Chapter 2
The New Economic Geography Approach and Other Views

To say that urbanization is the result of localized external economies carries more than a hint of Moliére's doctor, who explained that opium induces sleep thanks to its dormitive properties. Or as a sarcastic physicist remarked to an economist at one interdisciplinary meeting, "So what you're saying is that firms agglomerate because of agglomeration effects.
Paul R. Krugman (1995, Development, Geography, and Economic Theory, p. 52)

Paul Krugman has clarified the microeconomic underpinnings of both spatial economic agglomerations and regional imbalances at national and international levels. He has achieved this with a series of remarkably original papers and books that succeed in combining imperfect competition, increasing returns, and transportation costs in new and powerful ways. Yet, not everything was new in New Economic Geography.
Masahisa Fujita and Jacques-François Thisse (2010, "New Economic Georgraphy: An appraisal on the occasion of Paul Krugman's 2008 Nobel Prize in Economic Sciences," Regional Science and Urban Economics, Abstract).

2.1 The Setting

In the previous chapter we presented a wide variety of models showing how interactions between agglomeration and long-distance trade influenced the historical development of cities. The presence of nonlinearities most clearly associated with increasing returns of one sort or another lay at the foundation of the discontinuous bifurcations underlying this historical process and its actual historical ruptures. However, since 1991 a literature has appeared that emphasizes different aspects of these ideas, focusing on the increasing returns within a context of monopolistic competition as the source of the nonlinearities and agglomerative tendencies underlying the development of urban centers. This approach ultimately depends on demand-side effects rather than supply-side effects. Cities arise not due to production externalities, but due to consumers favoring a variety of goods, with greater

J.B. Rosser, *Complex Evolutionary Dynamics in Urban-Regional and Ecologic-Economic Systems*, DOI 10.1007/978-1-4419-8828-7_2,

product differentiation occurring within larger urban areas. Cities arise not because of production advantages, but because of the lure of "bright lights" in the big city.

The workhorse model of this approach since 1991 has been the model of monopolistic competition due to Avinash Dixit and Joseph Stiglitz (1977). It was used by Paul Krugman (1979, 1980) to provide an approach to analyzing increasing returns in international trade. This effort, in combination with related work by others (Brander, 1981; Grossman and Helpmann, 1991), would come to be called the New International Trade theory, and the first portion of the citation for Paul Krugman when he won the 2008 Nobel Prize in economics emphasized this breakthrough on his part. It was not illogical then that he would follow the path of the previous Nobel Prize winner in international trade theory, Bertil Ohlin (1933), in moving from international trade to regional economics, aka economic geography, in applying the same model.

While others applied the Dixit–Stiglitz model to regional economics prior to him (Abdel-Rahman, 1988; Fujita, 1988) in the field journal *Regional Science and Urban Economics*, it is not surprising that attention would go to him when he did so without citing their efforts when he made his own application of it in his 1991 article in the *Journal of Political Economy* that would be cited in the second part of the statement about his Nobel Prize, and he would be hailed as the "father of the new economic geography."[1] While he would later coauthor with Fujita on various occasions and then cite his work, he has never cited any of the work presented in the previous chapter, not one single item discussed in that chapter. In the world of Krugman, none of this ever happened, or if it did, it was of no importance whatsoever.

This author does not know exactly what to make of this, but can attest that on more than one occasion he made efforts to get Krugman to acknowledge the existence of this earlier literature, much of which the astute reader will realize was carried out by noneconomists and published in noneconomics journals, although not all of it. One such occasion was in a public setting in the early 1990s at an American Economic Association session that Krugman chaired on complexity economics in which he presented certain ideas related to this that would appear in his 1996 book *The Self-Organizing Economy*. In front of roughly 100 people I asked him if he would be willing to acknowledge some of the unmentioned sources of what he had presented, to which he replied, "We can discuss sources later, next question," and that was the end of that, to this very day. Later this author would send him a draft of my review of his book quoted above (Krugman, 1995), which appeared not too long afterwards (Rosser, 1996) and to which he never replied. This review took him to task much as he is being now for not mentioning any of this literature, and it concluded with the following sentence: "If Paul Krugman is the emperor of the new economic geography, then he is an emperor without clothes."

Indeed, his attitude is fairly well summarized in the quotation from the beginning of the chapter and from that book. While in his 1991 article and in various later writings he recognizes that many have invoked production effects and externalities, going all the way back at least to the work of Alfred Marshall (Marshall and

Paley Marshall, 1879; Marshall, 1919; Belussi and Caldari, 2009),[2] he dismisses such approaches for an alleged lack of mathematical and theoretical rigor, suggesting that they are ultimately circular and empty black boxes, despite a considerable empirical literature studying the subject. His quote from the sarcastic physicist about agglomeration being due to "agglomeration effects" amounts to the high point of this argument, but I leave it to the reader to decide if the sorts of arguments discussed in the previous chapter are totally lacking in mathematical or theoretical rigor.

Now it must be admitted that for some of these models part of Krugman's argument may hold. Thus, while in much of his 1995 book he dismisses earlier work by such figures as Pred (1966) as being not mathematical, he also argues (without citing any literature that he might be referring to) that arguments that can be fitted clearly into conventional neoclassical economic theory are superior. Indeed, this is the great advantage of the Dixit–Stiglitz model as he presents it, not that it is more realistic than other models (in places he admits that its realism is severely limited), but that it is a model that is consistent with standard economic theory, bringing the shaggy dog of increasing returns into the nicely kept house of that theory. Nevertheless, while none of these models invoke the demand-side effects associated with the Dixit–Stiglitz model, many are by economists and provide rigorous mathematical models based on production-side agglomerative effects that closely resemble results presented by Krugman in various of his later works, particularly Papageorgiou and Smith (1983) and Weidlich and Haag (1987). We shall consider his versions of some of this analysis but will note now that it remains a professional scandal that Krugman has to this day never acknowledged the existence of any of this literature, some of which have appeared in economics journals, notably Papageorgiou and Smith in *Econometrica*. There simply is no excuse for this.

