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Ad usum delphini:

A Primer in 'New Economic Geography'

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Ad usum Delphini:
A primer in 'new economic geography'*

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Abstract

This paper discusses the intellectual origins of the so-called 'new economic geography' and provides its basic insights by means of a streamlined framework which stresses the generality of their implications.

*At the court of the king of France Louis XIV the education of the crown prince (*Delphinus*) was also pursued by streamlined versions of classical Latin writers. These versions were written *ad usum Delphini*, that is 'for the use of the crown prince', and they were later adopted as textbooks in French schools.

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1 Introduction

What forces shape the economic landscape? What brings economic agents together or drives them apart? Why do regions, that have been similar for centuries, all of a sudden start becoming increasingly different? What is the role of obstacles to trade and factor mobility?

Despite some valuable early contributions made by Perroux (1950), Myrdal (1957), or Hirschman (1958), these questions remained unanswered by mainstream economic theory for a long time. It is only recently that economists have become able to provide an analytical framework explaining the emergence of economic agglomerations in an otherwise homogeneous space (see, e.g., Beckmann and Thisse, 1986). As argued by Krugman (1995), this is probably because economists lacked a model embracing both increasing returns and imperfect competition, the two basic ingredients of the formation of the economic space, as shown by the pioneering work of Hotelling (1929), Lösch (1940), Isard (1956) and Koopmans (1957).

A general model of general equilibrium with imperfect competition has so far been out of reach (Bonanno, 1990). However, specific models have been developed that, taken together, have increased our understanding of the way the space economy works (Fujita and Thisse, 1996).

Among these models an increasing number of contributions (see, e.g., Krugman, 1991a; Krugman and Venables, 1995; Fujita, Krugman and Venables, 1999, to cite only the three best known works) make use of a particular implementation of the Chamberlinian paradigm (Chamberlin, 1933) of monopolistic competition (Spence, 1976; Dixit and Stiglitz, 1977). Their aim is to use this specific analytical framework in order to construct 'clarifying examples' enhancing our understanding of how the obstacles to the spatial mobility of goods and factors affect economic geography (Krugman, 1995).

This line of research, sometimes dubbed, with some abuse of name, 'new economic geography' (Krugman, 1991b)¹, is the updated version of

¹See Ottaviano and Puga (1998) for a detailed survey of what has been accom-

an ambitious research project that goes back at least to Ohlin's (1933; 1967, revised edition) fundamental contribution to the theory of international trade.² In his essay Ohlin challenges the common wisdom that considers international trade theory as separate from location theory:

"international trade theory cannot be understood except in relation to and as part of the general location theory, to which the lack of mobility of goods and factors has equal relevance"
(Ohlin, 1967, p.97, emphasis in the original).

The reason being that changes in the transportability of commodities as well as in the mobility of factors affect the location of industry, the distribution of labor and capital, the geography of demand and, therefore, the pattern of trade.³

Building on the seminal works by von Thünen (1826), Marshall (1890), and Weber (1909), Ohlin provides deep insights on how the explicit consideration of space affects (and, sometimes, even reverses) some of the main conclusions of the neoclassical paradigm of trade theory.⁴ However, once more, the robustness of the analysis is undermined by the lack of a model dealing with both increasing returns and imperfect competition,⁵ so that, somewhat paradoxically, Ohlin's contribution is mainly identified with his spaceless model: *International Trade Simplified*.⁶ New and more powerful analytical tools being available now, 'new economic geography' may be seen to start from where Ohlin had to stop.

In a strict sense to the so-called 'new economic geography' belong all the models that use chamberlinian monopolistic competition to study the impact of trade costs on the geographical distribution of economic

published in this field. For an outsider's critical assessment see Martin (1999).

²See, also, Ohlin, Hesselborn and Wijkman (1977) and Findlay (1995).

³See, Ohlin (1967), Ch. XI-XII.

⁴See, Ohlin (1967), Part Three, pp. 97-165.

⁵See, Ohlin (1967), Ch. III.

⁶Ohlin (1967), Part Two, pp. 49-93.

activities.⁷ Since the seminal contributions by Paul Krugman (1991a,b) models of this kind have proliferated in a somewhat chaotic way giving rise to what is often perceived as a *collection of special cases*. To this perception contribute many factors. First of all, the vocabulary is confusing. Different people call the same things with different names and different things with the same names. Second, the common literary roots are not always acknowledged. Authors show idiosyncratic tastes for precursors and like to trace back their inspiration to petty defunct economists. Third, most models are based on very restrictive modelling choices and nonetheless are not amenable to analytical solutions. A skeptic cannot help reading their numerical results as special cases of special cases. The overall impression might well be to face a group of researchers who speak about the same issues using different languages, having a patchy idea of the literature and showing little awareness of the potential weakness of their results.

