

# DISCOVERY OF LOCATION IN ECONOMICS: AN ANALYSIS OF PAUL KRUGMAN'S THEORY

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## Abstract

Traditionally, mainstream economics has largely neglected the location of economic activity, that is, the choices of consumers and producers about where to consume and where to produce as well as how these two sides of optimal decision making interact. Finally, since 1990s, theoretical and empirical work began to emphasize the importance of spatial aspects of the economy and transportation. Much of this work is pioneered by Paul Krugman, who won the 2008 Nobel economics prize for his analysis of trade patterns and location of economic activity.

This paper summarizes Krugman's ideas in a comparative framework and analyses the contributions of new economic geography to regional, urban and international economics.

**Keywords:** new economic geography, spatial economics, international trade, transportation, regional science, urbanization, agglomeration

## Özet

Geleneksel olarak, iktisadi düşünce ekonomik faaliyetlerin meydana geldiği yer kavramını, demek ki tüketicilerin nerede tüketim ve üreticilerin nerede üretim yapmayı optimal olarak seçtiklerini ve bu iki tarafın kararlarının birbirini ne şekilde etkilediğini, ihmal etmiştir. Nihayet, 1990'lardan itibaren gerek teorik gerek ampirik çalışmalar iktisadın mekansal boyutunu ve nakliyatın önemini vurgulamaya başlamışlardır. Bu çalışmaların öncüsü, dış ticaret alanına dahil ettiği iktisadi faaliyetlerin yerleri analiziyle 2008 Nobel ekonomi ödülüne layık görülen Paul Krugman'dır.

Bu makale, Krugman'ın fikirlerini karşılaştırmalı bir çerçeve içinde değerlendirerek yeni iktisadi coğrafya alanının yöresel, kentsel ve uluslararası iktisada katkısını incelemektedir.

**Anahtar kelimeler:** yeni iktisadi coğrafya, mekansal iktisat, uluslararası ticaret, nakliyat, yöresel bilim, kentleşme, kümelenme

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### **Economic Geography**

It is obvious that economic activity in the world is not distributed evenly. In fact, most activity, especially economic, happens in agglomerated regions. The scale of agglomeration can be small, as in many apparel shops clustering in a mall; or it might be worldwide, like the Silicon Valley. Moreover, urban places follow a strict hierarchy as described by the Central Place theory.

Therefore, economic geography, that is the study of where economic activity takes place and why at that particular place, should be an interesting and important subject to study for economists. Economists have increasingly branched out into new fields by using the methods of economics to address the research problems of other disciplines. To give some important examples, one may think of the work of Gary Becker and James Coleman in economic sociology, Anthony Downs in political science, or the impact of the new institutional economics on law studies. This has frequently resulted in a fruitful exchange of research problems, ideas, and methods.

However, until recently, much of mainstream economics ignored economic geography. This should not necessarily be taken as a lack of interest or ignorance. The main reason economists did not work on this topic is because they regarded it as intractable and could not formally model imperfect competition. Although regional scientists and urban economists have both provided suggestions, their agglomeration effects and externalities were ad hoc, and their models were loose and sloppy. However, as new tools, in particular, models for industrial organization, international trade, and endogenous economic growth were developed, technical barriers that kept economists away from this field have been removed.

Real world concerns have also driven this search of interest. The field received a big boost, particularly, by plans to unify the European market and the attempt to understand how this deeper integration will work by comparing international economics within Europe with interregional economics within the USA. Other globalization trends, such as NAFTA and WTO's strife for free trade, have also fueled research in this field.

### **New Economic Geography**

Since late 1970s the field of "new economic geography" emerged. The catalyst was the development of tractable models of competition in the pre-

sence of increasing returns to scale. In particular, Dixit and Stiglitz developed a formalization of Chamberlin's concept of monopolistic competition that laid the foundation for this field.