Before moving on to discuss the details of how this approach works (and it is able to provide useful insights), I would like to mention how in his 1995 book Krugman dismisses both the earlier nonmathematical literature Pred (1966) while simply pretending that the literature from the 1980s (Papageorgiou and Smith, 1983; Weidlich and Haag, 1987) discussed in this book does not exist. He begins the book by comparing the earlier students of agglomeration (and of economic development as well) to explorers of the African coast in the 1500s. They had maps showing portions of the interior of Africa with real features shown, but also with many errors, such as the presence of nonexistent mythical creatures. Then as knowledge of mapmaking improved, later maps dropped all the information about the interior as it was deemed not to be sufficiently reliable. The pearls of wisdom were lost, until finally in the 1800s explorers with improved technology explored the interior and provided accurate maps that reinstated the previous knowledge, but on a solid foundation. Krugman openly compares himself to these later mapmakers, thereby implicitly not only putting down the earlier figures for their weak mathematics and theory but also simply ignoring all the other "mapmakers" who were working with advanced methods prior to him, but whom he conveniently ignored in his papers in the most widely read journals.

We shall dispense with any further polemics on this unfortunate matter and will proceed to consider the contents of and uses to which this Dixit–Stiglitz approach to the new economic geography (NEG) have been put in subsequent sections, along with some related controversies and issues.

2.2 The Three Returns to Scale

As discussed in the previous chapter, the emergence and existence of spatial concentrations of human population ultimately involves some form of economies of scale to be gained by their so concentrating. These returns to scale broadly take two forms, with one of those subsequently having a further subdivision. The first two are *internal* and *external* economies of scale, a distinction first clearly made by Alfred Marshall (1879), with external economies also taking on this other label of *agglomerative economies*. In turn, external economies of scale are divided between those that occur between firms within a single industry, often called *localization economies*, and those that occur across industries and are associated with the size of the urban area, also called unsurprisingly, *urbanization economies*. Marshall's discussion of the first of these tends to occur using the language of Adam Smith, attributing the internal economies of scale to the division of labor. Regarding external economies, he largely discussed those associated with localization economies, using the term *industrial districts* in most of his discussions. He did not analyze the larger-scale urbanization external economies, and this distinction became more fully developed later as by Hoover and Vernon (1959) and by Chinitz (1961).

The first of these can be characterized as follows. Let production by a firm of a given good i be given by

$$Q_i = f(L_1, \ldots, L_n), \tag{2.1}$$

with Q being output and the Ls being factor inputs. There will exist internal economies of scale for this good by this firm if for any $k > 1$,

$$f(kL_1, \ldots, kL_n) > kf(L_1, \ldots, L_n). \tag{2.2}$$

While Smith emphasized division of labor, the full development of such internal economies of scale in later industrial economies came to be associated with large-scale machinery worked on by many specialized workers, with the development of the assembly line bringing this to its culmination.

Most literature on urbanization does not emphasize this form of economies of scale much as a major source. Part of this is because this formulation is usually set at the firm level, and firms can operate in many locales, with the internal economies coming from organization in the form of managerial economies of scale. What is relevant for urbanization are such economies as they exist for a single production plant within a firm. If such a production facility produces a good that is exported from the area, thus constituting part of the *economic base* of the area, then the needs of its workers and their families for many goods and services of a local sort can lead to the development of the secondary economic activities associated with the export base through a standard Keynesian-style multiplier. Thus, if a plant can become sufficiently large, it can support an urban population that is somewhat larger than the number of its employees.

Probably the major reason that one does not read much regarding such internal economies for urbanization is that there are distinct limits to such internal economies ultimately in all industries. Indeed, it is unlikely that there has ever been a single production facility whose workforce has exceeded 100,000, although the Lenin Steel Works in Magnitogorsk in Siberia employed as many as 60,000 workers at the height of its production activities.[3] This can give us a likely outer limit for such economies as the source for urbanization. If the typical family has four persons, then the workers and their families at a plant the size of the Lenin Steel Works would directly support almost 250,000. Assuming an export base multiplier of 2, this means that a plant such as that could support a city nearly up to half a million people, a pretty good size, but certainly far below by that of the largest cities, indeed probably two orders of magnitude less than the most expansive estimates of the population of metropolitan Tokyo, the world's largest urban agglomeration. Of course, some of these heavy industries with substantial plant-level internal economies of scale also exhibit localization economies, such as in the auto industry in Detroit and the steel industry in Pittsburgh in the past.

Localization economies were the main focus of Marshall in his discussion of industrial districts, and in his 1919 *Industry and Trade* he contrasted them with internal economies not as sources of urbanization per se, but rather in a contrast with American industry, seen as the rival that was to be overcome in any effort to advance British industry in the aftermath of World War I. The US economy was characterized by firms exhibiting internal economies of scale, whereas the British economy was characterized by clusters of small firms and plants within the industrial districts for particular industries such as cotton textiles in Lancashire, woolen textiles in Yorkshire, or cutlery in Sheffield (Belussi and Caldari, 2009). Such localization economies can be characterized as existing for good i if

$$Q_{ix} = f(L_1, \ldots, L_n, Q_{iy}), \tag{2.3}$$

with Q_{ix} being the quantity of good i produced by firm (plant) x and Q_{iy} being quantity of good i produced by firm (plant) y, with these plants being located in the same urban area.

Between his books of 1879 and 1919 as well as in the various editions of his *Principles of Economics*, 8th edition being in 1920, Marshall identified most of the sources of these localization economies that exist, a point that Krugman (1993) largely recognizes. Belussi and Caldari (2009, p. 337) list the following such identifiable sources found in Marshall's work.