The aim of this short paper is to challenge this overall impression by pointing out some fairly general insights of ‘new economic geography’. This will be achieved by distilling its essence, that is, by stripping its conceptual framework to the bones and by sorting out its vocabulary. The remainder of the paper is in four parts. Section 2 provides a streamlined textbook model of ‘new economic geography’. Section 3 ties some of its loose ends and points out some directions of future research. Section 4 provides a concise dictionary. Section 5 concludes.

2 Conceptual framework

Contrary to the general perception, the basic underpinnings of ‘new economic geography’ can be easily conveyed by means of models which are very simple and yet have quite general implications. This section presents

⁷Trade costs consist of all costs associated with the exchange of goods and factors among agents located in different places. Some of these costs are due to the sheer existence of distance (e.g., transport costs), others arise from institutional barriers (e.g., tariffs or quality and safety standards) or even from linguistic and cultural differences (e.g., business practices).

a couple of examples with the aim of clarifying the two blueprint mechanisms that 'new economic geography' stresses as key explanations of the geographical agglomeration of economic activities.

2.1 Demand linkages

The first model is meant to capture the insights of Krugman (1991a,b). The idea is that, when a firm moves its production facilities to a new site, some of the income it generates is spent locally (*demand linkage*). As a result, when a new firm starts production in a certain place, it has a double effect on the local market conditions. On the one side, it makes local competition fiercer (*competition effect*). *Ceteris paribus*, this would cut profits industrywide forcing some firms to leave the market. On the other side, the fact that some of the income it generates is spent locally increases the size of the local market (*market size effect*). *Ceteris paribus*, this would increase local profits attracting more firms from other regions. With perfect competition this latter effect is negligible so that, if locations are fairly similar in terms of preferences, technology and factor endowments, the agglomeration of an industry in a few locations will never be observed in equilibrium. By contrast, with imperfect competition, the market size effect may be strong enough to offset the competition effect. In this case, since they offer higher profits, locations with even slightly more firms are better places to set up new firms. This creates a circular causation mechanism among firms location decisions that is able to foster industrial agglomeration.⁸

A simple way to model this idea is the following. Consider an economy made of two regions, a home region and a foreign region. Things pertaining to the former bear no label while those pertaining to the latter are labelled by a star. Each region is endowed with two factors. One factor cannot move between regions and its endowment, say A , is the

⁸This is reminiscent of the results obtained in recent shopping models where more firms in a given location attract more consumers due to the higher expected match, and earn higher profits despite the intensified competition (Schultz and Stahl, 1996; Gehrig, 1998).

same in both regions. The other factor is mobile, its total endowment is L^T and is split so that L units are in the home region. Factor owners reside where their belongings are located so that factor incomes are linked to factor locations. There are two goods, a homogeneous good Y and another good X , which is horizontally differentiated in N varieties.

The Y -good is produced by employing the immobile factor A as the only input under constant returns to scale. This good is freely traded between regions and is chosen as numéraire. The X -good uses only the mobile factor L under increasing returns to scale. Its interregional exchange is hampered by trade costs: τ units of the numéraire have to be paid for each unit of X shipped.

To sharpen the analysis, assume that preferences are separable across the two goods, being linear in good Y and symmetric in the varieties of good X . In particular, in the home region the demand for a typical variety is assumed to be:

$$q = [a - p + bP][A + L] \quad (1)$$

and symmetrically in the foreign region. In (1) q is the quantity demanded of the typical variety, p is its price, P is the market price index:

$$P = (np + n^*p^*)/N \quad (2)$$

In (2) n and n^* are the numbers of varieties produced respectively in the home and in the foreign regions ($n + n^* = N$). Therefore, P is the average market price in the home region. The function (1) shows that the demand for a variety decreases with its price and increases with the price of other varieties. The intensity of this second effect depends on the value of $b < 1$ that measures the substitutability between varieties. As it is reasonable, if substitutability is good (b is large), the demand for the typical variety is strongly affected by the price of other varieties.

Turning to the supply side, we assume that production of the Y -good requires one unit of factor A for each unit of output, while production of the X -good needs a fixed input requirement f of factor L to start production plus c units of the numéraire for each unit of output. Market structure is perfectly competitive in sector Y and monopolistically competitive in sector X .

The existence of the fixed cost f implies increasing returns to scale in the production of the differentiated X -good varieties so that each firm supplies one and only one variety. Moreover, it pins down the number of firms/varieties hosted by the home region. As it can be easily seen, the L -factor market clearing condition, yields:

$$n = \frac{L}{f} \quad (3)$$

Condition (3) also implies that the total number of firms is a constant determined by the exogenous total endowment of factor L , $N = L^T/f$.