A number of theorists applied the analytical tools of the new industrial organization theory to international trade; and a few years later the same tools were applied to economic growth. In each case new concepts needed to be developed and debates over models had to be made. The new economic geography is at a similar stage right now.

The cornerstone paper of this field was Krugman's 1991 seminal paper. This was followed by a number of papers by Krugman, Fujita, Venables and Puga. All of this work was put into a single perspective and improved in the 1999 book of Fujita, Krugman and Venables: *The Spatial Economy*. This FKV book is more than a collection of related papers; it is a coherent, self-contained composition that tries to model the centripetal and centrifugal forces of urbanization.

### **Agglomeration Effects**

Economic activities are unevenly distributed across space. The analysis of the determinants of spatial differences in patterns of production can be posed at a number of different levels. Basically, scale agglomerations can take the form of finely defined sector concentrations, such as highly specialized industrial districts, or of large phenomena, which cut across state and country boundaries, such as the US "Manufacturing Belt" (approximately contained in the parallelogram Green Bay – Saint Louis – Baltimore – Portland) and the European manufacturing core (represented by the area between South East England, Ruhr Valley, South East France, Southern Germany and Northern Italy).

The location of production of a firm strictly depends on the trade-off between centripetal and centrifugal forces, which, in turn, determines whether a country/region will or will not experience industrial agglomeration.

Centripetal forces come from classical Marshallian sources of external economies, which are referred to as pecuniary externalities, that is, externalities that depend on market interactions rather than on physical proximity, the latter being technological ones. To make the point clear, consider a classical example: A single producer moving towards a new region increases the local supply of manufactures, which, in turn, reduces the price of that final good,

which is an evident benefit for the whole community. According to this reasoning, the home-market size will become larger because of new customers' entry (due to the above-mentioned benefit), and by a chain effect, a larger domestic market will tend to make the manufacturing sector more concentrated in that location. This "circular and cumulative causation" (Myrdal, 1957) creates demand (or backward) linkages and it may be even reinforced by cost (or forward) linkages, both sustaining agglomeration. The latter refer to the fact that being close to the core makes it less expensive to buy the (intermediate) goods locally supplied. The dichotomy of backward-forward linkages was formulated by Hirschman (1958). More precisely: Backward linkages (or demand linkages) stand for the incentive for producers of final or intermediate goods to locate their production sites close to their customers. Forward linkages (or cost linkages) refer to the incentive for economic agents demanding final or intermediate goods to locate themselves close to the firms supplying those products. Obviously, to trigger off a chain effect of the kind described above, agents who are not price-takers need to be modeled. However, this rules out perfect competition and constant returns to scale.

Increasing returns to scale production functions and presence of transportation costs are the primary reasons of agglomeration. Other centripetal forces are knowledge spill-overs, that is, transfer of technology among companies at the same location, and thick markets, that is, availability of labor of some specific skill at the same location. On the other hand, immobility of (neo-classical) production factors, primarily land, and to some extent labor, oppose agglomeration. Other centrifugal forces are land rent and traffic congestion, both of which tend to increase with agglomeration and offset benefits of agglomeration. In sum, the trade-off between these centripetal and centrifugal forces determine the spatial distribution of economic activity.

In the FKV book, across a variety of contexts, a consistent story is told about the trade-off between centripetal and centrifugal forces, about the conditions under which agglomerations are sustainable, about break-points when dispersed patterns become unstable, and about the "no black hole" condition necessary to avoid the spatial economy collapsing to a zero dimensional point. The FKV book reproduces previously published arguments about agglomeration, cities, and international trade, but also extends these.

## **Dixit-Stiglitz Model**

### **The Problem: Increasing Returns to Scale**

The basic problem with respect to doing theoretical work in economic geography is that agglomeration of economic activity is not possible without having an increasing returns to scale (IRS) production technology. Suppose that all production functions were constant returns to scale (CRS), as assumed by most economic theories. This would basically give no incentive to agglomerate economic activity and would lead to “backyard capitalism”, in which each household or small group produces most items for its own consumption. (And managers who specialize in mergers and acquisitions would be out of work.)