(1) Hereditary skill. “The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously” (Marshall, 1920, p. 271).
(2) The growth of subsidiary trades, usually of inputs. Subsidiary firms “grow up in the neighborhood, supplying it with implements and materials, organizing its traffic, and in many ways conducing to the economy of its material (ibid.).
(3) Use of highly specialized machinery, with high division of labor in a district “in which there is a large aggregate of production of the same kind, even though no individual capital employed in the trade be very large” (ibid.).
(4) Local market for special skill, wherein there is “a constant market for skill” (ibid.), and factories do not have a problem finding workers. Krugman (1993) emphasizes that this is a two-way street, with workers possessing the skill willing to work there even though the wages might be slightly lower because of the lower risk of losing a job. If the firm they work for closes, there are others to go to work for, as has been seen in Silicon Valley in California.
(5) Industrial leadership, which “derives from an industrial atmosphere” that stimulates “more vitality than might have seemed probable in view of the incessant change of techniques” (Marshall, 1919, p. 287).
(6) Introduction of novelties into the production process, with good ideas being quickly adopted because they are “in the air” of the district working through its social networks: “If one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas” (Marshall, 1920, p. 271).

Urbanization economies can be characterized at a simple level by changing (2.3) to be externalities across industries. However, they are more frequently simply modeled as economies for a given industry as a function of the size of the urban area itself directly, and Ellison, Glaeser, and Kerr (2010) show that this Marshallian industrial district’s model empirically explains industrial location and urban-scale patterns quite strongly, without any reference to any use of the Krugman application of the demand-side Dixit–Stiglitz approach. We shall now turn to how the Dixit–Stiglitz model has been used to model this phenomenon more specifically.

2.3 The Dixit–Stiglitz Model of Monopolistic Competition

In discussing the Dixit–Stiglitz model, we shall draw from the approach of Fujita, Krugman, and Venables (1999, Chap. 4), henceforth to be labled “FKV.” While they grant that the model is “grossly unrealistic,” they aver that it is “tractable and flexible” and leads to a “very suggestive set of results” (FKV, p. 45). The key to the model is the idea that utility is tied to the diversity of products available, and this diversity increases with the size of an urban area, which becomes the basis for the agglomerative increasing returns. People move to the big city to work because of the diversity of products available for them as consumers, not because of any productive efficiency in the places of work that they might be employed in.

Central to the argument is the formulation of the utility function, assumed identical across agents, which is of the CES form. Letting A be agriculture consumed and $m(i)$ be consumption of the ith manufactured good with n the range of such manufactured goods, utility is given by

$$U = A^{1-\mu}\left[\int_0^1 m(i)^\rho \mathrm{d}i\right]^{\mu/\rho}, \quad 0 < \rho < 1. \tag{2.4}$$

As with CES functions, a crucial variable is the elasticity of substitution, σ, which happens to equal $1/1–\rho$. This determines the strength of the agglomerative effect and falls with σ.

The budget constraint is given by

$$Y = p^A A + \int_0^n p(i)m(i)\mathrm{d}i, \tag{2.5}$$

where the ps are the respective prices of agricultural and manufactured goods. A price index can be constructed as

$$G = \left[\int_0^n p(i)^{1-\sigma}\mathrm{d}i\right]^{1/(1-\sigma)} = p^M n^{1/(1-\sigma)}. \tag{2.6}$$

Given all this, maximizing (2.4) subject to (2.5) yields uncompensated demands

$$A = (1-\mu)Y/p^A, \tag{2.7}$$

$$m(j) = \mu Y p(j)^{-\sigma}/G^{-(\sigma-1)}, \quad \text{for } j \epsilon [0,1], \tag{2.8}$$

associated with indirect utility function

$$U = \mu^\mu (1-\mu)^{1-\mu} Y G^{-\mu} (p^A)^{-(1-\mu)}. \tag{2.9}$$

Introducing this into a spatial context to analyze regional economic activity, transportation cost must be considered, with Krugman in his key 1991 paper introducing the notion of the volume of goods arriving at a destination declining linearly with distance from their production site like an iceberg melting over a distance it travels in water.[4] If production is at site r, then transport cost of M from r to site s is given by ${T_{rs}}^M$, and the delivered price index is given by

$$G_s = \left[\sum\nolimits_{i=1}{}^R n_r ({p_r}^M {T_{rs}}^M)^{1-\sigma}\right]^{1/(1-\sigma)}, \; s = 1, \ldots, R, \tag{2.10}$$

which implies that the quantity of r variety manufactured good consumed at s will be

$$q_r^M = \mu \sum\nolimits_{i=1}{}^R Y_s ({p_r}^M {T_{rs}}^M)^{-\sigma} {G_s}^{\sigma-1} {T_{rs}}^M. \tag{2.11}$$

Assuming Chamberlinian monopolistic competition, with F being fixed input requirement and c^M being marginal input requirement, the labor input for M will be

$$1^M = F + c^M q^M, \tag{2.12}$$

implying an equilibrium labor input of

$$1^* = F + c^M q^* = F\sigma, \tag{2.13}$$

derived from the profit-maximizing output

$$q^* = F(\sigma - 1)/c^M. \tag{2.14}$$

This implies a "home market effect" due to the nonexistent transport costs of home-produced goods (identified by Ohlin in 1933), which implies that as manufacturing increases, there is a gain in the real manufacturing wage at the production site r. Nominal manufacturing wage at r is expressed as,

$$w_r{}^M = \left[(\sigma - 1)/\sigma\right]\left[(\mu/q^*)\sum{}_{i=1}{}^R Y_s(T_{rs}{}^M)^{1-\sigma} G_s{}^{\sigma-1}\right]^{1-\sigma}. \tag{2.15}$$

Real wage, ω, is then given by

$$\omega_r{}^M = w_r{}^M G_r^{-\mu}(p_r{}^A)^{-(1-\mu)}. \tag{2.16}$$

If there is no limit on this effect, then the economy will simply collapse into a single point. This can be avoided by imposing a "no black hole condition," which can be assured by assuming that

$$(\sigma - 1)/\sigma = \rho > \mu. \tag{2.17}$$

With this assumption holding, a spatially dispersed economy can exist and persist, and we have the pieces in place to study the implications of the new economic geography.

2.4 Bifurcations of the NEG Core–Periphery Model

A major focus of the important 1991 paper by Krugman was to show the emergence of an urbanized area out of an even distribution of population through bifurcations of the system. This emerged urban area is viewed as a core in which manufacturing becomes concentrated, with the other areas containing only agricultural workers.