Free entry and exit imply that in equilibrium revenues are just enough to cover the costs of production so that operating profits are entirely absorbed by the owners of factor L .

As to prices, we have to remember that varieties from abroad incur a transport cost τ . This means that in most reasonable models of spatial competition with product differentiation and at least some price discrimination, in equilibrium we would observe $p^* > p$ with the difference between the two prices being an increasing function of τ .⁹ Consequently, in equilibrium the price index P is a decreasing function of n :

$$P = P(n, \tau), \quad P_n(n, \tau) < 0, \quad |P_{n\tau}(n, \tau)| > 0 \quad (4)$$

Equations (1), (2), (4) and (3) describe the model. They can be used to obtain the inverse demand for a typical home variety in the home market:

$$p = a + bP(n, \tau) - \frac{q}{A + fn} \quad (5)$$

Due to monopolistic competition, the firm producing the typical variety takes the average market price $P(n, \tau)$ as given.

The inverse demand (5) is represented in Figure 1. The horizontal and vertical intercepts of (5) are respectively $[a + bP(n, \tau)][A + fn]$ and $[a + bP(n, \tau)]$. The equilibrium values of q and p are shown as q' and p' .

⁹For a qualification of this statement see Ottaviano and Thisse (1998).

They are found by setting marginal revenue equal to marginal cost. The operating profits are shown by the shaded rectangle and accrue to the owners of factor L .

The picture is all we need to assess the conditions under which we should expect to observe agglomeration in this simple framework. To see why, start from an initial situation where regions are identical, $L = L^T/2$ and $n = L^T/2f$. Suppose that some firms move from the foreign to the home region so that n increases. For these firms to want to stay in the home region, operating profits have to increase. Indeed, were this not the case, the firms would rather go back to the foreign region.

Turn now to Figure 1. An increase in n has two opposite effects on operating profits. First, as new firms enter the home region, the price index $P(n, \tau)$ decreases. *Ceteris paribus*, this would shift the inverse demand (5) toward the origin of the axes and operating profits would shrink. This effect is due to increased competition in the home market and stems from the fact that fewer firms now face trade costs when supplying the home market. But this is not the only effect. For some firms to move to the home region, some owners of factor L have to follow. This means that, as n increases, also L goes up so that the market of the home region expands. *Ceteris paribus*, the horizontal intercept of the inverse demand would move away from the origin and profits would expand. This is a market size effect which is induced by the linkage between the locations of firms and factor L expenditures.

Since the two effects oppose each other, the net result is *a priori* ambiguous. But we can say more than that. In particular, we can assess which effect prevails depending on parameter values. Start with the competition effect that goes through $[a + bP(n, \tau)]$. This effect is strong if b is large, i.e. if varieties are good substitutes. It is also strong if $|P_n(n, \tau)|$ is large. As shown in (4), this happens if τ is large, because, when obstacles to trade are high, competition from the other region is weak and home firms care a lot about their competitors being close rather than distant. As to the market size effect, it will be strong if f is large because each new firm brings along many L -factor owners, and if A is small because immigrants have a large impact on the local market size.

We can therefore conclude that the market size effect dominates the competition effect, when goods are bad substitutes (b large), increasing returns are intense (f large), the immobile factor are unimportant (A small) and trade costs are low (τ small). Under such circumstances, the entry of new firms in one region would raise the operating profits of all firms. Higher profits would attract more firms, generating circular causation among firms location decision. Agglomeration would then be sustainable as a spatial equilibrium.

This line of reasoning is a fairly general way to convey Krugman's insights and it is explored in greater detail and rigour in Ottaviano and Thisse (1998) where (1), (2), (3) and (4) are shown to belong to a full-fledged model of monopolistic competition with horizontal product differentiation.¹⁰ However, Krugman (1991a,b) adopt a more restrictive formulation than (1), that is, an isoelastic specification.¹¹ It is therefore worthwhile showing that the general argument is unaffected by this choice.

With symmetric isoelastic demand (1) has to be substituted with:

$$q = p^{-\sigma} \tilde{P}^{\sigma-1} [A + fn] \quad (6)$$

where \tilde{P} is the corresponding CES symmetric price index:

$$\tilde{P}(n, \tau) = (np^{1-\sigma} + np^{*1-\sigma})^{\frac{1}{1-\sigma}} \quad (7)$$

The parameter $\sigma > 1$ represents both the own-price elasticity of demand for a typical variety and the elasticity of substitution between varieties. As far as the presence of trade costs leads to $p < p^*$, the prices index (7) exhibits the same qualitative properties as (4).

