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The Spatial Distribution of the Gains from Trade

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Abstract

The economic literature recognises that international trade certainly brings about gains for the countries involved, particularly gains of exchange and specialisation; however, such benefits could be localised in certain regions. The paper examines the neo-classical trade theory and finds an absence of spatial considerations, which implies that trade, takes place between two dimensionless points. One of the most remarkable results of the neo-classical theory is the equalisation of factor prices. In such scenario, concentration or dispersion of economic activity in certain places has no relationship whatsoever with trade. In contrast, a new literature (the "New Economic Geography") attempts to include territorial aspects among which transport costs, labour-market characteristics and production linkages. The result is a contrast between a world of equality —given the equalisation of factor prices— proposed by the neo-classical approach and a world where both equalisation and concentration and inequality emerge as the outcome of two countervailing forces.

Resumen

La literatura económica reconoce que el comercio internacional ciertamente trae consigo ciertas ganancias para los países involucrados, particularmente de intercambio y especialización; sin embargo, dichos beneficios pudieran localizarse en ciertas regiones en específico. El artículo examina la teoría neo-clásica del comercio internacional y encuentra una ausencia de consideraciones espaciales, lo cual implica que el comercio se da entre dos puntos sin dimensiones espaciales. Uno de los resultados más sobresalientes de la teoría neo-clásica, es el de la ecualización de los precios de los factores de producción. En dicho escenario, la concentración o dispersión de la actividad económica en ciertos lugares no tiene relación alguna con el comercio. Por otro lado, una nueva literatura (la "Nueva Geografía Económica") intenta incluir aspectos territoriales, entre ellos, los costos de transporte, las características del mercado laboral y los encadenamientos productivos. El resultado es un contraste entre un mundo de igualdad —dada la ecualización de los precios de los factores de producción— propuesto por el enfoque neo-clásico y un mundo en el que tanto la ecualización como la concentración y la desigualdad surgen como respuesta a un conjunto de fuerzas antagónicas.

Introduction

Discovering the effect of trade on growth and income is a concern that is far from new. In fact, the first propositions date back as far as Adam Smith and David Ricardo. Thereafter, neo-classical perspectives have dominated the debate. However, trade-related theories had not until very recently addressed growth-related issues, nor has it tackled spatial aspects. On the one hand, "in its present state, trade theory provides little guidance as to the role of trade policy and trade strategy in promoting growth" (Krueger, 1990: 95). In contrast, there is overwhelming empirical evidence indicating important links between trade and growth (Krueger, 1990). On the other hand, in research such as that carried out by Gallup, Sachs and Mellinger (1998), geography emerges as the central piece linking the two. What is more, Frankel and Romer (1999) have argued that the traditionally undetermined direction of the causation between trade and growth is related to the lack of geographical considerations; their results provide evidence to support the positive effect of trade on growth. Likewise, the work by Irwin and Treviö (2000) provides stronger evidence for the Frankel-Romer argument.

Despite such recent empirical findings, neo-classical-based models have not established a clear-cut link between trade and growth, nor do they consider the potential spatial implications of trade. Neo-classical studies have proved effective for determining the pattern of trade, as well as income and factor-price effects. The neo-classical approach can be subdivided into four main models: the exchange, the Ricardian, the Heckscher-Ohlin (H-O) and the specific-factors models. These models differ in the specification of factors and commodities, as well as in the degree of intersectoral factor mobility that is acknowledged. There are however, some common properties to all neo-classical approaches, particularly the fact that initial endowments can be related to commodity prices and national product. Moreover, a common set of assumptions can be identified (Jones and Neary, 1984). One of the most notorious implications of this approach is the factor-price-equalisation tendency, which is unleashed by exchange in commodities. Heckscher (1919) addressed income-distribution effects through linking changes in factor prices to contractions or expansions of trade. Later on, the Stolper-Samuelson theorem formalised such a relationship. However, the spatial aspects of trade were not taken into account.

During the 1980s, a body of literature called 'new trade theory' or 'strategic trade policy' was developed with the aim of tackling some of the most limiting assumptions made by the neo-classical approach: constant returns to scale, perfect competition and product homogeneity. Although the literature applied some of the new elements developed by Dixit and Stiglitz (1977) to

address imperfect markets, geographical aspects were still not addressed by the theory.

However, in recent years a stream of literature called the new economic geography has taken spatiality into account. It pays particular attention to the way in which the interaction of two countervailing forces, namely centripetal and centrifugal, determines the concentration or dispersion of economic activity. In fact, the theory not only deals with localisation-related issues, but also integrates trade into the analysis. One implication of the theory is that territorial divergence could result from reduced transportation/trade costs. However, it also leaves some scope for the equalising possibility.

The aim of this paper is to discuss the underlying relationship between trade and space and to consider and contrast the propositions made by neo-classical approaches and by the new economic geography. This paper initially compares free trade and autarky in order to explore whether there are gains from trade. Thereafter, the neo-classical approach to trade is explored, paying particular attention to the H-O model and related theorems. The most restrictive assumptions of the H-O model are relaxed in the new trade theory section. However, as no spatial implications are found in either theory, the paper concentrates on the propositions of the new economic geography. An antagonistic set of factors enables the possibility of further concentration or dispersion of activity, resulting in either convergence or divergence.

1. The Reasons to Trade

Trade supporters argue that the free flow of goods increases welfare. Improvement of welfare conditions is spurred through a more efficient allocation of resources stemming from the specialisation of production. Furthermore, increased competition will result *ceteris paribus*, in lower prices, enabling greater consumer benefit, which is typically measured through the consumer's surplus (Varian, 1992). Similarly, free trade will offset the negative effects that tariffs and other barriers to exchange introduce by producing inefficiencies such as deadweight losses; more precisely, an inefficient and unproductive allocation of resources. In fact, overall welfare is somewhat improved by trade (Markusen *et al*., 1995). Nevertheless, not all individuals will necessarily benefit from trade, since uneven distribution of the gains is possible. In other words, the gains-from-trade theorem[1] shows that the economy as a whole is better off than in autarky; yet, as will be explained below, some room is left for winners and losers with the emergence of trade.

