,i}$). Recalling the expressions for expenditure and population shares the condition for optimality is

$$\frac{L_i + K_i\pi^*}{\overline{L} + \pi^*\overline{K}} = \frac{L_i + K_i}{\overline{L} + \overline{K}}. \tag{16.20}$$

Therefore, except for the knife edge cases where $\pi^* = w$ or where $L_i/K_i = \overline{L}/\overline{K}$, the market outcome is not socially optimal. Further, the market allocates too many manufacturing firms to the larger region if and only if the larger region has a higher per capita income.

The analysis in this section is simple and insightful but, as recalled above, welfare results are sensitive to the model assumptions. For further welfare analysis using different models and different criteria see, e.g., Trionfetti (2001), Ottaviano, Tabuchi, and Thisse (2002), Baldwin et al. (2003), Ottaviano and van Ypersele (2005), Charlot, Gaigne, Robert-Nicoud, and Thisse (2006), and Ottaviano and Robert-Nicoud (2006).

Box 16.1 A Bird's-Eye View of Agglomeration

Satellite photographs of earth taken at night show the geographical distribution of artificial light. The presence of artificial light reveals the presence of human settlements which, in turn, implies the presence economic activity. Thus, the presence and density of artificial lights may be taken to reveal the presence and density of economic activity. Obviously, this is far from a precise way of measuring the agglomeration of economic activity, but has the advantage of revealing a lot of information at a glance.

The pictures speak clearly: even taking account of natural obstacles to human activity, such as deserts, ice, or high mountains, it is quite clear that human activity is unevenly distributed on the geographical space.

Europe and Africa

Asia and Oceania

North America

South America

Taking North America, for instance, we see that the lights are more densely present in the East than in the West, thus revealing a high concentration of economic activity in the East relative to the West. Taking smaller geographical units still reveals the presence of some agglomeration. For instance, within the East of North America human activity is concentrated in areas on the Southern shores of the Great Lakes and on the Boston-Washington strip.

The fact that economic activity is unevenly distributed does not tell us anything about the determinants of such an agglomeration. In this chapter we have studied the literature that highlights the role of endogenous agglomeration and dispersion mechanisms but there may be other and equally plausible explanations for the observed patterns of agglomeration. One such explanation is sheer chance. Think of throwing darts at a dartboard; the resulting distribution of darts will most likely exhibit some agglomeration pattern which would be the result of chance. Similarly, economic activity could settle randomly on the available land, yet such randomness could exhibit some agglomeration patterns (see Gabaix, 1999; Ellison & Glaeser, 1997). Another plausible determinant is represented by the presence of exogenous differences between location which make some of them objectively more attractive then others. Interestingly these differences in attractiveness could be such as to be relevant only at some point in history and yet such as to give rise to agglomeration patterns that persist throughout millennia. For instance, many major cities in the world today were founded near a river in ancient times. Proximity to a river was important then but its importance has faded away with time. Yet, most of these cities are at the heart of agglomerated areas still today (see Davis & Weinstein, 2002, 2008).

16.6 Conclusion

The NEG literature has evolved very rapidly but it may be argued that is still in search of a unified framework. The theoretical results obtained from the NEG are very sensitive to the models assumptions and even within a single model the sensitivity of the results to parameter values makes it difficult to draw general conclusions. This sensitivity becomes a true difficulty when it comes to drawing conclusions on welfare, or when prescribing policy recommendations, and when trying to assess the empirical validity of NEG models.

Policy research has so far addressed specific issues exploiting some, probably robust, features of NEG models. For instance, Martin and Rogers (1995) have studied the effect of infrastructure policy and Brülhart and Trionfetti (2004) have studied the effect of home-biased public procurement on international specialization and on agglomeration. Other papers have investigated some distinguishing features of NEG models that appear in tax competition. For instance, Baldwin and Krugman (2004) study the effect of agglomeration rents on tax competition. Agglomeration rents may be seen in Fig. 16.1, panels (b) and (c). The value of the phase line for $\lambda_i = 1$ (or $\lambda_i = 0$) is the real wage difference between regions. It is a rent for workers in the core in the sense that there are no endogenous economic mechanisms that erode it. This rent is taxable. The core region may tax local workers (or firms) as much as the rent without causing their departure. This possibility gives rise to a type of tax competition which would not emerge in the absence of agglomeration rents. Further works on tax competition and economic geography include Ludema and Wooton (2000), Kind, Midelfart-Knarvik, and Schjelderup (2000), Andersson and Forslid (2003), Brülhart and Jametti (2008), Brülhart and Parchet (2011), and

Brülhart, Jametti, and Schmidheiny (2012). Trionfetti (2012) studies instead the effect of public debt policies on economic geography and on tax competition.