The inverse demand that corresponds to (8) is given by:

$$p = q^{-1/\sigma} \tilde{P}(n, \tau)^{1-1/\sigma} [A + fn]^{1/\sigma} \quad (8)$$

¹⁰Notice, however, that the same argument would work with oligopolistic competition and homogenous goods. All that is needed are trade costs and pricing above the marginal cost of production (see, e.g., Venables, 1996b).

¹¹For details on the limits of monopolistically competitive models with CES utility, see Ottaviano and Thisse (1999a).

The equilibrium of the CES model is shown in Figure 2 where the shaded area corresponds again to the operating profits of the firm. If we now perform the same thought experiment as before and let n increase, we discover that the same effects are again at work. On the one hand, there is the competition effect. As n increases $\hat{P}(n, \tau)$ decreases and the inverse demand (8) is drawn closer to the origin of the axes: an increase in the number of home competitors make operating profits shrink in the home market. On the other hand, there is the market size effect. As more firms enter the home region, they bring L -factor owners with them. As n increases, also $[A + fn]$ increases and (8) is drawn away from the origin: because the income of the immigrant L -factor owners is spent locally, an increase in the home population enlarges the size of the home market.

As before, we can be more precise about the circumstances under which either effect dominates. The competition effect is strong if varieties are good substitutes (σ large) and if $|P_n(n, \tau)|$ is large, that is, if trade costs are high (τ large). The market size effect is strong if the L -factor owners constitute a large share of the population (A is small) and if a large input of that factor is required to operate a firm (f is large). Therefore, we end up with the same conclusions: the market size effect dominates the competition effect, when goods are bad substitutes (σ large), increasing returns are intense (f large), the immobile factor owners are unimportant (A small) and trade costs are low (τ small). If this is the case, the entry of new firms in one region raises the operating profits of all firms. Higher profits attract more firms and this generates a circular causation mechanism among firms location decisions which is able to sustain agglomeration.

This exact coincidence of results should be enough to establish - contrary to the skeptic impression - the logical robustness of the mechanism envisaged by Krugman (1991a,b) as an explanation of the geographical distribution of economic activities.

2.2 Cost linkages

A different explanation of the mechanics of economic agglomeration can be found in Venables (1996a). The idea is that, in most industries, firms are connected by input-output linkages: what is output for a firm is input for another and viceversa. Under this perspective, the fiercer competition induced by a new entrant in the local market is double-faced: the implied reduction in market prices is bad news for existing firms profits on the revenue side but it is good news on the cost side (*cost linkage*).

To embody this idea in the foregoing analysis only two changes have to be made to the framework of the previous section. First, assume that there is only one factor, say factor A , which is immobile between regions. This factor is used not only as the unique input in the production of the numéraire good Y but also to comply with the fixed requirement f in the supply of the differentiated good X . Second, the marginal cost of production c in this latter sector is paid in terms of the differentiated good itself. Therefore, X is demanded both as a final good by consumers A and as an intermediate good by firms n .

If, for simplicity, we assume that the same degree of substitutability characterizes the varieties no matter whether they are used by consumers as final goods or by firms as intermediates, the inverse demand function is now:

$$p = a + bP(n, \tau) - \frac{q}{A + n} \quad (9)$$

Figure 3 plots (9) along with the marginal cost $cP(n, \tau)$. To assess under which conditions agglomeration can arise in this setting, consider an initial situation in which the two regions are identical and suppose that some firms in sector X , decide to move to the home region. If their arrival increases the operating profits in the home region, then more firms follow, circular causation sets in and industry X agglomerates in the home region.

The analysis is readily conducted in terms of Figure 3. An increase in the number n of firms in the home region has three effects. First, as n increases, competition gets fiercer and $P(n, \tau)$ decreases (*competi-*

tion effect). *Ceteris paribus*, this would shift the demand towards the origin and operating profits - represented by the shaded area - would shrink. Second, as increased competition depresses $P(n, \tau)$, intermediates become cheaper so that the marginal cost curve moves downwards (*cost effect*). *Ceteris paribus*, this would raise operating profits. Third, as new firms enter the home region, they demand intermediates so that the market of the home region expands. That is, $[A + n]$ grows and, *ceteris paribus*, this would shift the horizontal intercept of the demand curve away from the origin (*market size effect*).

While the net effect on operating profits is a priori ambiguous, we can establish parameters values for which either effect dominates. Most of the results should be familiar by now. The competition effect is strong if varieties are good substitutes (large b) and if trade costs are relevant (large τ). The demand effect is strong when demand by firms is important relatively to demand by consumers (small A) and if each firm requires a small amount of factor A to operate (f small). Therefore, agglomeration is sustainable as an equilibrium when varieties are bad substitutes, trade costs are low and final demand is small relatively to intermediate demand. Needless to say, it could be easily shown that the same insights would carry through if the CES specification were chosen as in the original model by Venables (1996a).