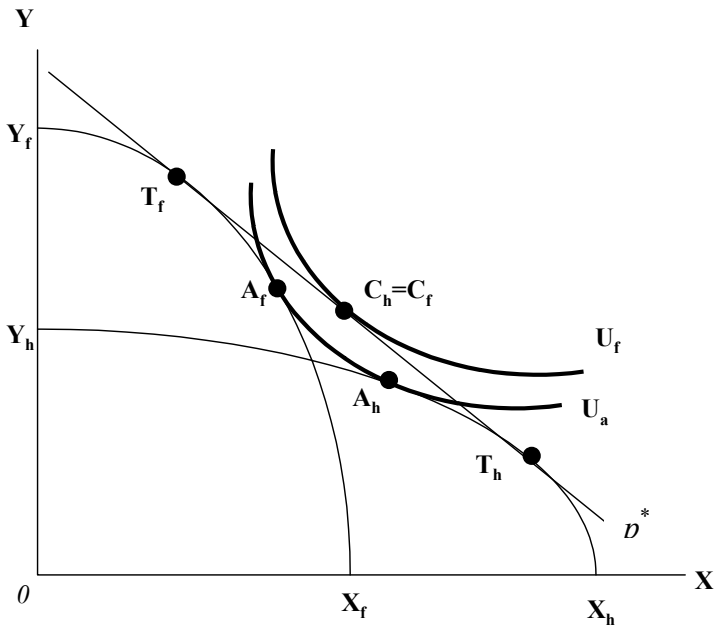
[1] ***The gains-from-trade theorem:*** Suppose that the value of production is maximised at free trade prices. Then the value of free trade consumption at free trade prices exceeds the value of autarky consumption at free trade prices. The free trade consumption bundle must thus, be preferred to the autarky bundle, because if it were not, consumers would pick the cheaper autarky bundle (Markusen *et al*., 1995).

Free Trade Versus Autarky

Consider Figure 1 in which two Production-Possibility Curves (PPC) concave to the origin are displayed; one for the home country (h) and another for the foreign country (f). Under autarchic conditions, maximum production combinations (between goods X and Y) for both countries are displayed at points A_h and A_f[2]. The price ratio at which the two countries trade is represented by the p^* straight line. Similarly, Ua and Uf depict utility functions for autarky and free trade respectively. Since an autarchic economy implies that foreign production does not enter the domestic market, the utility function efficiently achieved by autarky will necessarily lie tangent to the PPC. Alternatively, regardless of the price ratio between domestic and foreign prices under free trade, the utility function delivered by the absence of barriers to trade will always lie above the utility function of autarky, which, in turn, means a higher level of welfare is implicit with free trade. In Figure 1, the utility function reached by the exchange (U_f) allows the two countries to achieve consumption point C while producing at points T_h and T_f. Despite the specific characteristics of an economy, trade will always deliver a higher level of welfare than remaining in autarky (Markusen *et al.*, 1995).

F I G U R E 1

GAINS FROM TRADE



The above graphic analysis can also be expressed formally. Let subscripts t and a, denote, as above, conditions of free trade and autarky respectively; in turn, let p and c correspond to production and consumption. In a two-good scenario, the above figure shows that the value of free-trade production, at free-trade prices (p*) must be higher than that of autarky:

$$p_x^* X^t_p + p_y^* Y^t_p > p_x^* X^a_p + p_y^* Y^a_p \qquad \text{(Equation 1)}$$

The Gains-from-trade theorem will ensure free-trade consumption is preferred to that of autarky. Balance-of-trade constraints under free trade and market-clearing conditions in autarky will ensure that production quantities exhibited in Equation 1 are transformed into consumption ones:

$$p_x^* X^t_c + p_y^* Y^t_c > p_x^* X^a_c + p_y^* Y^a_c \qquad \text{(Equation 2)}$$

Moreover, Samuelson (1939) showed that the gains from trade are possible even under restricted trade, as long as free-trade prices diverge from autarky prices; that is, any other relative prices produce benefits compared to autarky prices. What is more, it can be argued that the more the prices diverged, the greater the benefits (Samuelson, 1939; Kemp, 1962). Both Samuelson (1939) and Kemp (1962) showed that gains from trade are possible for large and small economies (Corden, 1984).

However, the gains from trade are not necessarily distributed evenly amongst all members of a society. In fact, it is possible that they might benefit some groups, while worsening the situation of others; that is, not delivering a Pareto optimum. One of the reasons for such possibility lies in the fact that a society does not exhibit homogeneous tastes. The relative price of one of the commodities (in a two-good model) is raised when trade is introduced, a feature that eventually promotes specialisation. By distinguishing preferences, the reduced availability of the relatively more expensive good would worsen the situation for individuals choosing a bundle constituting relatively more of those goods. The result is an uneven distribution of the gains. A second way to achieve an uneven distribution of trade benefits is by differences in endowments, or better, as stated by Heckscher (1919), by a non-uniform distribution of factors of production amongst individuals. Trade induces changes in relative prices, which bring about specialisation. The implied shift in the production of one of the commodities (again, in a two-good model) would raise the demand for, and consequently the price of, the factor employed intensively in the production of the good favoured by specialisation. Unequal factor prices imply a worse-off situation for the less intensively used factor. As will be

[2] In autarky, efficiency and clearing market conditions imply equal levels of production and consumption.

explored below in relation to the Stolper-Samuelson theorem, income-redistribution effects may emerge based on endowment differences in society.

Two Types of Gains

The benefits from trade can be, for analytical reasons, divided into gains from exchange and gains from specialisation (Smith, 1784). The former recognises that differences in endowments or preferences can lead both parties to profit from trading with each other. The latter refers to the fact that specialising in a narrow range of activities results in efficiency.[3] In that sense, specialisation is related to Ricardo's idea that a pattern of comparative advantage exists regardless of an absolute advantage of one country over another in all goods.

International trade theory shows, using Figure 1 and Equations 1 and 2, that there are, in fact, gains from trade. Similarly, models developed using neo-classical approaches such as the H-O model consider that the initial endowment of factors of production can determine benefits from trade for the parties involved. However, the assumptions underpinning such model are rather restrictive. Amongst the more limiting are: perfect competition, constant returns to scale, homogeneous preferences and perfect mobility of factors of production. The next section will focus on developing the neo-classical ideas by presenting basic principles of the four models mentioned above.

2. Neo-classical Approaches to Trade

Trade theory has its roots in Adam Smith's consideration that the main condition for growth is a division of labour induced by trade (Evans, 1989). It is the possibility of exchanges that spurs people to specialise in certain activities, improving productivity to exchange the product of one man's labour for that of another. Thus, exchange is the ultimate motive for specialisation and division of labour. In the same way that individuals do so, nations specialise and exchange on the basis of a division of labour. According to Smith (1784), trade is driven by absolute advantage; to be precise, a country will export the commodities in which it has an absolute advantage. However, Ricardo (1817) takes the analysis further by stating that trade is determined by comparative rather than absolute advantage; specifically, relative factor productivities shape trade. Trade will be beneficial to both countries concerned as long as there are productivity inequalities across countries and goods (Ricardo, 1817). However, the comparative advantage notion has not succeeded in explaining factor-productivity discrepancies between countries and goods. That is, the source of comparative advantages remained unclear.

[3] The standard of living of everyone will be much lower if every person produced their own food, made their own clothes or built their own houses; similarly, countries can benefit from specialisation (Markusen *et al.*, 1995).

Neo-classical Models

Thereafter, neo-classical ideas have tried to explain the source of comparative advantage. However, the theory can be regarded as eclectic, since a variety of models are used, each one suited to a limited, but no less important set of questions (Jones and Neary, 1984). Within the neo-classical perspective, four models can be distinguished: the exchange, the Ricardian, the Heckscher-Ohlin (H-O), and the specific-factors model. However, it could be argued that the first model is actually a simplified version of the Ricardian, while the last one can be regarded as a variant of the H-O.