To carry out this analysis, we shall consider a two-region system. We introduce λ to represent the fraction of manufacturing workers that are in a region 1, implying that (1–λ) is the share of manufacturing workers for region 2. Given this and (2.4)–(2.17), equilibrium for the system is given by the following eight equations, which represent, respectively, the incomes for the two regions, the price indices for the two regions, nominal wages for the two regions, and real wages for the two regions, with both nominal and real wages being those for manufacturing (without superscripts), again from Fujita, Krugman, and Venables (1999, p. 65).

$$Y_1 = \mu\lambda w_1 + (1-\mu)/2, \tag{2.18}$$

$$Y_2 = \mu(1-\lambda)w_2 + (1-\mu)/2, \tag{2.19}$$

$$G_1 = [\lambda {w_1}^{1-\sigma} + (1-\lambda(w_2T)^{1-\sigma}]^{1/1-\sigma}, \tag{2.20}$$

$$G_2 = [\lambda(w_1T)^{1-\sigma} + (1-\lambda){w_2}^{1-\sigma}]^{1/1-\sigma}, \tag{2.21}$$

$$w_1 = [Y_1{G_1}^{\sigma-1} + Y_2{G_2}^{\sigma-1}T^{1-\sigma}]^{1/\sigma}, \tag{2.22}$$

$$w_2 = [Y_1{G_1}^{\sigma-1}T^{1-\sigma} + Y_2{G_2}^{\sigma-1}]^{1/\sigma}, \tag{2.23}$$

$$\omega_1 = w_1{G_1}^{-\mu}, \tag{2.24}$$

$$\omega_2 = w_2{G_2}^{-\mu}. \tag{2.25}$$

Bifurcations of this system are driven by variations in transport costs, T. With high T, both regions supply themselves with manufactures. As T declines, a bifurcation occurs with multiple equilibria possible, and as T declines further, the definite pattern of one region specializing in manufacturing (and presumably urbanized) with the other purely agricultural emerges. This pattern is shown in Figs. 2.1, 2.2, and 2.3 (Fujita, Krugman, and Venables, 1999, pp. 66–67), with for all of them the horizontal axis being λ, the share of manufacturing in region 1, and the vertical axis being ω_1–ω_2, the real manufacturing wage in region 1 minus that in region 2.

In the intermediate case, the even distribution outcome still exists and is stable, but there exist two unstable equilibria on each side of it, so that if the share is beyond those on one end or the other, an uneven distribution will emerge. This pattern of bifurcations is shown in Fig. 2.4 (Fujita, Krugman, and Venables,

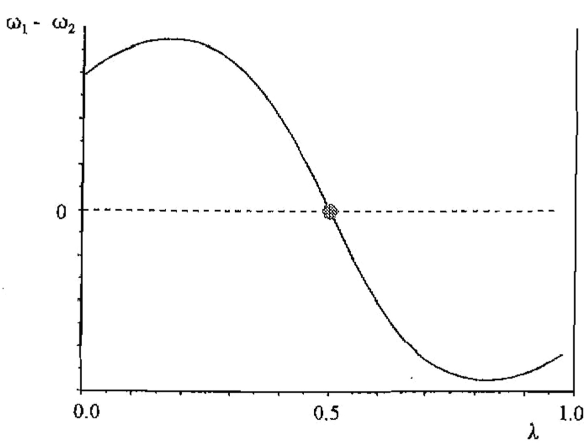


Fig. 2.1 Even distribution

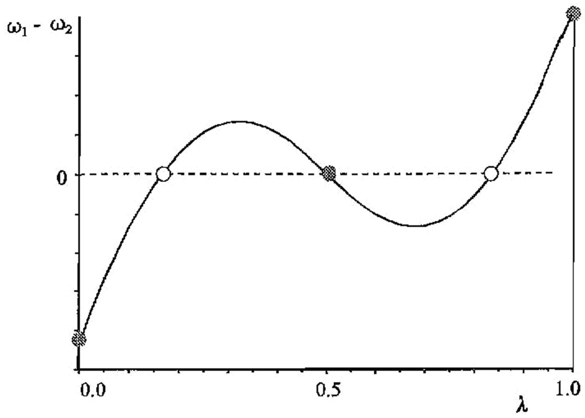


Fig. 2.2 Intermediate case (2 region case)