Notice the only qualitative difference between a model with input-output linkages plus intersectoral factor mobility and a model with demand linkages plus interregional factor mobility. While in the latter strong returns to scale (large f) favour agglomeration, in the former they work against it. The reason is that, while in the latter additional demand comes from factor owners who follow firms, in the former it comes directly from firms. Therefore, while in the latter a strong market size effect requires many factor owners to match few firms, in the former the reverse is true.

3 Tying some loose ends

3.1 Consumer surplus

The stories told in the foregoing sections are about firms in sector X changing location in the quest of the highest profits. The same results could have been equivalently reported by telling stories about factor owners looking for the highest utility: owners of factor L migrating between regions in the demand-linkage model and owners of factor A reallocating their resources between sectors in the cost-linkage model.

Then, under this respect, a basic ingredient is missing in the previous analyses, namely the impact of firms location choices on consumer surplus. This impact is visible in all the figures drawn: as n changes, the area of the surface below the inverse demand curve and above the horizontal line corresponding to the equilibrium price changes too. Less evident from the figures, but intuitively obvious, is that, as n increases and $P(n, \tau)$ decreases, the surplus of home consumers always rises because the entire array of differentiated varieties becomes cheaper for them as more firms produce locally and do not have to charge for trade costs.

The explicit consideration of consumer surplus, say $S(p, p^*, n)$, has two main consequences. First, for intermediate values of the parameters, its behaviour is crucial for the incentive to agglomerate. In particular, it may happen that, even if an increase in the number of local firms depresses their operating profits, the positive effect of higher n on consumer surplus is strong enough to more than compensate factor owners.¹² Second, the response of consumer surplus affects the functional shape of the relation between n and the benefit that factor owners obtain by reallocating their resources between regions and sectors. This has important implications for the spatial evolution of the economic landscape

¹²In the cost-linkage model this intermediate scenario is slightly more complex due to the additional negative impact of rising n on the costs of production. First, even if revenues shrink because of fiercer local competition, operating profits may still increase thanks to lower costs of production. Second, even if operating profits do shrink, agglomeration may still be worthwhile if consumer surplus grows enough.

as it will be discussed below.

3.2 Strategic considerations: pricing policies

The foregoing analyses have shown that a central ingredient of the agglomeration mechanisms presented above is the relation between the number of local firms and the price index $P(n, \tau)$. A thorough understanding of this relation requires the exact determination of equilibrium prices, p and p^* . In general, they should depend on both the geographical distribution of firms and the extent of their freight absorption, $p = p(n, \tau)$ and $p^* = p^*(n, \tau)$.¹³ The ways prices depend on the distribution of firms and trade costs are both crucial pieces of information because they are bound to affect the balance between competition and market size effects.

From this point of view, the CES model suffers from severe limitations. On the one side, in the CES model, monopolistically competitive firms set prices as monopolists would do by charging a constant proportional mark-up over marginal cost that disregards the number and the location of competitors.¹⁴ On the other side, when interregional trade costs of good X are paid in terms of good X itself ('iceberg' assumption), firms do not absorb any freight at all even when they are allowed to freely discriminate between close and distant customers ($p^* = (1 + \tau)p$). As a result, firms interact in a quite naive way imposing a straitjacket on the possible functional shapes of $p(n, \tau)$ and $p^*(n, \tau)$.

Since the functional shapes of $p(n, \tau)$ and $p^*(n, \tau)$ influence both the functional shape of consumer surplus $S(p, p^*, n)$ and the functional shape of firm profits $\Pi(p, p^*, n)$, a thorough investigation of firms pricing decisions is needed to understand the trade-off between competition and market size effects.¹⁵

¹³Firms are said to absorb some freight in so far as the difference between the prices they charge to distant and close customers falls short of the difference between the costs of reaching them (*trade costs*).

¹⁴In the demand-linkage model firms price at $p = c\sigma/(\sigma - 1)$. In the cost-linkage model they quote $p = \bar{P}(n, \tau)c\sigma/(\sigma - 1)$. In both cases the mark-up over marginal costs is proportional and constant being equal to $\sigma/(\sigma - 1)$.

¹⁵For a formal discussion of these issues, see Ottaviano and Thisse (1998).

3.3 Dynamic considerations: nonlinearities, adjustment and bifurcations

As already argued, firms relocation is driven by the intersectoral and interregional allocative decisions of factor owners who seek to maximize their utility. If we assume, as it is customary in 'new economic geography', that factor owners are atomistic, then their allocative decisions are discrete choices between two alternatives. In the demand-linkage model *L*-factor owners compare the indirect utilities that the two regions offer to them and move to the more generous region. In the cost-linkage model *A*-factor owners compare the indirect utilities they get when employed in the two sectors and move to the sector which offers them higher satisfaction.