Even though there can be some unevenness in population density due to differences in the natural environment, e.g. soil, climate and natural resources, by no means would this lead to the huge differences in the distribution of economic activity we see today. The concentration of particular industries in certain locations, e.g. Silicon Valley or Hollywood, cannot be attributed to differences in natural environment. They must be the result of some cumulative process that involves some form of IRS.

Unfortunately, IRS has always posed difficulties for economic theorists. Almost always it leads to the break-down of perfect competition: The biggest firm always drives smaller competitors out of the market since it can produce goods more efficiently. Thus, IRS ultimately leads to monopolies. Even if this problem can somehow be sidestepped, IRS poses problems in terms of the existence and uniqueness of equilibrium.

### **The Solution: Monopolistic Competition**

The monopolistic competition (MC) framework allows economists to use IRS without losing the competitive aspect. In a sense, MC lies between perfect competition (PC) and monopoly (M), combining good sides of both of them: competition from PC and IRS from M.

In MC framework, each firm has a monopoly power on the product it produces (a result of IRS production function), and yet feels the effect of competition. The reason behind this is the consumers’ love of variety: The consumer likes to consume as many goods as available and the goods are, at least to some degree, substitutes of each other. Moreover, the firm thinks that

he is a small firm, and therefore, the effect of his actions on the whole economy is negligible. All of these set MC apart from M, where one single firm has a dominant market power. Still, the firm is not a price-taker as it would be under PC, but it turns out that due to free entry and exit all firms in the industry end up with zero economic profits.

### **The Model**

The Dixit-Stiglitz model (the DS model) assumes an economy with two sectors, agriculture and manufacturing. The agricultural sector is perfectly competitive and produces a single, homogeneous good; whereas, the manufacturing sector is monopolistically competitive and provides a large variety of differentiated goods. The label “agriculture” need not always be interpreted literally: The sector’s defining characteristic is that it is the perfectly competitive sector, which is the counterpart to the action taking place in the IRS, imperfectly competitive manufacturing sector.

According to the DS model, the individual's utility is represented by a Cobb-Douglas function of an agricultural product and a constant elasticity of substitution (CES) sub-utility function of differentiated manufactured goods. The CES sub-utility increases not only with the quantities of the differentiated goods (their density), but also (and even more so) with their diversification, that is, the interval of brands over which the density distribution is defined. Each firm produces only one brand with own-price demand elasticity equal to the elasticity of substitution. IRS at the firm level and free entry in to the sector imply that MC yields markup prices, that is, the price exceeds marginal cost, and zero profits.

Later in the FKV book, the DS model is extended to its regional version by introducing costs for transporting the differentiated products (and, in some versions, the agricultural product as well) from the origin where they are produced to the destination where they are consumed. These costs are defined in terms of Samuelson’s “melting iceberg” transport cost, which are a constant fraction of the good. This trick implies that the own-price demand elasticity in terms of the mill price equals the own-price demand elasticity in terms of the delivered price. Therefore, the profit-maximizing firm does not use price discrimination; rather, it charges a uniform mill price, irrespective of its consumers’ location.

### **Observations with respect to the Model**

The DS model says that the size of the market affects neither the price markup over marginal cost, nor the scale at which individual goods are produced. As a result, all scale effects work through changes in the variety of goods available. Obviously, this is rather an unexpected result: Normally, one would think that larger markets mean more intensive competition, and that one of the ways the economy takes advantage of the extent of the market is by producing at larger scale. This model says, however, that all market-size effects work through changes in the number of varieties available, that is, as the market grows, the firms stay the same size, but there are more of them.