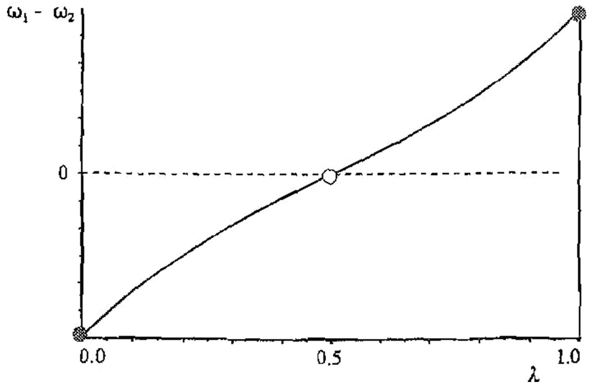


Fig. 2.3 Manufacturing concentrated in region 1

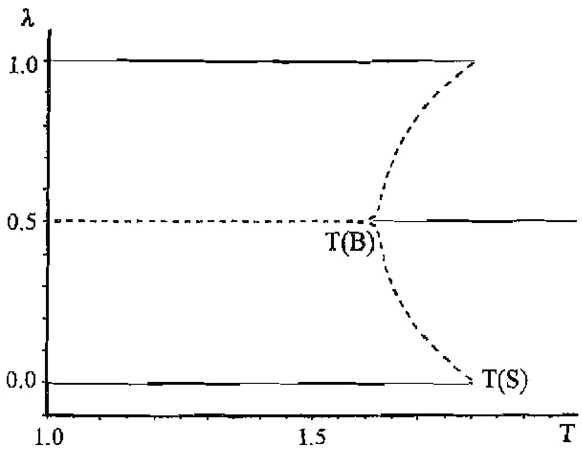


Fig. 2.4 Tomahawk bifurcation

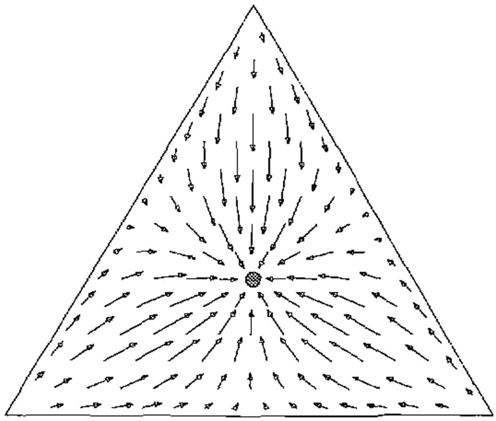


Fig. 2.5 Even distribution between regions

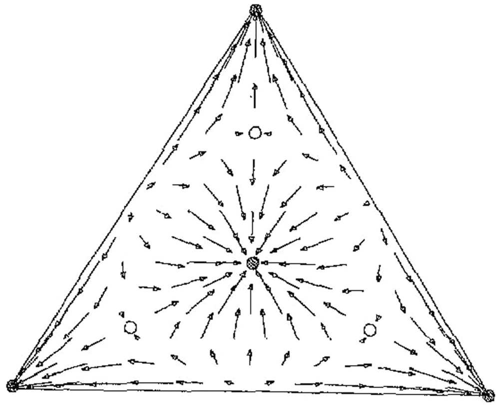


Fig. 2.6 Intermediate case (3 region case)

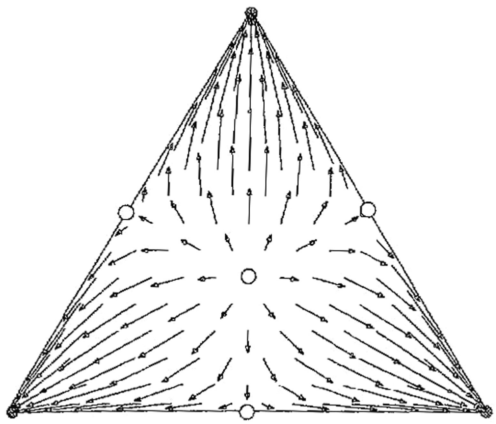


Fig. 2.7 Strong concentration in three regions

2003, p. 68), a "tomahawk" bifurcation, with transport cost on the horizontal axis and the manufacturing shares of the regions shown on the vertical axis.

If one extends this analysis to the three-region case, one gets a similar set of results, three cases ranging from even distribution, through an intermediate case of multiple equilibria, to one of a single region emerging as the core center. These are shown in Figs. 2.5, 2.6, and 2.7 (Fujita, Krugman, and Venables, 1999, pp. 80–81). Note the close similarity of this analysis to that of Weidlich and Haag (1987), as shown in Figs. 1.2, 1.3, and 1.4.

2.5 The Core–Periphery Model at the Global Level

The core–periphery model based on agglomeration reflects a long tradition of studying cumulative processes across trading regions (Rosenstein-Rodan, 1943; Perroux, 1955; Myrdal, 1957; Dendrinos and Rosser, 1992; Matsuyama, 1995; Fujita and Thisse, 2002). Closely linked to the models of endogenous growth, this idea has also been extended using models based on the Dixit–Stiglitz model as laid out above (Baldwin, 1999; Martin and Ottaviano, 1999; Puga, 1999), with these arguments being summarized in *Economic Geography and Public Policy* Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud (2003), henceforth BFMOR. It is useful at this point before proceeding further to clarify some of the features of what has been derived so far, which are familiar from our earlier discussions of catastrophic processes in Rosser (2000a, Chap. 2), reappearing in this volume as Appendix A.

The first of these is *circular causality*. This arises from both demand-side features due to the positive feedback of increased diversity of goods and cost-side effects due to the magnifying home market effect, although in some broader applications one or the other of these may not be operative.

Another is *endogenous asymmetry*. This is the feature in which a lowering of transport costs brings about the bifurcation in which one region specializes in manufacturing while the other does not, with a divergence in real incomes arising from this. In the broader BFMOR view, this lowering of transport costs can also be associated with an increase in economic integration or freer trade at a global level in terms of international trade.

Another is *catastrophic agglomeration*. This is simply the process that develops after a bifurcation point is passed that results in the endogenous asymmetry. Symmetry of even development across regions is broken, and there is a concentration of the industrial growth in one of the regions.

Another is *locational hysteresis*. This is associated with the multiple equilibria arising from the tomahawk bifurcation. Once a bifurcation is passed and catastrophic agglomeration occurs, it is not so easily undone by a reversal of the underlying trends of parameter evolution.

Yet another is *hump-shaped agglomeration rents*. This is essentially a measure of the difference in real wages in the two regions that arises after the catastrophic agglomeration occurs. However, this reflects a feature we have not observed previously particularly. This feature implies that while initially there is an increase in the difference from zero to a positive number as transportation costs decline, eventually this difference will turn around and start declining after some point as the transportation costs continue to decline with it, disappearing again when those costs reach zero. After all, it is the existence of positive transportation costs that is crucial to the existence of the home market effect, which disappears if those transportation costs are zero. In effect, in this extreme case, the two regions have effectively collapsed into one from the standpoint of regional economics, as it is the existence of transportation costs that allows for the differentiation between regions in the first place.

Finally there is the possibility of *self-fulfilling expectations*. In a situation where the system is in the "overlap" zone of multiple equilibria from an initial symmetry, expectations of agents can put a region into one side or the other, with reallocations possible. That has been implicitly a matter of a random shock, but that shock may itself be due to some actions by agents in one or the other of the regions to make it move first to gain an edge in the industrialization process.

In BFMOR (Chap. 7), the model is expanded to bring in endogenous growth with investment in fixed capital and learning. A particularly interesting model is derived based on *local spillovers*, which differs in certain features from what we have seen previously.[5] In particular, the tomahawk bifurcation reverses itself so that there is no longer a zone of five equilibria. This is seen in Fig. 2.8 (Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud, 2003, p. 179), in which S_K now represents the share of industrial capital stock in one region versus the other, and $\Phi = 1/T$ from the earlier analysis. That is, Φ can be viewed as the degree of "trade openness" or integration associated with lower transport costs.