The market structure typically used in new economic geography models is monopolistic competition. However, as noted by Neary (2001), this market structure limits the amplitude of the strategic behaviour of firms in relation to location decisions. Combes (1997) was the first to study this matter by replacing monopolistic competition with Cournot oligopoly. More recently, Combes and Lafourcade (2011) evaluate the role of competition and input–output market access in shaping the geography of economic activity. Annicchiarico, Orioli, and Trionfetti (2012) study instead the link between competition policy and market integration and their effect on firms location in the context of Cournot oligopoly.

Empirical investigation has started with some delay and still comprises only a few works. Crozet (2004) verifies the empirical validity of the cost of living linkage and estimates the parameters of the core-periphery model, finding strong support for it. One of the distinguishing features of NEG models is the presence of multiple equilibria. Thus, Davis and Weinstein (2002, 2008) search for empirical evidence of the existence multiple equilibria. The logic of their study may be understood with reference to Fig. 16.1, panel (b) where a large enough perturbation of the symmetric configuration will eventually move the economy towards a stable configuration different from the initial one. One of their findings is that even after a large and exogenous perturbation to the initial configuration (the allied bombing to Japanese cities) the economy returns to its initial geographic configuration. This means no evidence of the existence of multiple equilibria.

Redding and Sturm (2008) verify the empirical validity of the housing congestion model studied above. They study the distribution of economic activity in Western Germany before and after the sudden trade opening between East and West Germany occurred with the fall of the iron curtain. They find that after the trade opening economic activity in the former West Germany has relocated towards the former East/West border. This is coherent with the model. Brülhart, Carrère, and Trionfetti (2012) study the effect of the fall of the iron curtain on the geographical distribution of economic activity and on wage differences between Austrian regions. They find a good adherence of the model to the data especially when heterogenous preferences for locations are added to the housing congestion model. For a comprehensive appraisal of the empirical literature, see Redding (2010).

The new economic geography has come a long way since Krugman's seminal paper. Yet, as argued by Behrens and Robert-Nicoud (2010), further major breakthroughs will probably be achieved only by facing the hard questions. Two such questions concern iceberg costs and the use of numerical solutions. Iceberg costs are omnipresent and crucial but clearly a fiction. Numerical solutions are necessary in NEG models but given the large number of parameters they give rise to a large taxonomy of cases from which it is difficult to draw clear conclusions. Modeling the transport sector and moving from numerical simulation to sound calibration appear as promising lines of research.

References

Alonso-Villar, O. (2005). The effects of transport costs revisited.

Andersson, F., & Forslid, R. (2003). Tax competition and economic geography.

Annicchiarico, B., Orioli, F., & Trionfetti, F. (2012). National oligopoly and economic geography.

Baldwin, Richard E. (2001). The core-periphery model with forward-looking expectations.

Baldwin, Richard E., Forslid, R., Martin, P., Ottaviano, G. I. P., & Robert-Nicoud, F. (2003). *Economic geography and public policy*.

Baldwin, Richard E., & Krugman, P. R. (2004). Agglomeration, integration and tax harmonisation.

Baldwin, Richard E., Martin, P., & Ottaviano, G. I. P. (2001). Global economic divergence, trade and industrialisation: The geography of growth takeoffs.

Beckmann, M. J. (1987). Location of economic activity.

Behrens, K., & Robert-Nicoud, F. (2010). Tempora mutantur: In search of a new testament for neg.

Brülhart, M., Carrère, C., & Trionfetti, F. (2012). How wages and employment adjust to improved market access: Evidence from Austria.

Brülhart, M., & Jametti, M. (2008). Does tax competition tame the leviathan?

Brülhart, M., Jametti, M., & Schmidheiny, K. (2012). Do agglomeration economies reduce the sensitivity of firm location to tax differentials?