This result is an artifact of the constant elasticity of substitution (CES) demand functions, together with the non-strategic behavior implied by the assumption that firms take the price indices to be constant as they solve their profit maximization problem. If we were to relax the assumption of non-strategic behavior, each firm would then recognize that its choice changes the price index, and this recognition of market power would tend to reduce the firm's output and increase its price-cost margin. If we adopt a specific form of oligopolistic interaction, such as Cournot or Bertrand competition, then we can derive explicit expressions for the pricing rule, and in both of these cases the price-cost margin is a decreasing function of each firm's market share. Under these assumptions an increase in market size has a pro-competitive effect. It causes entry of firms which reduces price-cost margins and means that firms must operate at larger scale (and lower average cost) in order to break-even.

### **Regional Models**

Although Fujita, Krugman and Venables (FKV) regard the Dixit-Stiglitz (DS) model as “grossly unrealistic”, they used the model as a starting point to build models that deal with regionalization and urbanization. They divide the wage equation by a cost of living index, which is proportional to manufacturing price index and the price of the agricultural good, to find real wages at different locations. They then use wage differences between regions as a motivator for migration. They assume that migration happens at a very slow speed and therefore, the system is in equilibrium at any given time. They use the migration patterns to explain agglomeration of economic activities by finding conditions under which a city or multiple cities would form or disperse.

The main effects of the FKV regional models can be understood by the forces that determine whether firms and workers concentrate in a central region or remain dispersed. Those forces are called centripetal and centrifugal forces, respectively. Workers and firms relocate to where real wages, which is directly proportional to their utility, are highest. If the movement of a worker increases the incentive for other workers to move as well, a circular process is started. To understand the centripetal and centrifugal forces, a thought experiment is useful: Suppose both regions are identical to begin with. A worker then moves from one region to the other forming a center and a periphery. The center not only has more workers, but also more firms and more product varieties than the periphery. What impact does the movement of the worker and the increase of varieties in the center have on relative prices and relative wages? There is no impact on the quantity supplied by a firm, as pointed out before. The impact on the demand curve is ambiguous.

The fundamental resource allocation trade-off in the FKV regional models stems from the immobility of farmers. Since transporting differentiated products is costly, manufacturing and agricultural workers have conflicting needs for accessibility with respect to the firms supplying the differentiated products. Agglomeration of manufacturing firms allows manufacturing workers to have more access to differentiated products, whereas dispersion allows agricultural workers to have more access to land. In advanced versions of the FKV regional models, transporting the agricultural product is costly too. The dilemma then becomes more complicated because agglomeration reduces manufacturing workers' access to agricultural products.

How is the above trade-off solved in the market? As consumers, individuals derive utility from living close to a manufacturing agglomeration because they face relatively lower prices there. Firms are attracted to such agglomerations by the lower nominal wage due to the lower price index (backward linkages), as well as by the larger demand that can support more firms (forward linkages). On the other hand, firms are repelled from agglomeration and attracted to the periphery, where competition is less intense. The demand confronting the firm is higher in the periphery relative to the core because the demand for a brand is a decreasing function of the number of firms. Thus, the FKV regional models imply market push and pull (or centrifugal and centripetal forces), with the relative strength of each determining the spatial allocation.

One of the salient results of the FKV regional models is the non-monotonic effect of transport costs on agglomeration. When transporting agricultural products is costly, a core-periphery structure (concentration of all the manufacturing firms in one region), emerges only when the transport costs of manufactured products are neither too high nor too low.

### **Urban Models**

The FKV book is also concerned with urban systems. To that end, the previous models are further extended by incorporating spatial aspects: The locations of economic activities and the allocation of land to agricultural production are simultaneously determined (however, the cities themselves still remain aspatial). Using this setup, the concept of market potential is defined and used to explore the conditions under which von Thünen's (1966) mono-centric structure prevails and the conditions for the emergence of a multiple-city economy exist. For example, it is shown that if transporting agricultural products is sufficiently expensive relative to transporting differentiated products, a mono-centric structure cannot be sustained; if transporting agricultural products is sufficiently inexpensive, the mono-centric structure prevails when the population is small, but becomes unsustainable when the population is sufficiently large.