This model has similar features as that of the basic core–periphery model, with the main exception being that there is no longer the ability for self-fulfilling expectations to effectuate a reallocation once the bifurcation point has passed. This

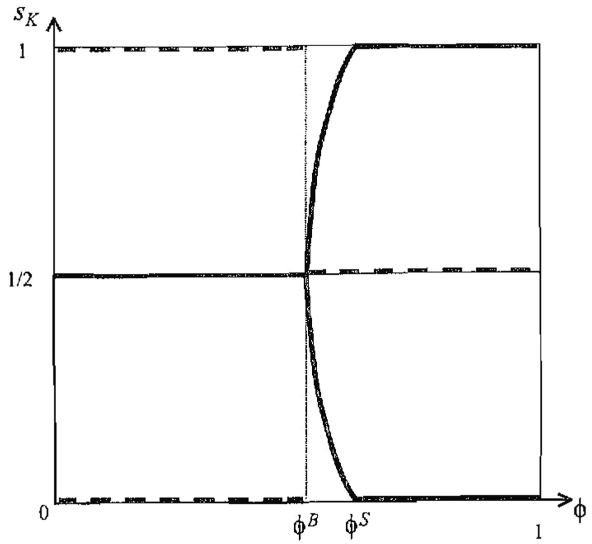


Fig. 2.8 Tomahawk bifurcation with local spillovers

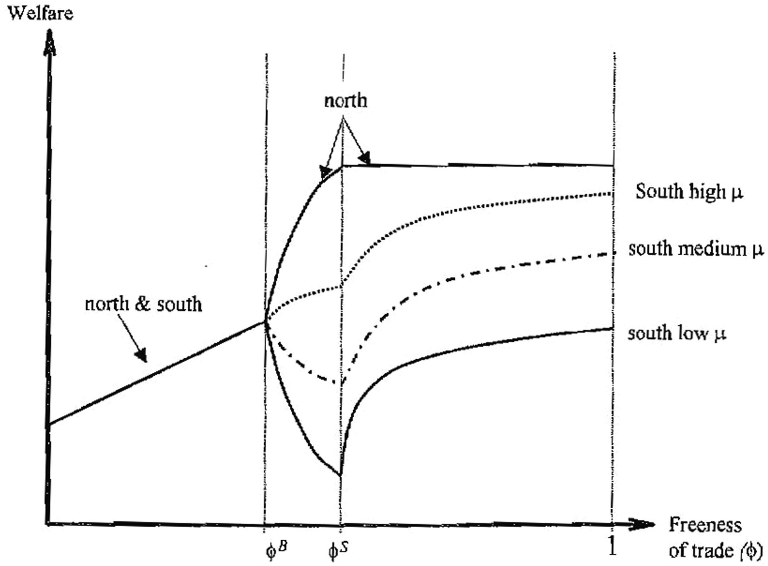


Fig. 2.9 Can the periphery gain from agglomeration?

is tied to the reversal of the tomahawk bifurcation. Intuitively, with fixed capital and reinforcement due to learning in the labor force, the distinct equilibria are now more seriously entrenched and cannot be so easily restructured.

Figure 2.9 (Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud, 2003, p. 185) provides a broader picture of this outcome, with the industrialized region being labeled "north" and the agricultural region being labeled "south." The parameter μ is the same as in earlier equations in this chapter and plays an important role. Thus, in all cases the breaking of the symmetry at the bifurcation leads to a regional divergence of incomes with the north doing better than the south. However, whether the south actually experiences an initial decline in income or not depends on its relation to the industrial sector. It can fall or it can rise, but once the "sustain" point is reached, it will rise.[6] But it will more rapidly approach the income level of the north if μ is higher in the south. The more it purchases industrial goods, in effect the more it can take advantage of the economies of scale that are occurring in the agglomerating region, with its purchases reinforcing those returns to scale.

2.6 Chaotic Dynamics in a Discrete Version of the Core–Periphery Model

It is well known that for many systems that chaotic dynamics can occur for cases that are discrete with one less dimension than for the case of a continuous version. The literature we have discussed so far have involved continuous dynamics. None of the models discussed have been shown to exhibit chaotic dynamics. However, indeed, core–periphery models along the lines that have been presented here so far have been shown capable of exhibiting chaotic dynamics when in discrete form (Currie and Kubin, 2006; Commendatore, Currie, and Kubin, 2007; Commendatore, Kubin, and Petraglia, 2009; Commendatore and Kubin, 2010). While the second of these involves footloose capital between the regions, we shall look more closely at the first of these, which suggests that some of the generalizations made for the continuous model may not be robust considering a discrete version. In particular, destabilization may occur for the case of high transport costs in contrast with the continuous model.

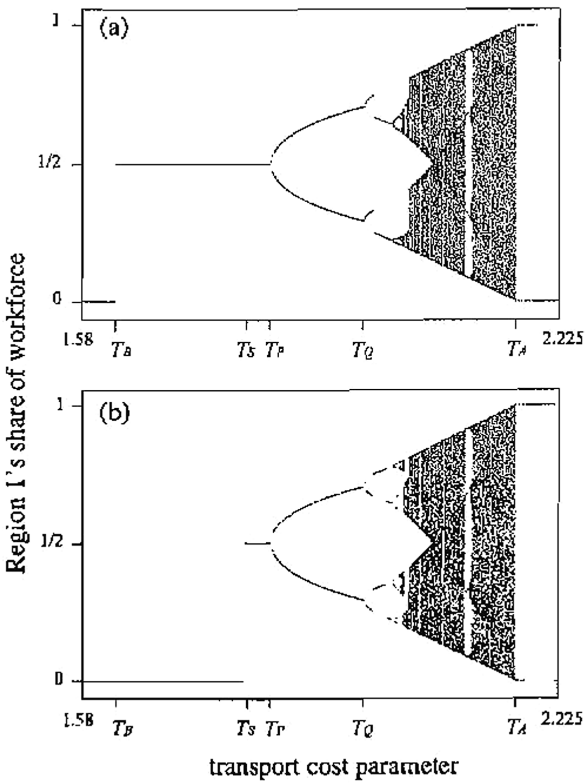
Currie and Kubin (2006) draw on the FKV model as presented above for their analysis. Their change in the model involves two elements. One is to introduce a migration speed parameter, γ, and also to make migration a discrete process. It is the combination of these two changes that alters the qualitative dynamics of the system. It does not do so for the low transport cost case, where changing migration speeds within the discrete formulation merely changes how rapidly the system converges onto a particular core–periphery equilibrium pattern. However, for the high transport cost case, the qualitative dynamics change.