In reality, such reallocations are not free but rather take time and money due to various sorts of adjustment costs. For example, one may think of migration costs in the demand-linkage model and of retooling costs in the cost-linkage model. The result is that the adjustment is not instantaneous but rather gradual.

A reduced-form model encompassing the main insights of both the demand- and the cost-linkage models is useful to investigate the implications of gradual adjustment. For expository purposes, let us explain how things work in terms of the demand-linkage-cum-migration story only.

Denote the indirect utility of an *L*-factor owner in the home region as:

$$V(p, p^*, \bar{p}, \bar{p}^*, n) \equiv S(p, p^*, n) + \Pi(p, p^*, n) + \bar{\Pi}(\bar{p}, \bar{p}^*, n) \quad (10)$$

where the star, as before, labels variables pertaining to foreign agents and the upper-bar labels variables pertaining to the foreign market. For example, p is the price quoted by home firms in the home market, p^* is the price quoted by foreign firms in the home market, \bar{p} is the price quoted by home firms in the foreign market, etc.. Therefore, $S(p, p^*, n)$ is the consumer surplus of an *L*-factor owner residing in the home region; $\Pi(p, p^*, n)$ and $\bar{\Pi}(\bar{p}, \bar{p}^*, n)$ are the operating profits of home firms in the

home and foreign markets respectively. Only the number of home firms appears in (10) because the number of foreign firms is determined as a residual: $n^* = L^T/f - n$.

By symmetry, the indirect utility of an L -factor owner residing in the foreign region is:

$$V^*(p, p^*, \bar{p}, \bar{p}^*, n) \equiv S^*(\bar{p}, \bar{p}^*, n) + \Pi^*(p, p^*, n) + \bar{\Pi}^*(\bar{p}, \bar{p}^*, n) \quad (11)$$

The migration decision of an L -factor owner is based on the comparison between (10) and (11), i.e. on the sign of their difference:

$$\Delta V \equiv V(p, p^*, \bar{p}, \bar{p}^*, n) - V^*(p, p^*, \bar{p}, \bar{p}^*, n) \quad (12)$$

Remembering that, in general, the pricing policies of firms depend on n and τ , we can rewrite the indirect utility differential in a more compact way as:

$$\Delta V = \Delta V(n, \tau) \quad (13)$$

where $\Delta V(n, \tau)$ is assumed to be a smooth function of its arguments.

ΔV is the statistic that guides L -factor owners location decisions.¹⁶ If $\Delta V > 0$ (< 0) those who reside in the foreign (home) region want to migrate to the home (foreign) region. If $\Delta V = 0$ there is no incentive for anybody to change location. Gradual adjustment can be simply captured by the following mechanism:

$$\dot{n} = \gamma \Delta V(n, \tau) \quad (14)$$

where \dot{n} is the instantaneous change of n and $\gamma > 0$ is a measure of the speed of adjustment. The differential equation (14) is a reduced-form spatial model that encompasses both the demand- and the cost-linkage models discussed above. A steady state of the model is obtained when motion stops: $\dot{n} = 0$. Therefore, there are two possible types of steady

¹⁶To be precise, this is a good approximation to forward-looking migration decision only if L -factor owners discount the future heavily (Ottaviano, 1996), which is assumed here for expository purpose.

states: interior steady states for n such that $\Delta V(n, \tau) = 0$ and corner steady states for $n = N$ ($n = 0$) if $\Delta V(1, \tau) > 0$ ($\Delta V(0, \tau) < 0$).

The number and the stability of steady states depend on the shape of $\Delta V(n, \tau)$. Some remarks can help to be more precise about this statement. First, in general, there always exists at least one steady state. Since the model is symmetric, it is the steady state corresponding to $n = N/2$. Second, this steady state is (locally) stable (unstable) if $\Delta V_n(N/2, \tau) < 0$ ($\Delta V_n(N/2, \tau) > 0$) where subscripts denote partial derivatives with respect to the corresponding arguments.¹⁷ If it is unstable there also exist two additional steady states that, due to the symmetry of the model, are symmetric around $n = N/2$. Third, following previous discussions, for small trade costs the market size effect dominates the competition effect, while the reverse is true for large trade costs. Consequently, if $\Delta V(n, \tau)$ is a smooth function of its arguments, there must exist some value of τ , say τ_0 , such that $\Delta V_n(N/2, \tau_0) = 0$ and $\Delta V_n(N/2, \tau) > 0$ ($\Delta V_n(N/2, \tau) < 0$) for $\tau < \tau_0$ ($\tau > \tau_0$). Therefore, as τ varies and goes through τ_0 , the local stability properties of the steady state $n = N/2$ change ('local bifurcation').