The exchange model ignores the production process and concentrates on the demand-side effects of trade.[4] The problems tackled by the model are related mainly to stable equilibrium and the effect of exchange on the terms of trade, which are solved by isolating demand effects to find that both are related to income (Samuelson, 1952). Nevertheless, the model suffers from a complete failure to acknowledge supply-side effects. In addition, the hampered mobility of factors of production and the rigid assumption of having specific factors dedicated to single-production structures seriously limit the model's scope.

The Ricardian and the exchange models consider contrasting conditions. While the latter assumes fixed-sectoral factors and thereby omits the possibility of resource transfer, the former allows for perfect factor mobility. In fact, the emphasis on demand-side questions placed by the exchange model is reversed here, since the Ricardian model focuses on production changes induced by trade, without overlooking demand-side influences. The Ricardian model is a useful scheme to pinpoint technology asymmetry and uneven-scale production between countries (Jones and Neary, 1984). As mentioned above, the model predicts benefits from trade stemming from specialisation based on comparative advantage.

Of those models based on the neo-classical approach, the H-O model is the most frequently used. Moreover, the importance of the H-O model eclipsed the emergence of the specific-factors model (Jones and Neary, 1984). The basic H-O model incorporates elements left out by the Ricardian model. The former expands the number of factors of production to two, instead of one contemplated by the latter. The inclusion of an additional factor of production allows for differences in factor-proportion utilisation across countries and industries. Countries vary in their endowments of factors of production, but not in technologies.[5]

[4] It considers two sectors where two goods are produced with a distinctive and specific factor; thus, it does not allow for factor migration across sectors. Although disregarding the supply side may appear to be rather restrictive, it is a useful vehicle to study demand-behaviour problems (Jones and Neary, 1984).

[5] The implication of this is that according to the H-O theorem, if the production of a particular commodity is capital intensive in one of the countries, it will be assumed that identical technologies must also be capital intensive in the other country (Yarbrough and Yarbrough, 1988).

From the H-O model, scholars have derived four theorems: the Stolper-Samuelson, the Rybczynski, the Heckscher-Ohlin and the factor-equalisation theorems. As discussed earlier, the Stolper-Samuelson theorem examines the effect of trade on both, factor prices and income distribution. Liberalisation of trade raises the relative price of the factor used intensively, while reducing the price of the other (Kenen, 1994). The shift in factor prices is greater than that experienced in commodities.[6] Income distribution effects can be deduced by observing that the abundant factor will have a greater bearing on national income than the one that is scarce.

The Rybczynski theorem explores variations in output resulting from factor-endowment changes. If prices are constant, an increase in the endowment of only one of the factors will increase the output of commodities that intensively use that factor and will reduce the production of commodities that intensively use the other factor (Evans, 1989). The reason for the necessary contraction in capital-intensive production is the fact that even the labour-intensive industry needs a proportion of capital.[7]

The H-O theorem presents the possibility that patterns of comparative advantages and trade are determined by differences in factor endowments (Markusen *et al.*, 1995). It states that a country will export the commodity that intensively uses the relatively abundant factor, while it will import commodities supplied by the industry that intensively employs the non-abundant factor (Leamer, 1984; Suranovic, 2000). Trade flows will continue until the prices of the two goods are equalised in both countries.

According to the factor-price equalisation theorem, each country will supply one distinctive good, which in turn is produced making intensive use of the abundant factor. Free trade allows the exchange of, and thereby an increase in the demand for, the good produced with the abundant factor, which, in turn, raises its price. In contrast, the price of the non-abundant factor falls;[8] hence factor prices are equalised. In fact, exchange in commodities is a substitute for factor mobility across countries, since the equalisation of their prices is achieved (Salvatore, 1983). Furthermore, trade and factor mobility are substitutes for one another (Mundell, 1957).

The minimal version of the specific-factors model contemplates two sectors; in addition, one of the factors of production (typically capital), is

[6] The reason for the magnified effect on labour demand stems from the fact that a unit of labour-intensive production will require more labour than a unit of capital-intensive output. Thus, real wages will rise, whereas real returns to capital will fall. The result will be the opposite if capital-intensive production is considered.

[7] With the endowment of capital held constant, the only way to obtain additional capital, which will enable the labour-intensive industry to take advantage of the expanded labour force, is through the release of capital from the capital-intensive industry (Yarbrough and Yarbrough, 1988).

[8] When no extraordinary profits are made from the production process, as in perfect competition, the price of the good is comprised of factor payments. If there is an increase in the price of a particular commodity, this will be transferred to factor prices.

considered specific to a particular industry.[9] Although the assumptions of this model differ from H-O in just this respect, the properties of the two models can be contrasted. First, a change in the relative price of one of the commodities brings about an increase in output of that good, which in turn employs more labour. It follows that wage rates must raise relatively less than commodity price increases. By way of contrast, the returns on both industries' specific factors rise relatively more than the increase in commodity prices. In such a case, capital returns will be greater than labour returns, which will eventually entail a redistribution of income. Second, a change in factor endowments has an ambiguous effect on wages. The returns to labour are reduced first by the labour-force growth, while they are raised by the endowment of either specific factor. With more factors than commodities, in the specific-factors model, trade does not lead to absolute, but rather to partial factor-price equalisation (Jones and Neary, 1984).

Extensions of the H-O Model: Relative Equalisation

The two-goods-two-factors-two-countries model explored up to this point, was not the original idea behind Heckscher and Ohlin's work. In fact, "the two-factor assumption especially deviates sharply from the original Heckscher-Ohlin theory. These theories assumed many factors right from the beginning" (Harbeler, 1977: 3). The basic model has been used as an effective illustrative example. What is more, factor of production "does not refer simply to the broad categories land, capital, and labor but to the different qualities of each of these. The number of factors of production is thus practically unlimited" (Heckscher, 1919: 48). To put it another way, "labour and capital are not homogeneous masses, but can and have to be subdivided in various ways" (Baldwin, 1972: 142).

Instead of considering two goods as in the models above, an alternative could be to regard them as groups of goods such as manufactured commodities or agricultural produce. If more than two goods are introduced factor-intensity ratios could produce non-unique results. That is, in the ranking of factor-intensity ratios the country well-endowed with capital will export capital-intensive goods and the relatively labour abundant will export labour-intensive commodities, but some indeterminacy will emerge with respect to the third good which has a relatively intermediate composition of capital. In other words, the second term in Equation 3 would yield an undetermined result.

$$Ky/Ly > Kz/Lz > Kx/Lx \qquad \text{(Equation 3)}$$

[9] A factor can be industry-specific if it was specifically designed in the case of capital – or specifically trained in the case of labour – to be used in a particular production process. Thus, it could be impossible or at least costly, to move across industries.