In particular, higher migration speeds can lead the system to overshoot the symmetric equilibrium if it does not start from there initially, which also emphasizes that the system is sensitive to starting-point conditions. If such an overshoot occurs, then it is possible for cycles to emerge where workers migrate back and forth, with the possibility of a core–periphery outcome also obtaining. As the migration speed increases or the transport costs increase, period-doubling bifurcations can occur, and chaotic dynamics can emerge. Such an outcome for rising transport costs for a given set of values of σ (the taste for diversity), μ (the share of manufacturing), and the labor supply, L, is shown in Fig. 2.10 (Currie and Kubin, 2006, p. 262), with 2.10a showing the starting point near a symmetric fixed point, while 2.10b shows the starting point far from a symmetric fixed point. In both cases, chaotic dynamics tend to emerge when transport costs are higher.

Regarding the role of migration speed, if it is slow enough, then for the high transport cost case, the symmetric fixed point of equal dispersion of industry can be a stable attractor, as in the continuous case. However, for a given set of other parameters for the high transport case, there will exist a bifurcation value of the migration speed, γ_p, such that for migration speeds exceeding this, the symmetric equilibrium becomes destabilized and cyclical and even chaotic dynamics can appear. This phenomenon arises from the discrete map of shares, λ_t and λ_{t+1}, becoming "stretched" as γ increases. There are actually two critical values, with another one appearing above which the system simply goes to an agglomeration outcome, γ_p. This stretching does not involve any change in the positions of the equilibrium outcomes, merely in the dynamic patterns going on around them. This is depicted in Fig. 2.11 (Currie and Kubin, 2006, p. 268), with 2.11a showing the stretching of the discrete map, and 2.11b showing how these critical values of γ vary with the transport cost, T.

Thus, in a discrete setting, substantially greater complexity of dynamics can be seen for the new economic geography model of core–periphery dynamics. The generalization that core–periphery outcomes appear only with low transport costs

Fig. 2.10 Bifurcation diagrams for T from different initial points



disappears, and it is also clear that outcomes are dependent on such matters as migration speeds as well as initial conditions.

2.7 Criticisms of the New Economic Geography

It is not the author's intention now to revisit the points raised in the opening section of this chapter. Rather, given the widespread use that the new economic geography has come to have with numerous researchers investigating the implications and extensions of the model, we now wish to consider other critiques that have been raised regarding its use, noting that not all of these arguments the author necessarily agrees with.

Some of the criticisms represent ongoing debates between traditional geographers and economists, although others are more complicated. However, some of the arguments by traditional geographers involve criticizing the use of mathematical economic theory as opposed to studying specific cases and their circumstances, harking back to the old *methodenstreit* between the Neoclassicals and the Historical

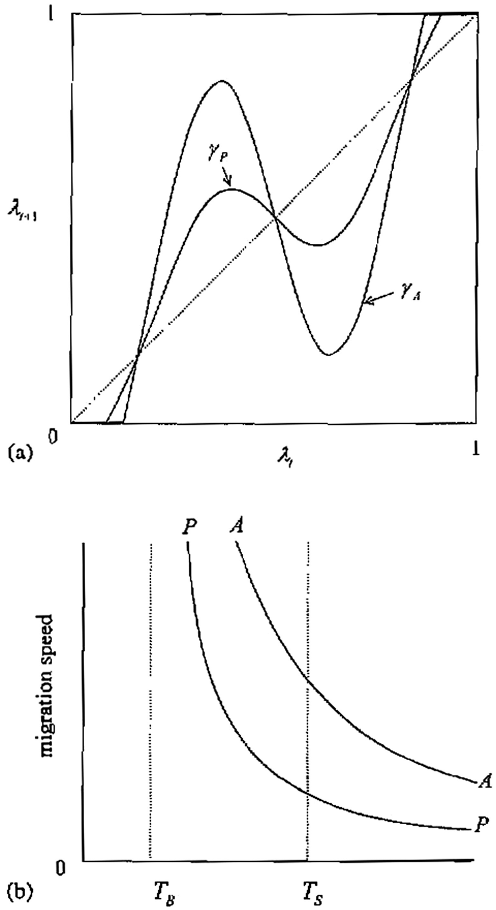


Fig. 2.11 Significance of migration speed

School in Germany in the late 1800s, which was replayed in the US in economics in the twentieth century, with the Institutionalists standing in for the Historical School.

Much in this vein was a critique by the geographer Ron Martin (1999), although published in an economics journal (the *Cambridge Journal of Economics*). Martin's aim is much broader than just the Fujita–Krugman version of new economic geography presented above. It is indeed all of formal mathematical theory, including the formal location theory of the German tradition from von Thünen (1826) through Weber (1909) to Christaller (1933) and Lösch (1940), although he seems to accept strictly geometric analysis coming out of this tradition. He sees this tradition as being broken into two strands by Walter Isard (1956) with his invention of *regional science*, which is seen as formal and mathematical. It is to be contrasted with *economic geography*, and Martin's position in favor of the latter is given by the following (Martin, 1999, p, 66).

> Economic geography, on the other hand, had by this time [1950s-60s] evolved into a more eclectic and empirically-orientated subject, in which formal neoclassically-orientated location theory had been largely displaced by concepts imported from other branches of economics: for example, Keynesian business cycle models, Myrdalian cumulative causation theory, and Marxian notions of uneven accumulation. Since the late 1980s, economic geography has undergone a further vigorous expansion, incorporating ideas from French regulation theory, Schumpeterian models of technological evolution, and institutional economics. And, even more recently, it has turned to economic sociology and cultural theory for inspiration.