These three remarks together are consistent with the following properties of $\Delta V(n, \tau)$:

$$\Delta V(N/2, \tau) = 0 \quad \forall \tau, \quad (15)$$

$$\Delta V_n(N/2, \tau_0) = 0, \quad \Delta V_{n\tau}(N/2, \tau_0) < 0, \quad (16)$$

$$\Delta V_{nn}(N/2, \tau_0) = 0, \quad \Delta V_{nnn}(N/2, \tau_0) \neq 0 \quad (17)$$

Property (15) says that $n = N/2$ is always a steady state (persistent steady state). Properties (16) say that as τ increases from 1, the steady state $n = N/2$ turns from unstable to stable as soon as τ grows above τ_0 . Properties (17) says that, as soon as the steady state $n = N/2$ changes stability, two additional steady states appear in its neighbourhood. Due to the symmetry of the model such steady states are symmetric around it.

¹⁷If $\Delta V_n(N/2, \tau) < 0$ a small perturbation of $n = N/2$ would be compensated by migration. On the contrary, if $\Delta V_n(N/2, \tau) > 0$ any small perturbation would be amplified by migration.

All these properties together say that the reduced model (14) undergoes a (local) 'pitchfork bifurcation' at $\tau = \tau_0$. If $\Delta V_{nnn}(N/2, \tau_0) > 0$ the bifurcation is 'subcritical': as τ grows above τ_0 the persistent steady state $n = N/2$ gains stability giving rise to two unstable symmetric steady states in its neighbourhood (see Figure 4). If $\Delta V_{nnn}(N/2, \tau_0) < 0$ the bifurcation is 'supercritical': as τ falls below τ_0 the persistent steady state $n = N/2$ loses stability giving rise to two stable symmetric steady states in its neighbourhood (see Figure 5).¹⁸

This fairly technical analysis suggests that both the number and the stability of the steady states of our reduced-form model depend crucially on the functional shape of the indirect utility differential function $\Delta V(n, \tau)$. This leads back to the shape of consumer surplus and operating profit functions as pointed out by (10) and (11).

3.4 Welfare

A detailed welfare analysis is required if one is to draw logically coherent policy implications from the models presented. Unluckily, this is not an easy task. The reason why is that such models depart from the walrasian competitive paradigm under three main respects.

First, there are increasing returns and imperfect competition: at the market equilibrium, because firms have market power, they operate at an inefficiently low scale.

Second, there is horizontal product differentiation: the market equilibrium may overprovide or underprovide variety. On the one hand, since revenues from producing a certain variety do not capture the corresponding consumer surplus, they may not cover costs even when the net social value of the variety is positive. This creates a potential bias towards too

¹⁸Notice that a differential equation can undergo only (combinations of) three types of bifurcations: saddle-node, transcritical and pitchfork bifurcations. A saddle-node bifurcation does not exhibit any persistent steady state. A transcritical bifurcation has a persistent steady state but other steady states are not symmetric around it. Therefore, (14) can only feature pitchfork bifurcations. For further details see, e.g., Guckenheimer and Holmes (1990).

few varieties. On the other hand, when a new variety is introduced, it affects the profits of existing firms and gives rise to another external effect because the profit of the new entrant does not, in general, correspond to the net change in profits in the economy as a whole. If varieties are complements, this effect also favours too few of them. However, if varieties are substitutes, it fosters too many of them so that the net outcome is ambiguous.

Third, there are demand and cost linkages: when relocating, firms do not take into account the external impact of their decisions on other firms demand conditions and production costs. More precisely, when a firm leaves one region and moves to the other, it does not realize that it creates demand and cost linkages in the region of destination while destroying existing linkages in the region of origin. Therefore, in the presence of such linkages, it is not a priori clear whether the market outcome leads to inefficiently strong or inefficiently weak agglomeration.

A way out could be to adopt a second-best approach by taking for given the first two kinds of inefficiency - market power cum increasing returns and product differentiation - as they are not specific to the spatial models under scrutiny. This would allow to focus on the true spatial policy issues: Is there (second-best) inefficient agglomeration at the market outcome? If so, what policy tools can be used to deal with such (second-best) inefficiency? Is there a potential conflict between the needs of mobile and immobile factor owners?