It is possible that as a result of having a third factor, the capital-abundant country could export capital or labour-intensive commodities, or even production with intermediate levels of capital intensity (Markusen *et al.*, 1995). Therefore, "results such as those given by the Stolper-Samuelson theorem and the Rybczynski theorem, which make use of bilateral comparisons, do not easily generalise to higher dimensions" (Markusen *et al.*, 1995).[10] Moreover, the two theorems are not easily generalised when the more-goods-than-factors case is taken into account; as a result, "there are only very restrictive or weak generalized propositions to test or to apply" (Flam, 1981: 19). A model of this kind (two-good, three factors of production with mobility) was presented in Jones and Easton (1983), showing that the extent to which substitution between the middle factor and the other two is the key determinant of output and factor prices. However, as long as the number of goods equals the number of countries, the main results of the H-O model–including the factor-price equalisation theorem–will hold.

In the so-called 'even' case, an equal number of factors and goods would yield a variety of results related to the Stolper-Samuelson-theorem generalisation (Jones and Neary, 1984). In a different vein, Ethier (1974) has argued that less restrictive assumptions regarding technology, would result in stronger evidence for supporting the 'even' case, as long as all factors are used to some extent (Jones and Neary, 1984). However, the 'even' case is a particular scenario and altering the balance can yield very different results. On the one hand, a model comprising more factors than commodities would increasingly approach factor-price equalisation, to the extent that commodities, the prices of which fluctuate freely, are reduced. On the other hand, a greater number of commodities than factors, as mentioned above, would bring about production indeterminacy, which in turn will be resolved by allowing specialisation or by introducing non-supply-side considerations (Jones and Neary, 1984).

Trade theory becomes then, a casuistic theory replete with exceptions and assumptions. Indeed, "the picture which emerges is that of a mosaic of interrelated, overlapping and occasionally conflicting theories and models, each applicable to certain situations" (Harbeler, 1977: 10). It is no longer easy to generalise results in terms of factor prices, income and trade patterns in light of different goods-factors proportions and when including n-number of countries. In fact, the Heckscher-Ohlin theorem "is valid only in the highly abstract environment of the two-factor, two-good, two-country model that has been the mainstay of trade theory for half a century" (Deardorff, 1982: 683). According to Deardorff (1982), the H-O-theorem proof, employing factor content of trade for any number of factors, goods and countries, has resulted in additional restrictive assumptions. One of them is the absence of factor-

[10] This requirement has been known as the Heckscher-Ohlin-Vanek theorem or the factor-content theorem.

intensity reversals; that is, the possibility that a particular industry finds it relatively easier to substitute capital for labour without altering its production levels. An approach adopted by some scholars has been to address limited questions in the context of general models, rather than the opposite, which as explained above, becomes restrictive.

Other extensions of the neo-classical model allow for geographical mobility of factors; the result is, again, an equalisation of factor prices. However, it is worth mentioning that these extensions are based on a more relative equalisation than the absolute proposition forwarded by the factor-price equalisation theorem. Accordingly, the less restrictive assumption of a tendency towards (rather than actual) equalisation can be labelled the 'relative factor price convergence' (Wood, 1994). Consequently, whether an absolute or a relative equalisation is taken into account, the resulting proposition is that an eventual convergence of factor prices results from trade. Finally, none of the neo-classical models explored in this section directly addressed spatial considerations. Although the issues of income and factor prices discussed above are related to space, they are not directly linked in the theory. Thus, in the effort to connect trade theory and spatial transformations, it seems that the most the neo-classical models have done, as is explained below, has been to acknowledge the intimate relationship between trade and the location of activity.

Factor-Price Equalisation, Location and Income Convergence

Trade allows countries to exchange the commodities that they produce. Factor-endowment effects on comparative advantage, as discussed earlier, determine specialisation of production and exchange. Such endowments differ both across countries and within countries. Therefore, trade theory, at least implicitly, refers to the location of production (Johnson, 1981). Moreover, trade theory verges on location theory; questioning the reasons for exchange between countries is tantamount to looking for the underlying motives for a certain array of production between countries (Ohlin, 1933). However, neo-classical theory has not explicitly tackled localisation-related issues, nor has it addressed the question of geographical convergence of income. The sole premise postulated by the factor-price equalisation theorem is that there is an eventual convergence of factor prices across countries. Thus, the neo-classical theory signals the possible relationship between trade and geography, but it has not yet devised any framework to analyse such aspects. In light of the lack of spatial insight gained in the most prominent theory of trade, this section turns to a brief exploration of more recent developments.

New Trade Theory

As argued above, trade theory has undertaken the analysis of particular questions with variations of general models. Moreover, as argued by Brander (1995), traditional trade theory could not explain some real-world phenomena such as intra-industry trade or exchange between similar countries. Therefore since the 1980s, international trade economists have begun to introduce imperfect-competition features such as oligopoly, in order to address the situations discussed above. Neo-classical models also have failed to incorporate considerations such as increasing returns to scale and research and development (R&D), amongst others (Brander, 1995). New trade theory or strategic trade policy, as it is often known, has employed models featuring increasing returns to scale, imperfect competition and product differentiation as seen in Krugman (1980), Venables (1987) and Helpman and Krugman (1989), to try to respond to some of these questions. Similarly, it has addressed real-world phenomena, such as the increasing role played by multinational enterprises, as in Markusen and Venables (1995). The central argument is that intervention can alter interaction amongst oligopolistic firms; thus, government interaction is used to maximise national welfare. It is not the intention of this paper to give a thorough review of this stream of literature, but simply to indicate that neither the neo-classical theory nor the new trade theory have addressed the spatial issues examined in this paper. Nevertheless, the recent emergence of a new body of literature that focuses explicitly on geographical aspects has resulted, as is explored below, in a formal attempt to link trade theory and economic geography.

3. The New Economic Geography's Core-Periphery Model

The Assumptions

The basis for dealing with increasing returns to scale is provided by the framework developed by the Dixit-Stiglitz monopolistic competition model. Spatial versions of the model have been developed and are being included in the new economic geography literature (Krugman, 1991a and 1992; Krugman and Venables, 1995; Fujita, Krugman and Venables, 1999). Although there are extensions of the model, which relax some of the assumptions presented below, initially the two-regions-two-sector model assumes that manufacturing faces imperfect competition, whereas agriculture operates under no market distortions, as is the case in Krugman (1991c) and Krugman and Venables (1995). Labour is the only factor employed by both sectors, and its endowment is the product of an exogenous and fixed supply. Although that is not the case later on when trade is introduced, for now, manufacturing-employed labour is mobile over time.

Up to this point, the model appears to be a combination of the one-factor Ricardian model and the relevance of endowment considered by H-O model. Nevertheless, it is novel at least in that it introduces imperfect competition in one of the sectors. Furthermore, the introduction of transport costs is central to the story (Krugman, 1998). Using iceberg transport costs as first presented in Samuelson (1954), the model assumes that a part of the production in manufacturing to be exchanged between regions simply melts away in transit. However, at least initially, the transportation of agricultural production is assumed costless. In addition, agricultural wages are the same in both regions since its production exhibits constant returns to scale and can be transported freely. It is assumed that workers move towards the region that offers higher real wage rates.