In order to explore the conditions under which new cities emerge and the characteristics of the emerging urban system, a dynamic setup is constructed and solved numerically via computer simulations. The dynamic process is composed of two consecutive steps: The first is an incremental population growth process. The second is a population redistribution process across locations that continues until the market potential is nowhere higher than one (i.e. until the real wage is equalized across occupied locations and not larger than one elsewhere). As the aggregate population size increases, existing cities bifurcate, and overall concentration declines. In the long run, the urban population becomes more dispersed, distributed among cities of equal size with equal market areas (excluding two cities, each located at one edge of the linear segment representing the urban-rural space).

The FKV urban-rural model is further extended by considering several manufactured goods, each composed of its own interval of brands. This extension allows the derivation of Christaller's (1933) hierarchical structure, where each higher-order city also produces all the manufactured goods supp-

lied by the lower-order cities. However, the model falls short of generating the rank-size rule. This part also discusses some empirical evidence on the rank-size rule, its non-economic explanation, and the implications of heterogeneous space.

### **Contributions and Shortcomings of the New Economic Geography**

In order to evaluate the contribution of the FKV book and the contribution of the new economic geography (NEG), in general, to urban economic theory, to regional science and to geography one has to examine its main findings from an appropriate perspective: What do we know about size distribution of cities and urban geography before 1991 and after the introduction of the NEG. In this review, we distinguish between size distribution of cities, an aspatial concept, and urban geography, which focuses on the spatial distribution of activities inside and among cities.

### **Size Distribution of Cities**

Concerning the size distribution of cities, the contribution of the FKV book is twofold. First, the FKV book provides new explanations for the scale economies and diseconomies that generate the inverted U-shaped configuration of the real wage rate, or utility vs. city size relationship. Second, the FKV book suggests a dynamic process that determines the emergence of urban systems as population increases. Because this process can be equally well applied to any alternative real wage, or utility vs. city size configuration, one can evaluate the new explanation for the inverted U-shaped real wage rate, or utility vs. city size configuration independently of the dynamic process. Hence, one has to evaluate the new explanation according to its economic coherence, consistency with stylized facts, and (if possible) empirical evidence, as well as its robustness. Before turning to such an evaluation, we would like to mention some of the traditional explanations provided for the inverted U-shaped utility vs. city size configuration.

In ancient Greece, Plato and Aristotle maintained that an optimal city size exists because cities that are too small cannot satisfy all the needs of their citizens, whereas cities that are too large become “unwieldy”. Lösch (1940) asserted that there is an optimal city size because, on the one hand, urban production exhibits scale economies (external and internal to firms),

but on the other hand, an increase in city size is associated with increased crowding, intra-city transportation costs, and costs of transporting manufacturing goods to an extended hinterland. A similar assumption is made by Tiebout (1956), who suggested a different explanation for scale economies, namely, the advantage of reducing per capita burden of pure local public goods as population increases. The sources of scale diseconomies in Tiebout is a fixed supply of some local resource, notably land. Tiebout was the first to suggest the concept of a (quasi) market for cities as suppliers of pure public goods. The concepts of optimal city size and a market for cities were further formalized and analyzed by Mirrlees (1972), Dixit (1973), and Henderson (1974).

In all of these models, with the exception of Lösch (1940), scale diseconomies (a centrifugal force) stem, in one way or another, solely from land scarcity inside the city. In the FKV book, as far as urban structure is concerned, scale diseconomies follow from an increase in the cost of transporting differentiated products to farmers. Hence, according to NEG, the centrifugal force is generated outside the city.