These normative questions are barely addressed in the literature, but answers are badly needed if 'new economic geography' is to say anything relevant about regional planning in the real world.¹⁹

4 Concise dictionary

As we already discussed, one of the reasons why 'new economic geography' might not look like a coherent line of research is the heterogeneous

¹⁹See Ottaviano and Thisse (1999b) for a first attempt in this direction.

vocabulary it uses. Different authors call different things with the same names and the same things with different names. The aim of this section is to provide a brief semantic clarification.

agglomeration and dispersion forces: factors that bring economic agents together and apart respectively; market size and competition effects are examples of agglomeration and dispersion forces.

backward and forward linkages: demand and cost linkages.

ball bifurcation: combination of supercritical pitchfork bifurcations.

centripetal and centrifugal forces: see 'agglomeration and dispersion forces'.

complexity: nonlinear dynamics.

cumulative causation: circular causation.

factor price effect: net effect of market size and competition on operating profits.

home market effect: market size effect.

intertemporal linkages: demand and cost linkages between R&D and production.

macroeconomic complementarities: see 'agglomeration forces'.

market based agglomeration forces: demand and cost linkages.

market potential: market size.

pecuniary externalities: demand and cost linkages.

pitchfork bifurcation: (combination of) supercritical pitchfork bifurcation(s).

positive feedback: circular causation.

price index effect: competition effect.

symmetry breaking: pitchfork bifurcation.

tomahawk bifurcation: (combination of) subcritical pitchfork bifurcation(s).

5 Conclusion

This paper has identified the main roots of 'new economic geography' inside mainstream economic theory. An extensive discussion of its troublesome relations with other intellectual traditions can be found in Martin's (1999) polemical survey.

By cutting through the complexities of the its main models, the paper has shown that, in essence, 'new economic geography' provides more general results than what is usually thought. As it is often the case, analytical simplicity and intellectual robustness go hand in hand.

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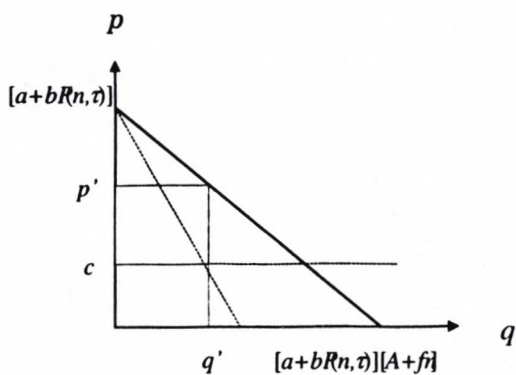


Figure 1 - The demand-linkage model

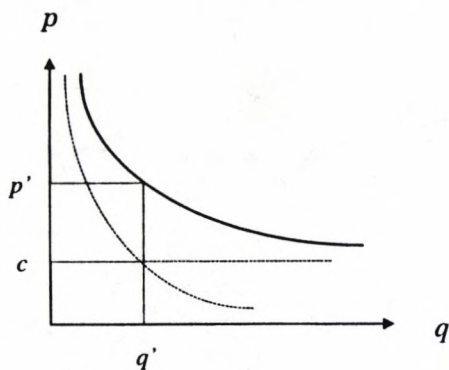


Figure 2 - The CES demand-linkage model

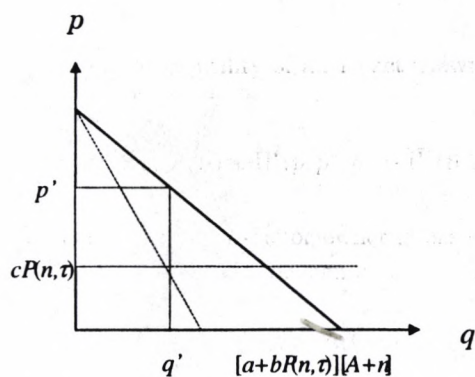


Figure 3 - The cost-linkage model

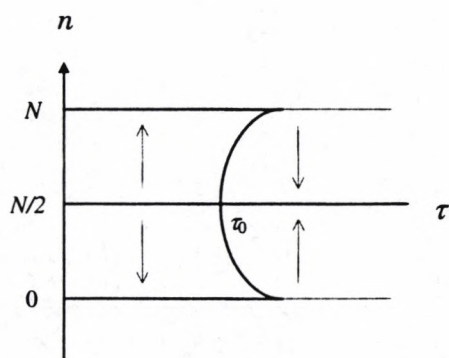


Figure 4 - Subcritical pitchfork bifurcation

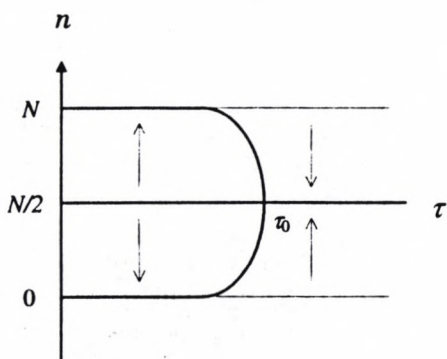


Figure 5 - Supercritical pitchfork bifurcation



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