The Model at Work

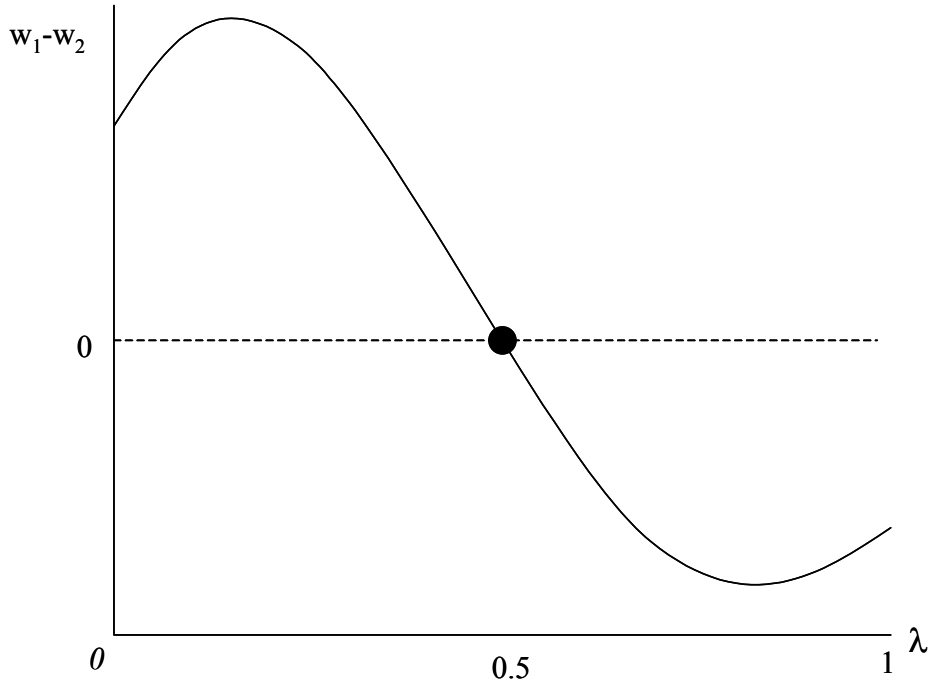
Let us consider that the agricultural labour force is evenly distributed between the regions. There are different equilibria arising from the model, depending on the level of transportation costs. For high-level transportation costs there is a single and symmetrical equilibrium, as shown in Figure 2. Manufacturing employment (represented by □) is evenly distributed between the two regions and wage (represented by w) differentials are zero. The reason for this is that the regional differential of wages is negative for the region that has more than half the manufacturing labour and positive for the region that has less; thus, workers will migrate to the region with the highest wage level increasing its share and equalising factor prices once again.

By contrast, when transport costs are low, production will concentrate in either of the two regions, as in Figure 3. There is now an incentive for firms to locate close to each other and produce for both regions; thus, backward and forwards linkages[11] act to establish agglomeration. The higher the manufacturing share of a region the higher wages it will offer, which in addition to the lowered prices induced by the wider variety of products available from the locally agglomerated industry, will produce further concentration. Although the symmetric equilibrium is still possible, it is unstable; that is, as soon as there is a slight disparity in the size of the two regions' manufacturing shares, the above-described concentration process will be set in motion.

[11] Advantages for firms that choose to locate near to each other to gain access to larger markets and supplies (Fujita, Krugman, and Venables, 1999).

F I G U R E 2

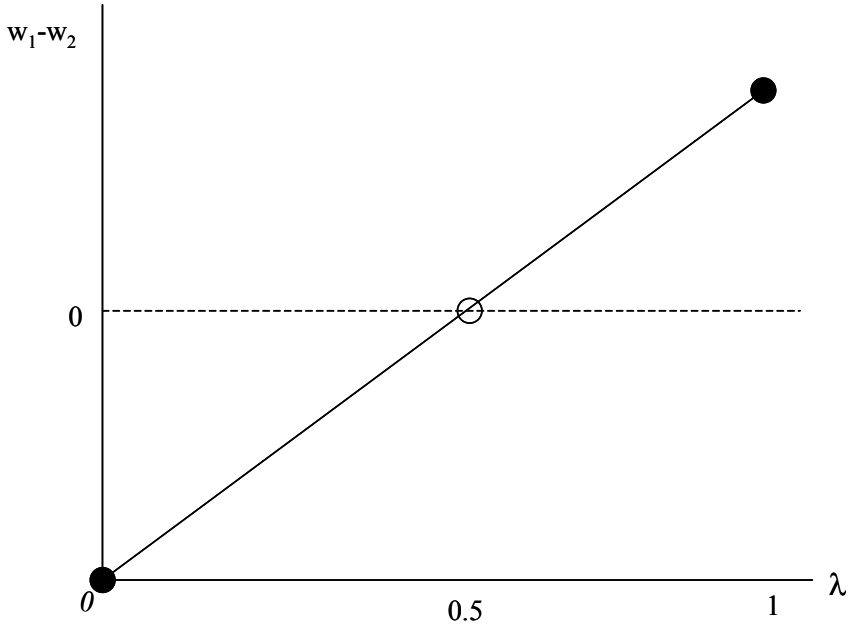
EQUILIBRIUM WITH HIGH TRANSPORTATION COSTS



For intermediate levels of transport costs, a five-equilibria scenario as depicted in Figure 4 emerges. The symmetric equilibrium is stable, but it is flanked by two other unstable equilibria; if the manufacturing employment share starts from a sufficiently high or low level, concentration will take place (Krugman, 1992 and 1998; Venables, 1993; Fujita, Krugman and Venables, 1999). The concentration outcome resulting from lowering transport costs to either intermediate or low levels is recognised by the theory as the core-periphery pattern. Such a pattern is sustainable when a certain transport cost value has not been reached. However, that value can vary depending on the elasticity of substitution amongst manufacturing varieties; the core-periphery critical value can be stretched by elasticity increases, and be shrunk by decreases. Likewise, a large manufacturing sector will extend the range of values that sustain agglomeration, whereas a small one will reduce it (Krugman, 1991b; Fujita, Krugman and Venables, 1999).