This explanation is quite plausible for an economy dominated by agricultural production and consumption, as it was during the 19<sup>th</sup> century. Nonetheless, to some economic geographers, it is hardly convincing in explaining the evolution of urban structure in modern advanced economies, where agricultural employment, output, and consumption are much less important. Is it plausible that suburbanization of metropolitan areas (perhaps the most pervasive and problematic spatial phenomenon following the Second World War) could be an outcome of increased demand for agricultural output? For example, do high-technology companies choose their location along Route 128 so that they can be accessible to farmers in Boston's hinterland?

Another problematic feature that persists in the FKV book is the decline in agglomeration as population grows. In many developing countries, however, urbanization is associated with increasing rather than decreasing agglomeration. Once again, the functional specification of FKV implies their result, which is not robust to alternative specifications.

Another criterion for evaluating the contribution of NEG is how consistent are the implications of the analysis with empirical evidence? In this respect, two salient characteristics of urbanization, as described by FKV, are problematic: According to FKV, new cities emerge from a catastrophic process of bifurcation. However, this growth pattern is not common empirically.

Furthermore, if the Cobb-Douglas utility of differentiated products and housing is replaced by a constant elasticity of substitution (CES) utility function, the population partition under a market situation becomes dependent on the aggregate urban population. Therefore, FKV's use of specific functions and arbitrary numeric parameters is not really without loss of generality.

### **Urban Geography: City Hierarchy and Specialization**

NEG's most striking achievement in urban regional modeling, as represented in the FKV book, is its extension to urban geography, in which the spatial distribution of economic activities and their intensities are endogenously determined. This extension was achieved by integrating the (aspatial) regional version of the Dixit-Stiglitz model with the (spatial) von Thünen model, in which agricultural production requires land as an input. Once land is used in the production of agriculture and workers live where they work, space can be described in terms of type of land-use and its intensity, that is, in geographical terms. Applying the market potential analysis in this setup, FKV were able to derive the emergence of the city hierarchies of Christaller.

Similar to the explanation provided for the emerging size distribution of cities, FKV need agriculture to explain the emerging urban geography. One can, therefore, hypothesize that the relative locations of cities in space were determined when agriculture was a dominant sector. This geographical distribution then became the initial condition for the later changes in the size distribution of cities, which were mainly affected by the centrifugal and centripetal forces inherent in the urban economy itself. In this sense, FKV provide an excellent explanation for the emergence of the urban structure, in both its spatial (geographical) and aspatial aspects, during the surge of urbanization. It is directly relevant to the urbanization in the presently developed countries during the 19<sup>th</sup> century and in the developing countries during the second half of the 20<sup>th</sup> century. Nonetheless, this explanation for the emergence of urban structure is less relevant to what happened in advanced economies in the 20<sup>th</sup> century and, especially after the Second World War.

### **Sunk costs**

Migration decisions in the FKV book are based on the ongoing comparison of location-specific incentives, that is, of the indirect utility differential

across regions. Each movement alters, in turn, the balance between forward and backward linkages for all producers, and consequently modifies some of the incentives that have determined that previous migration. Thus, in the short to medium-run, each manufacturer constantly faces new and stronger incentives to relocate again until the process of agglomeration achieves a spatial equilibrium.

This short to medium run process highlights one of the limits of NEG modeling. In fact, the relocation of firms takes a very long time, and setting up production in a new region requires significant set-up costs, which, by definition, are incurred independently from producing the output. Thus, consecutive migrations would make the firms incur these costs all over again without any chance of amortization. Such costs are termed as “fixed capital” or “sunk costs” that emphasize the fact that they are irreversibly employed in the short to medium run and therefore, they cannot be removed from their original destination, at least not easily or at zero cost. Some examples are construction of plants, leasing of equipment, contracts for supplying factors of production.

In sum, in the short to medium run, there is rigidity in the process of agglomeration which comes from aversion from relocating<sup>2</sup> due to the sunk costs. The FKV book seems to neglect this aspect.