It is not surprising given this that Martin concludes that the new economic geography is a "case of mistaken identity," with "too little region and too much mathematics." He accuses both regional science and the new economic geography of the sin of "positivism" and argues that proper economic geography is empirically based and builds "up from below" a view of what is going on in a particular area, following the precepts of critical realism instead (Lawson, 1997). He poses as good examples of the way to go the "Third Italy" movement of neo-Schumpeterian neo-Marshallians who empirically and institutionally and historically have studied industrial districts in Italy (Brusco, 1989; Antonelli, 1990), with the study by Buenstorf and Kappler (2009) of the Akron tire cluster fitting into this tradition as well.

Despite his criticism of the use of mathematics, Martin has since joined those advocating an *evolutionary economic geography* (Boschma, 2004; Boschma and Martin, 2007; Frenken and Boschma, 2007; Jovanović, 2009). While this approach does not use standard formal mathematics, this group tends to an interest in complexity and nonlinear dynamics approaches, although calling more on such figures as Beinhocker (2006) for inspiration than Puu, or Allen, or Weidlich. Nevertheless, Arthur (1994) is a strong inspiration, and Fujita provided a friendly Foreword to the book by Jovanović (2009). In any case, this group also continues to stress empirical study of specific cases from an eclectic perspective.

Perhaps a sharper critique comes from J. Peter Neary (2001) who does not have much sympathy for the arguments of Martin (1999), with Neary having no problems at all with conventional mathematical neoclassical theory. While he agrees with Martin that the new economic geographers have been very weak on doing empirical studies, he sees the approach advocated by Martin as being too much of a "case studies" approach that fools itself into thinking that it is "theory free." He does suggest that the few empirical studies attempting to support the new economic geography have provided mixed results, with Kim (1995) finding the story breaking down for the US after World War II, a result that Krugman himself now agrees with (2009).[7] At the same time Davis and Weinstein (1999) find support for it in regional patterns of industry within Japan.

Another is that there is effectively no theory of the firm arising from the Dixit–Stiglitz model. Free entry exists at all locations leading to "footloose cities" in principle, although variations of fixed or floating capital in the new economic geography models did come to be studied by Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud (2003). But there remains no ability for firms to strategically interact with each other. The “myopic Chamberlinian firms” cannot engage in industrial strategies to “shore up their positions” (Neary, 2001, p. 50). “They cannot make strategic commitments to create artificial barriers to entry, nor vertically integrate to internalize the externalities arising from the combination of intermediate inputs with increasing returns. And, of course, out-sourcing or cross-border horizontal mergers in response to changes in trade, policy, technology, or market size are not allowed.” (ibid) All this reduces the relevance of the model to industrial location theory, according to Neary.

Finally, Neary is unhappy about the simplification that the model is implicitly on a line rather than in a true space. While it is able to show the “shadow” of an emergent urban center on a neighboring area as a potential urban center, it does not present the full array of possibilities. This combines with some other simplifying assumptions, such as free transport of agricultural goods,[8] to place serious limits on the generality of the approach, especially given the weaknesses already mentioned regarding its lack of focus on the supply side and its weak theory of the firm. Nevertheless, in spite of all the criticisms, Neary in the end praises the new economic geography as harking back to the work of Bertil Ohlin that combined international and interregional trade theory.

Notes

1. Of the inventors of the model used by Krugman, of course Stiglitz had earlier won a Nobel Prize for his work on asymmetric information in 2001, while Dixit never has, which is true of Fujita as well.
2. Although Marshall had priority, the possibility of multiple equilibria when there are positive externalities of other firms in a region was recognized in the classical German industrial location theory of Weber (1909), as well as in Rietschl (1927), Ohlin (1933), and Palander (1935), as well as later literature such as Kaldor (1970) and Arthur (1986). Most of this literature was mathematical, assuming as in our analysis below that the externalities are production-related rather than deriving from the demand side as with Dixit and Stiglitz (1977), Fujita (1988), and Krugman (1991).
3. The Lenin Steel Works was named a Hero Plant by Josef Stalin for its role in producing steel for the tanks used in the decisive battles of Stalingrad and Kursk during World War II against the Germans, with their location east of the Ural mountains protecting them against the German invaders. It is a pathetic commentary on the problems of socialist central planning that when the Soviet Union finally collapsed at the end of 1991, the steel produced at the Lenin plant could only be sold on international markets as scrap metal, a symbol of its ultimate dysfunctionality in an age in which such internal economies have become far less important.
4. This “iceberg” analogy first appeared as such in Samuelson (1952), although it can be seen as similar to the idea found in von Thünen (1826) that animals eat grain as they are transported to a final consumption location.
5. Other models discussed by Baldwin, Forslid, Martin, Otaviano, and Robert-Nicoud (2003) include a footloose capital model, a footloose entrepreneur model, a constructed capital model with global spillovers, along with some other minor variations.
6. This corresponds in effect to the argument of Krugman (2009) in his Nobel Prize address in which he argues that the divergence between the core and the periphery between US regions reached a maximum during the 1920s and that in effect the declines in transport costs since then have been associated with a movement toward convergence between the regions rather than more divergence.

7. While the support for the Krugman-inspired use of the Dixit–Stiglitz model is weak, support for the supply-side approach of Marshall is strong (Ellison, Glaeser, and Kerr, 2010). This model is really kind of halfway between being a model of simply industry agglomeration and a broader urbanization model in that it looks at linkages across industries as explaining the agglomeration of a given industry cluster, thus providing the foundation for explaining how the presence of one industry can attract another closely related to it, much as in classic models of development looking at "forward" and "backward" linkages.
8. Davis (1998) shows that transport costs for nonindustrial goods are nearly as great as those for industrial goods and that this can break down the "home market effect" argument as it is presented by Krugman.

Springer

http://www.springer.com/978-1-4419-8827-0

Complex Evolutionary Dynamics in Urban-Regional and Ecologic-Economic Systems
From Catastrophe to Chaos and Beyond
Rosser, J.B.
2011, XI, 320 p., Hardcover
ISBN: 978-1-4419-8827-0