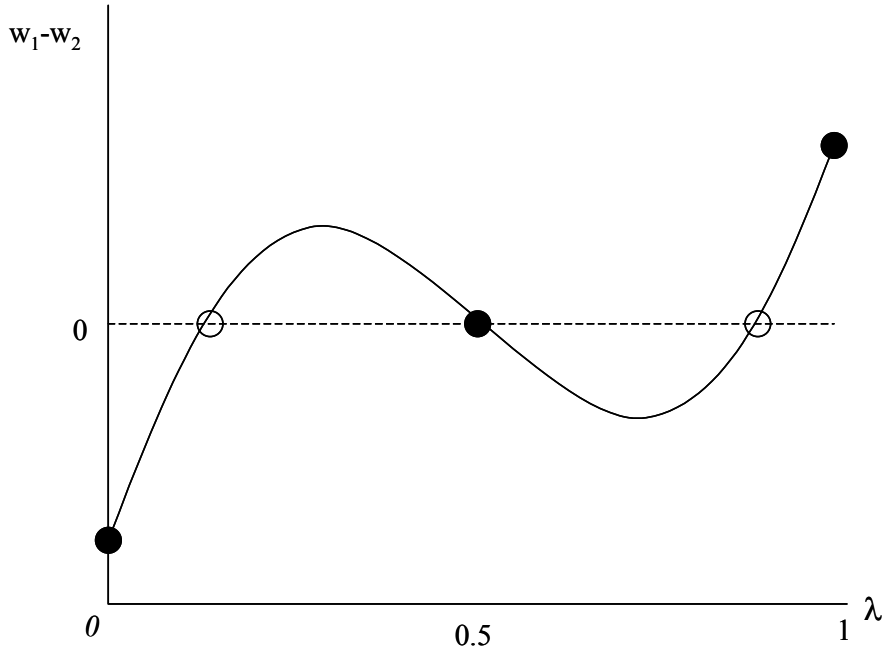
F I G U R E 3

EQUILIBRIA WITH LOW TRANSPORTATION COSTS



F I G U R E 4

EQUILIBRIA WITH INTERMEDIATE TRANSPORTATION COSTS



Extensions of the Model: Relaxing the Assumptions

From the model described here, it can be observed that agglomerations are the product of the interaction of economies of scale at the level of the firm, transport costs and factor mobility. There is also a notable tension between centrifugal and centripetal forces, namely linkages and factor immobility respectively (Fujita, Krugman and Venables, 1999). However, some of the assumptions upon which the core-periphery model is based restrict its efficacy.

Extensions of the model include the expansion of the number of regions considered in the analysis, as well as the introduction of agricultural transport costs. The inferences of the original model are virtually unchanged. First, the introduction of additional number of regions results in a symmetric equilibrium with high transport costs, concentration with low costs, as well as concentration and symmetrical equilibria arising from intermediate levels.

Second, the introduction of iceberg costs in agriculture has two distinct effects, caused by the fact that wages and prices in the sector are no longer equalised. On the one hand, the region with higher agricultural wages is able to attract more manufacturing through its enhanced income. On the other hand, the higher prices of agricultural products in the region lead to labour out-migration. The tension between these two effects will determine whether agglomeration or equalisation is attained. However, the essential implications of the model are again unchanged. Low transport costs will favour the core-periphery pattern. Intermediate levels, although with a reduced range of transportation costs, still allows agglomeration. High transportation costs again support a symmetrical division of labour. Nonetheless, the level of transportation costs at which agglomeration takes place is influenced by such parameters as the size of the manufacturing sector and the elasticity of substitution amongst manufacturing varieties. In the case of the former, a higher share of mobile workers through greater demand levels fosters backward linkages that in turn enable the emergence of concentrations. The latter has the opposite effect, higher levels of substitution reduces the range of values at which agglomeration is sustainable (Fujita, Krugman and Venables, 1999).

The Underlying Factors in the Model

The core-periphery model allows the new economic geography to predict equalisation or concentration based on the tension between centripetal and centrifugal forces, as well as on the interaction between increasing returns to scale and factor mobility when transportation costs vary. The two underlying factors of the model are the presence of increasing returns to scale and factor mobility, since they represent the basic structure upon which the model operates.

The existence of increasing returns to scale makes it profitable to locate production in few sites; hence, a supply-side incentive for concentration emerges. In addition, factor mobility provides a demand-side incentive that encourages the process of agglomeration (Krugman, 1979). Transportation costs play a more active role in determining the outcome. Indeed, different levels of transportation costs, as argued above, can produce either concentration or equalisation. In addition, due to transportation costs, the best locations turn out to be the ones with access to the market and other firms that can provide intermediate goods. Such backward and forward linkages attract producers and mobile factors to the agglomeration (Krugman, 1992).

Centripetal Versus Centrifugal Forces

While comparative advantage, stemming from factor endowment differentials and non-homogeneous technologies, is important, so too is specialisation, which is driven by external economies and firm-level increasing returns to scale (Krugman, 1993). Moreover, external economies are shown to be more important than increasing returns. In addition, the perfect competition scenario is abandoned in favour of an imperfect competition scheme allowed by monopolistic competition models (Spence, 1976; Dixit and Stiglitz, 1977). Such external economies are typically backward and forward linkages that arise from firms' closeness to the market and suppliers respectively. Therefore, an analysis of the way in which these work, as well as the elements operating against them, is of paramount importance.

Based on ideas developed by Marshall (1920), we can identify a core-periphery pattern that fosters not only a concentration of manufacturing in successful regions in the centre, but also a periphery that supplies agricultural goods to the core (Krugman, 1991a). The reasons for the conformation of such agglomerations are identified by Krugman (1991a) as: pecuniary externalities, rather than the purely technological ones implied by Marshall (1920); proximity to large markets, to reduce transportation costs; and the existence of a pooled labour market. The main departure from Marshall's ideas intended by Krugman (1991a) is that the explanation for concentration patterns, and thereby disparities amongst regions, lies in the relation between core and periphery regions. Pecuniary externalities are associated with demand or supply linkages rather than just with technological spillovers. In fact, the distinction between backward linkages, which influence firms to locate near the market, and forward linkages, which represent supply forces that attract firms to locate close to each other, is the essence of Krugman's approach to external economies (Venables, 1998).

On the other hand, centrifugal forces have been identified as being: immobile factors; land prices or commuting; and congestion or other pure external diseconomies (Fujita, Krugman and Venables, 1999). However, for the

sake of simplicity in the core-periphery model only two forces have been included thus far. The models considered by the new economic geography typically regard backward and forward linkages as the centripetal forces and factor immobility as the centrifugal one (Krugman, 1991a, 1991b and 1992; Fujita, Krugman and Venables, 1999).

Historical Accident Versus Self-fulfilling Expectations

There is an additional factor, which can be best summed up by a question: If the core-periphery pattern emerges due to the interaction of the above-mentioned elements, what region will become the core? The most logical answer is that region that manages to achieve a head start. However, this is not necessarily the case, since someone's prospects can generate a process where factors start to behave according to expectations; that is, in the manner of a self-fulfilling prophecy (Krugman, 1991c). Therefore, expectations can reinforce the role of history or can actually produce the rise or fall of urban centres and other agglomerations. In fact, expectations can reverse a historically determined situation only if the costs are offset by the discounted future value of the benefits (Krugman, 1991d). However, in reality factors will hardly move quickly enough to offset history; expectations can at most reinforce the effect of history (Krugman, 1991c and 1991d). Moreover, concentrations depend on initial conditions, since under increasing returns to scale history matters (Krugman, 1979). Increasing returns are an incentive for production to locate in few sites, which leads to the already-described process of agglomeration, which will in turn be influenced by history and expectations (Krugman, 1991b).