Brülhart, M., & Parchet, R. (2011). Alleged tax competition: The mysterious death of inheritance taxes in Switzerland.

Brülhart, M., & Trionfetti, F. (2004). Public expenditure, international specialisation and agglomeration.

Charlot, S., Gaigne, C., Robert-Nicoud, F., & Thisse, J.-F. (2006). Agglomeration and welfare: The core-periphery model in the light of bentham, kaldor, and rawls.

Combes, P.-P. (1997). Industrial agglomeration under cournot competition.

Combes, P.-P., & Lafourcade, M. (2011). Competition, market access and economic geography: Structural estimations and predictions for France.

Crozet, M. (2004). Do migrants follow market potentials? An estimation of a new economic geography model.

Davis, D. R., & Weinstein, D. E. (2002). Bones, bombs, and break points: The geography of economic activity.

Davis, D. R., & Weinstein, D. E. (2008). A search for multiple equilibria in urban industrial structure.

Dreher, A. (2006). Does globalization affect growth? Evidence from a new index of globalization.

Dreher, A., Gaston, N., & Martens, P. (2008). *Measuring globalization – gauging its consequences*.

Ellison, G., & Glaeser, E. L. (1997). Geographic concentration in U.S. manufacturing industries: A dartboard approach.

Findlay, R. (1995). *Factor proportions, trade, and growth* (chap. 6).

Forslid, R., & Ottaviano, G. I. P. (2003). An analytically solvable core-periphery model.

Gabaix, X. (1999). Zipf's law for cities: An explanation.

Gandolfo, G. (2009). *Economic dynamics*.

Gupta, S. D. (Ed.). (1997). *The political economy of globalization*.

Helpman, E. (1998). The size of regions.

Kind, H. J., Midelfart-Knarvik, K. H., & Schjelderup, G. (2000). Competing for capital in a 'Lumpy' world.

Krugman, P. R. (1991a). *Geography and trade*.

Krugman, P. R. (1991b). History versus expectations.

Krugman, P. R. (1991c). Increasing returns and economic geography.

Krugman, P. R. (1993a). On the relationship between trade theory and location theory.

Krugman, P. R., & Venables, A. J. (1995). Globalization and the inequality of nations.

Lösch, A. (1954). *Economics of location* (English translation of 1940 German original).

Ludema, R. D., & Wooton, I. (2000). Economic geography and the fiscal effects of regional integration.

Martin, J. P., & Rogers, C. A. (1995). Industrial location and public infrastructure.
Martin, P., & Ottaviano, G. I. P. (1999). Growing locations: Industry location in a model of endogenous growth.
Martin, P., & Ottaviano, G. I. P. (2001). Growth and agglomeration.
Neary, J. P. (2001). Of hype and hyperbolas: Introducing the new economic geography.
Nocco, A. (2005). The rise and fall of regional inequalities with technological differences and knowledge spillovers.
Ohlin, B. (1933). *Interregional and international trade*.
Ohlin, B., Hesselborn, P., & Wijkman, P. M. (Eds.). (1977). *The international allocation of economic activity*.
Ottaviano, G. I. P. (1999). Integration, geography, and the burden of history.
Ottaviano, G. I. P. (2001). Monopolistic competition, trade, and endogenous spatial fluctuations.
Ottaviano, G. I. P., & Robert-Nicoud, F. L. (2006). The 'Genome' of NEG models with vertical linkages: A positive and normative synthesis.
Ottaviano, G. I. P., Tabuchi, T., & Thisse, J.-F. (2002). Agglomeration and trade revisited.
Ottaviano, G. I. P., & van Ypersele, T. (2005) Market size and tax competition.
Puga, D. (1999). The rise and fall of regional inequalities.
Redding, S. J. (2010). The empirics of new economic geography.
Redding, S. J., & Sturm, D. (2008). The costs of remoteness: Evidence from German division and reunification.
Ricci, L. A. (1999). Economic geography and comparative advantage: Agglomeration versus specialization.
Stern, R. M. (2009). *Globalization and international trade policies*, (chap. 2, sect. II).
Trionfetti, F. (2001). Public procurement, economic integration, and income inequality.
Trionfetti, F. (2012). Public debt and economic geography.