### **Space and Distance**

For main stream economists, a micro-foundation in individual rational choice is an essential starting point, and equilibrium outcomes are a desired endpoint. Incidentally, one of Krugman's enduring contributions to the mainstream economic theory is to convince economists that more than one equilibrium is possible. Interdependencies between economic actors, such as input-output models or interdependent utility functions, are not regarded as essential features of an economy. Economists are also content to treat geographic space as homogeneous, that is, each location is equally close to every other location, one dimensional, and Newtonian, that is, the distance metric is given exogenously, as in the iceberg model. Such assumptions condition how economists think about economic geography - as a branch of economics.

By contrast, economic geographers have become increasingly uncomfortable with the possibility that society is ever at or near equilibrium. They have always paid a lot of attention to interactions, and thus, are reluctant to

abstract away from input-output flows. They see human agents not as perfectly informed rational agents with given preferences, but as imperfectly informed learners whose beliefs, information and actions are shaped by their surroundings and by those they interact with. They also have become very uncomfortable with uniform plains and exogenously given distance metrics. It is now a commonplace among geographers to talk about space (and distance) as socially constructed - which among other things means that transportation is an industry that endogenously creates economic distances in the space economy as a function of the infrastructure built, the transportation technologies developed, and communication costs.

### **Methodology**

A hallmark of good theory is consistency, that is, theories of different subfields employ consistent assumptions. A main purpose of the FKV book is to demonstrate that many of the stylized facts of urban and regional economics, such as the emergence of cities and countryside, city hierarchies, manufacturing districts, etc., can be derived from a set of common assumptions, including most notably the presence of space and transport costs, increasing returns to scale and monopolistic competition.

In contrast, the competitive general equilibrium theory of economics, which assumes constant or decreasing returns to scale, cannot explain these stylized facts. Unless some way can be found to adapt competitive general equilibrium theory to accord with these stylized facts, it may be necessary to change the focus of future modeling in all fields of economics towards a theory of general equilibrium which includes space, transport costs, increasing returns to scale and monopolistic competition as central elements. Future model building in economics will have to treat the spatial structure of economic activity as endogenous. In this sense, "... there is now no excuse for neglecting the spatial aspect of economic life". In any case, there is a need to unify fields in economics, and the FKV book has contributed significantly to this discourse.

### **Assumptions and Theoretical Models**

All theories (mathematical or otherwise) are based on assumptions. The assumptions that are not called into question by a research community are

those that its scholars are willing to take as axiomatic. What distinguishes different intellectual traditions is precisely the set of assumptions that a community is willing to take as axiomatic. Such differences between the community of geographers and that of economists remain as a major gap.

One community's axioms are frequently regarded by other communities as ridiculous assumptions. One response to the charge that one's assumptions are ridiculous is what one might call the “damn the assumptions” approach. As Friedman famously argued, and early economic geographers happily endorsed, it does not matter how simplistic the assumptions are, as long as the conclusions look realistic. At times, the FKV book comes close to such a position, when the authors state that elegance and ability to derive general theorems is to be valued above any unrealism in the assumptions necessary to derive such results. However, Nagel and other logical positivist philosophers of social science have shown that Friedman's philosophy is extremely problematic arguing, in effect, that garbage in usually means garbage out.

We cannot avoid carefully examining the assumptions made by a community of scholars, and their implications for its theories. In examining the very different assumptions acceptable to economists and to geographers, the first question is whether the assumptions underlying a theory are critical to its deductions. If they are not critical in this sense, then relaxing the assumptions may alter the detailed predictions of a theory but not its core propositions. For example, in the FKV book, relaxing some assumptions may alter where the agglomerations are to be found, but will not undermine the deeper story about the centripetal and centrifugal forces defining equilibrium agglomerations. Critical assumptions are those which, when relaxed, do undermine the core propositions of that theory. In such cases, garbage in really does mean garbage out.