Introducing Trade in the Core-Periphery Model

Until now, the core-periphery model has provided an explanation for agglomeration in which increasing returns, transportation costs and factor mobility interact. Centripetal and centrifugal forces determine whether equalisation or concentration is attained. However, as mentioned in the neo-classical section, location-theory concerns are virtually equivalent to the issues tackled by international trade theory (Ohlin, 1933). The following section will outline an international trade model that will provide an explanation for regional imbalances.

When considering international trade, one should bear in mind that nations hinder factor mobility not only through tariffs and quotas, but also through other trade costs such as transportation costs, language and cultural differences, communication difficulties and government-imposed costs, among others (Krugman and Venables, 1990). Otherwise, a reduction not only in traded goods, but also in factor-mobility costs across countries could lead to reduced

trade, since the labour-intensive country might end up losing labour (Norman and Venables, 1993). However, the inclusion of trade barriers usually implied by the existence of different nations represents a central element in the international version of the model. In that case, the mechanics of the core-periphery model do not necessarily work here, since factor mobility partly determines concentration. Nonetheless, the model is adapted to take on board international-factor immobility imposed by the fact that we are dealing with nations. The model considers two countries and intermediate goods substitute the role played by factor mobility in the previous version. Manufacturing is, in addition to labour, an input; thus, manufacturing is both a downstream industry that produces for final consumption, as well as an upstream industry that is used as input for other varieties (Venables, 1993; Fujita, Krugman and Venables, 1999). Demand for manufactured goods comes from both consumers and producers. The greater the number of firms located in a particular region, the larger the demand for intermediate goods. Moreover, an increased number of firms will also result in a greater total expenditure on manufacturing. Labour is assumed to be intersectorally mobile, but also, as already mentioned, internationally immobile.

Under these circumstances, let us consider an increase in the manufacturing labour supply operating in one of the countries. Four forces interact to produce further concentration. First, agricultural employment migration to manufacturing would rise the marginal product in the former, which in turn would reduce the incentives for further concentration. Second, an increase in manufacturing's employment could be associated with an expansion in the number of varieties produced, which would reduce prices and the demand faced by each firm; thus, manufacturing wages are reduced and further agglomeration is hindered (Fujita, Krugman and Venables, 1999). However, these two stabilising forces counteract those that foster concentration, namely, backward and forward linkages. In the case of the former, increased manufacturing employment would expand total expenditures in that sector's goods, which would boost demand and the sector-related wages; thus, concentration is encouraged. In that of the latter, the already-mentioned reduction in prices also affects the prices and demand for intermediate goods, boosting manufacturing wages and fostering further agglomeration (Fujita, Krugman and Venables, 1999).

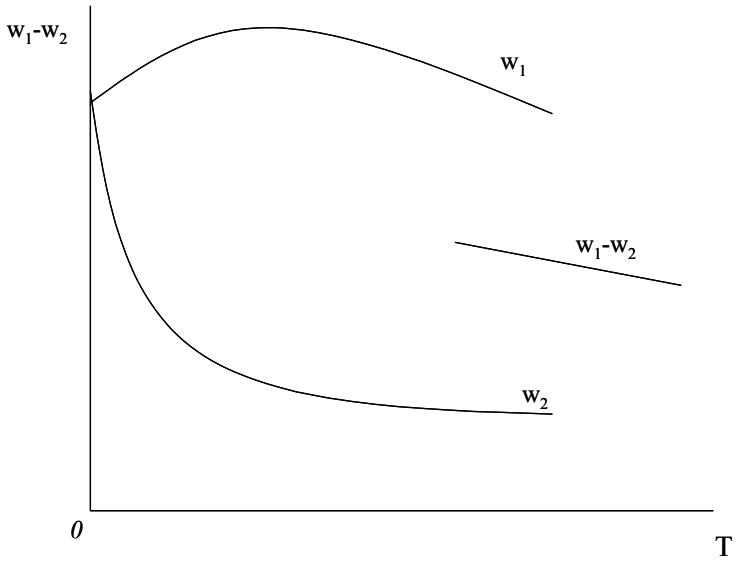
The outcome will be determined by the interaction of these forces. However, the results do not contradict in any way the inferences of the core-periphery model described earlier. There is, however, an important difference here. Transportation costs are substituted with a broader range of trade costs that include not only the former but also linguistic, cultural or any other difference (Krugman and Venables, 1990).

At high levels of trade costs, manufacturing is evenly divided and the two economies are symmetrical. When trade costs are low, the two-stable one-

unstable equilibria scenario applies and concentration is the result. Intermediate levels, as in the first core-periphery model, display a pattern composed by five equilibria, in which concentration in either country is possible, as is the symmetric outcome (Fujita, Krugman and Venables, 1999). However, the symmetrical equilibrium is flanked by unstable equilibria; thus, if equalisation is achieved, a slight change in employment shares will entail a process that would lead to concentration. Therefore, while high trade costs lead to equalisation, concentration becomes plausible with intermediate costs; however, low trade costs make it inevitable. Hence, lowering trade costs enhances the potential of backward and forward linkages to foster concentration.

F I G U R E 5

WAGE DIFFERENTIALS AND TRADE COSTS



Moreover, wage differentials between the countries follow a pattern of sectoral concentration. As can be observed in Figure 5, wages are equalised at high-trade costs, thereafter intermediate costs force a discontinuous increase in the wages of the region that attracts more manufacturing, establishing a wage-differential pattern. Such income disparities between countries would widen with further decreases in trade costs, until a break point is reached and the gap would start to close and total trade costs elimination would bring about equalisation. How wide this gap is and when it starts to close will depend on the proportion of intermediates in total production and the share of manufacturing products in total consumption. In the case of the former, wage differentials (the distance between w_1 and w_2 in Figure 2.5) will be the same,

but it increases the range of trade costs (the interval in which both, concentration and equalisation are possible) that can produce agglomeration, as the linkages in manufacturing are more relevant. In the case of the latter, the range of trade costs in which agglomeration is fostered is the same as the original case, but the wage differential is smaller producing a narrower gap.

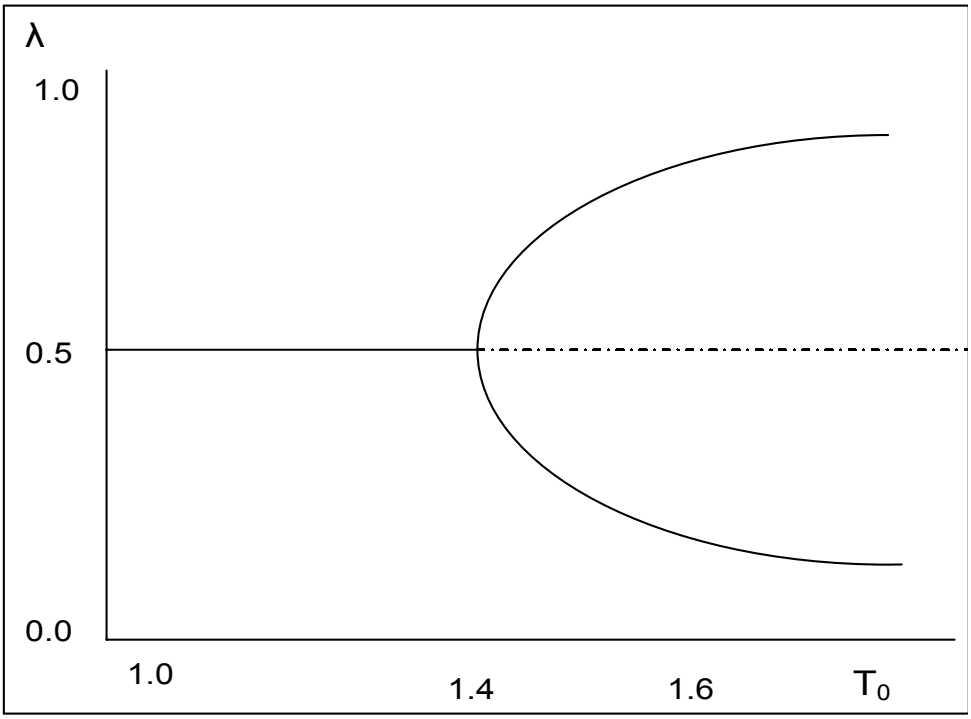
Extensions of the model include making agriculture a decreasing function of the sector's employment, as well as the inclusion of other regions. The former has the effect of narrowing the range of values in which agglomeration occurs, while the latter entails a process in which industrialisation spreads out in a series of waves (Puga and Venables, 1996; Fujita, Krugman and Venables, 1999). It is important to highlight the fact that under such model extensions, economic integration –which not only reduces transportation costs but also other trade costs- first produce and then dissolve disparities amongst countries.

Three Regions and Two Countries

In the previous section the original core-periphery model was adapted to international trade. Factor immobility was introduced, and manufacturing became –through intermediate goods- an input and trade costs reflected the many ways by which exchanges can be hindered. The model, however, was based only on two countries and disregarded the internal structure of each country. It is important, therefore, to make a final adjustment to the model to consider more regions than the two-countries two-regions extension described above. The prime example of this extension has been the model developed by Krugman and Livas Elizondo (1996). The final model considers a world economy offering three locations. Location 1 and 2 refer to two different regions (as in the model that does not include international trade) within a country. Location 0 which represents the outside economy, engages locations 1 and 2 in international trade. If we assume that labour is the only factor of production and that there is no agricultural sector, then concentration in either of the two domestic locations (1 and 2) becomes possible (since neither capital nor agricultural labour prevents it). As it stands, only centripetal forces seem to be present in the model and as long as there is a small variation in the employment share –as in past models- concentration becomes possible. However, the model in Fujita, Krugman and Venables (1999), introduces (for simplicity) congestions diseconomies to the size of the agglomeration that diminishes real wages.

F I G U R E 2.6

CONCENTRATION UNDER DIFFERENT LEVELS OF TRADE COSTS



As it becomes evident from Figure 6 the results are fairly similar to the ones achieved by previous models.[12] That is, low trade costs are related to an equal division of employment since the larger market (location 0) to which a large proportion of the production of 1 and 2 go to, make backward and forward linkages rather weak (production is not oriented towards these domestic markets but to international ones) compared to congestion costs. In contrast, high trade costs are associated to concentration since firms rely more on the domestic market and congestion costs are bearable in order to exploit larger linkage effects. However, instead of total concentration in one single location, the two domestic centres of production are of unequal sizes. Therefore, as we increase the number of locations and this become associated to larger or smaller trade costs depending on the proximity to the larger market of location 0, the possible results that emerge can lead either to dispersion or concentration.

The effect of trade liberalisation is therefore, the emergence of a "hierarchy of domestic locations, in which locations have different population

[12] Again, λ refers to employment shares and T to trade costs (in this case, the subscript 0 denotes the international location). Similarly, dashed lines represent unstable equilibria.

sizes and different industrial structures. External trade liberalization causes deconcentration of population and simultaneously, the clustering of particular industries" (Fujita, Krugman and Venables, 1999: 336). In fact, external trade liberalisation results in similar effects to those of a reduction of internal trade costs[13], with the difference that, under free trade, because consumers depend less on local firms, backward linkages are weaker and industrial clustering or specialisation can occur. Therefore, both concentration and dispersion can be the outcome of a process of trade liberalization. Furthermore, concentration of employment does not necessarily entail concentration of all industries since specialisation or clustering can occur.

[13] We can remember that as Ohlin himself expressed, countries are just special types of regions.

Conclusions

The H-O model as explained earlier, based, amongst other things, on initial-endowments differentials between countries, expects factor prices to be equalised (either absolutely or relatively). Such partial or total equalisation of factor prices affects income distribution in the economies involved (Stolper-Samuelson theorem). Just as factor endowments vary across countries, they usually vary across regions in a country. Regional endowment differentials will bring about territorial specialisation and factor-price inequalities. In a similar vein, just as the factor-price equalisation theorem leads to equalisation of factor prices (and income distribution effects according to the Stolper-Samuelson theorem), endowment differentials across regions are likely to result in territorial specialisation and convergence across regions. In fact, Ohlin himself argued that trade is explained by the array and localisation of production in space. Therefore, at least implicitly, trade theory refers to location of production (Johnson, 1981). However, neo-classical models have not yet been extended to include spatial issues.[14]

Similarly, the new trade theory has also disregarded the question of space. Yet new trade theorists have introduced more realistic features such as increasing returns and imperfect competition, which have then, been applied to other theories (such as the new economic geography). In contrast, the new economic geography addresses the interaction between trade and geography, suggesting the possible results of spatial convergence or divergence, depending on the outcome of two countervailing forces: centripetal and centrifugal. In that sense, external economies, proximity to the market and a pooled labour market are the centripetal forces that foster divergence and disparities. However, the theory also contemplates centrifugal forces, which can be regarded as factor immobility, land rent, and congestion costs or any other type of negative externalities that incite both firms and workers to locate elsewhere.

Nevertheless, a common ground can be identified. Despite the evidently differing stories and outcomes of both approaches, they both recognise that initial conditions are a central factor in determining trade (neo-classical) and location (new economic geography). Furthermore, the proposals of both theories acknowledge the benefits of trade. However, they may come to different conclusions when it comes to the distribution of such gains. On the one hand, neo-classical theory, as argued above, implicitly refers to convergence of regions.[15] On the other hand, the new economic geography contemplates both convergence and divergence as possible outcomes. Thus, the

[14] Although Ohlin himself considered that the link between trade and localisation of production was fundamental.

[15] It has previously been acknowledged that the neo-classical theory does not focus on spatial issues and, therefore, this indirect possibility is only addressed here.

new economic geography has taken into account both space and trade and contemplates both dispersion and concentration of activity as a result of two types of forces that operate antagonistically. The recognition of such factors could allow policy makers to design different policies in different arenas –labour, entrepreneurship, R&D, trade, transport, urbanization, amongst others- that take into account the fact that there is in fact, a space to be considered.

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