An economic theory can be said to be robust to geographers' concerns about its abstract or theoretical nature, if none of its assumptions are critical in the sense described above. But even if some of the assumptions are critical, however, then geographers can legitimately complain that there are problems in applying economists' thinking to economic geography. This key question has not received much attention until today, because geographers and economists have diverged on a deeper meta-assumption, namely, whether mathematics is the best language for theory construction.

From the viewpoint of economic geographers, two kinds of reactions can be identified. Those who have already turned away from mathematical formalism as a useful theoretical language for geographical problems dismiss the simplicity of such models outright. Yet many of those who still accept the use of mathematics, at least in part, to theorize economic geography, also feel profoundly uncomfortable with the self-imposed limits placed on the FKV book. This latter disagreement is not based on a dislike of mathematical modeling, but of how economists use it. In short, how economists think about geography and how geographers think about it are quite different, even when the same language of argument is deployed.

Nonetheless, some economic geographers did build mathematical theories providing some grounds for assessing the applicability of economic thinking. While the literature is only fragmentary, some important claims have been made suggesting that some of the assumptions invoked by economists are indeed critical. Sheppard and Barnes (1990) argue that in a spatially extensive and geographically differentiated economy, in which transportation and thus, the metric of economic space is endogenous to the economy, Sraffa's criticisms of neoclassical macroeconomic theory applies, where factor prices are no longer equal to their marginal productivity. Moreover, similar criticisms can be made about the validity of core propositions in aspatial Marxian and post-Keynesian economic theory: Sheppard, Plummer, and Haining (1998) argue that in spatially extensive markets, where consumers have limited information and are not perfect price discriminators, the strategy of profit rate maximization dominates that of total profit maximization - the strategy generally used in microeconomic theories of the firm. Webber and Rigby (1999) argue that serious attention to the far-from-equilibrium dynamics associated with technical change calls into question analytical Marxist theorems on the falling rate of profit.

### **Origin and Formulation of Concepts**

Reading through the originality claims of some of the underlying concepts used in the FKV book, some economic geographers feel a lack of attention to their previously published work. Is it really the case that nobody else has examined micro-motives behind the lattices and hierarchies of the central place theory; derived the existence of central cities and land use patterns; theorized the emergence of hierarchical sub-centers around cities; or

deployed spatial potential models. The works of Dacey, Curry, Puu, Papageorgiou, and Denike, which address these topics, do share economists' current concern for micro-foundations.

Just as the new trade theory, as well as the new growth theory were synthesized by cornerstone papers, the FKV book aims to do the same for the new economic geography. However, their claim to originality is debatable since many of the underlying ideas about cumulative causation through forward and backward linkages are old and well known. For instance, in the spatial Dixit-Stiglitz model a core periphery structure emerges when transport costs fall as a result of certain effects, which influence the distribution of manufacturing. This can simply be explained in terms of a well known three stage process: First, areas with large manufacturing sectors tend to have a lower price index. Such areas also tend to pay higher nominal wages and, because of the price index effect, tend to offer manufacturing workers a higher real wage. Second, regions with a large demand for manufacturing goods also tend to have disproportionately larger manufacturing sectors, and therefore, tend to export manufacturing goods. Third, because manufacturing workers demand manufacturing goods, areas with a concentration of manufacturing also tend to have a larger demand for manufacturing goods. Because these effects emerge from the FKV models' basic dynamics, at no point do the authors try to measure their empirical significance. Clearly, what is new is not the underlying ideas, but their formalization and their reworking into equilibrium-type models.

### **Conclusive Remarks**

The FKV book notes the need for more empirical work and the test of the new economic geography will be whether it manages to combine its theoretical models with empirical evidence. The book also argues for more attention to the policy implications and predictions.

Therefore, further research needs to be devoted to finding empirical evidence supporting the claims made by the theories in the book. Lacking such evidence for the moment, it would be premature to start using the models for making policy recommendations.

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