

Dusek, Tamas

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## Two modes of spatial economy models: Thünen and Krugman

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## **Two modes of spatial economy models: Thünen and Krugman**

Paper presented to the 53<sup>th</sup> Congress of the European Regional Science Association,  
Palermo, Italy, August 27-31, 2013

Tamás Dusek  
Széchenyi István University  
Győr  
Hungary  
9026, Egyetem tér 1.  
[dusekt@sze.hu](mailto:dusekt@sze.hu)

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## Abstract

The aim of the study is to compare the methodology of spatial model building of two very influential economists, Thünen and Krugman. Thünen is a representative nineteenth century economist and Krugman represents the method of contemporary neoclassical mainstream economics. Thünen is mostly known from secondary and tertiary interpretations, which are sometimes superficial or misleading. Thünen's *Isolated State* has almost 700 pages, the most comprehensive German edition has 1260 pages, but the typical interpretation concentrates only on the first page which introduces the basic assumptions and the graphical presentation of the results. However, the methodology, the comparison of the theory and the empirics, the critical examination of the assumptions by Thünen are mostly neglected.

Thünen was aware of the fact, that his model is an idealization of the agricultural land-use pattern: "The abstraction from reality without which cannot come to any scientific knowledge has several dangers, namely: (1) We separate in thought what is in fact mutually interrelated. (2) Our conclusions rest upon assumptions of which we are not clearly conscious and which we therefore do not make expressly, and we then consider as generally true what is true only under these specific assumptions. The history of economics gives us many striking examples" (Thünen, 1930, pp. 407-408). He examines thoroughly the differences between his idealization and reality.

Variables used in Thünen's model are observable and measurable. Krugman, on the contrary, uses unobservable and immeasurable variables also. Similar to Thünen, Krugman uses several assumptions (or "tricks") during the model building: the Dixit-Stiglitz model of monopolistic competition, everyone shares the same Cobb-Douglas tastes, the iceberg treatment of transportation cost of industrial goods, costless transport of agricultural products, costless interregional movement of labor, punctiform regions and so on. However, in contrast with Thünen he does not examine the impact of various assumptions on the applicability of his models to any real world phenomenon.

The first part of the paper reconstructs Thünen's method, treatment of space and his original ideas according to his *Isolated State*. Compared to Thünen's original work, it is shown that the typical interpretations have some misunderstandings. For example, it is highly unhistorical to say about Thünen, that his model was based on neoclassical perfect competition. The second part deals with Krugman's method, treatment of space and his main results. The third part gives general comparison between the two methods.

JEL codes: B3, B4, R14

Keywords: Thünen, Krugman, new economic geography, history of regional analysis

## **Introduction**

According to a view about the accumulation of scientific knowledge, contemporary publications contain all achievement of the previous generations. Apart from the interest in the history of theories and the purpose of learning from the failures of corrected theories, examination of older works is superfluous.<sup>1</sup> The soundness of this antihistorical mentality can be proved by reading of original, classical writings, by comparison of the original works and their later and actual interpretations, and by comparison of the original works and the contemporary writings about the similar topics. This paper carries out this task by the analysis of the method of Johann Heinrich von Thünen, the founder of spatial economic analysis, and the method of one of the most prestigious contemporary writer, Paul Krugman.

### **1. Johann Heinrich von Thünen**

#### *1.1 Historical background of the Isolated State*

Thünen (1783-1850) was born on his father's estate in the region of Jever near the German North Sea coast. In 1799 he began to work on an estate in the vicinity to learn practical agriculture, and then went to the agricultural college at Gross-Flottbeck near Hamburg. He enrolled in a course at Institute of Agriculture in Celle in Summer 1803. His teacher was there Albrecht von Thaer. Thaer and Adam Smith were named by Thünen in the second part of the *Isolated state* as his teachers, the first one in agricultural science, the second one in economics (Thünen, 1930, p. 401). In October 1803, he registered at the University of Göttingen to study until the summer semester 1804. He developed already in 1803 the basic idea of the *Isolated state*, the impact of distance on agricultural activity. In autumn 1804 he visited his schoolmate in Mecklenburg and he fell in love with the sister of his schoolmate. He did not continue and never finished his study at the University. In 1810 he bought Tellow, a medium-sized estate 23 miles (37 kilometers) from Rostock and became a practical farmer. He began immediately to register every detail about the expenses and earnings of the estate. In 1819 he was ready with the first draft of the *Isolated State*. In 1826 he published the first edition of the book, upon the urging by his friends. In 1842 he published the enlarged version of the book. In 1850 the second part of the book was published. These two parts were published together in one book (with 678 pages) in 1910, 1921 and 1930, with an introduction

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<sup>1</sup> As a review writes about Thünen's English translation: „Regrettably the difficulty of the book must mean that its translation has little value other than to the specialist student of economic thought or as a source of data to the agricultural historian. Though its appearance enables one to pay homage to the pioneering ability of Thunen and to the value of his work his ideas can nowadays be more easily imparted with the aid of easily understood diagrammatic presentations” (Peters, 1967, p. 194).

written by Otto Waentig. I deal only with this version of the book in this paper. The third edition of the book was published in 1875 in four volumes with altogether 1260 pages. The first two volumes are the same as the books printed in 1842 and 1850, the third and fourth volumes were put together by Hans Schumacher from various materials written by Thünen. Hans Schumacher knew Thünen personally and he also wrote a book about the life of Thünen (Petersen, 1944; Waentig, 1930).

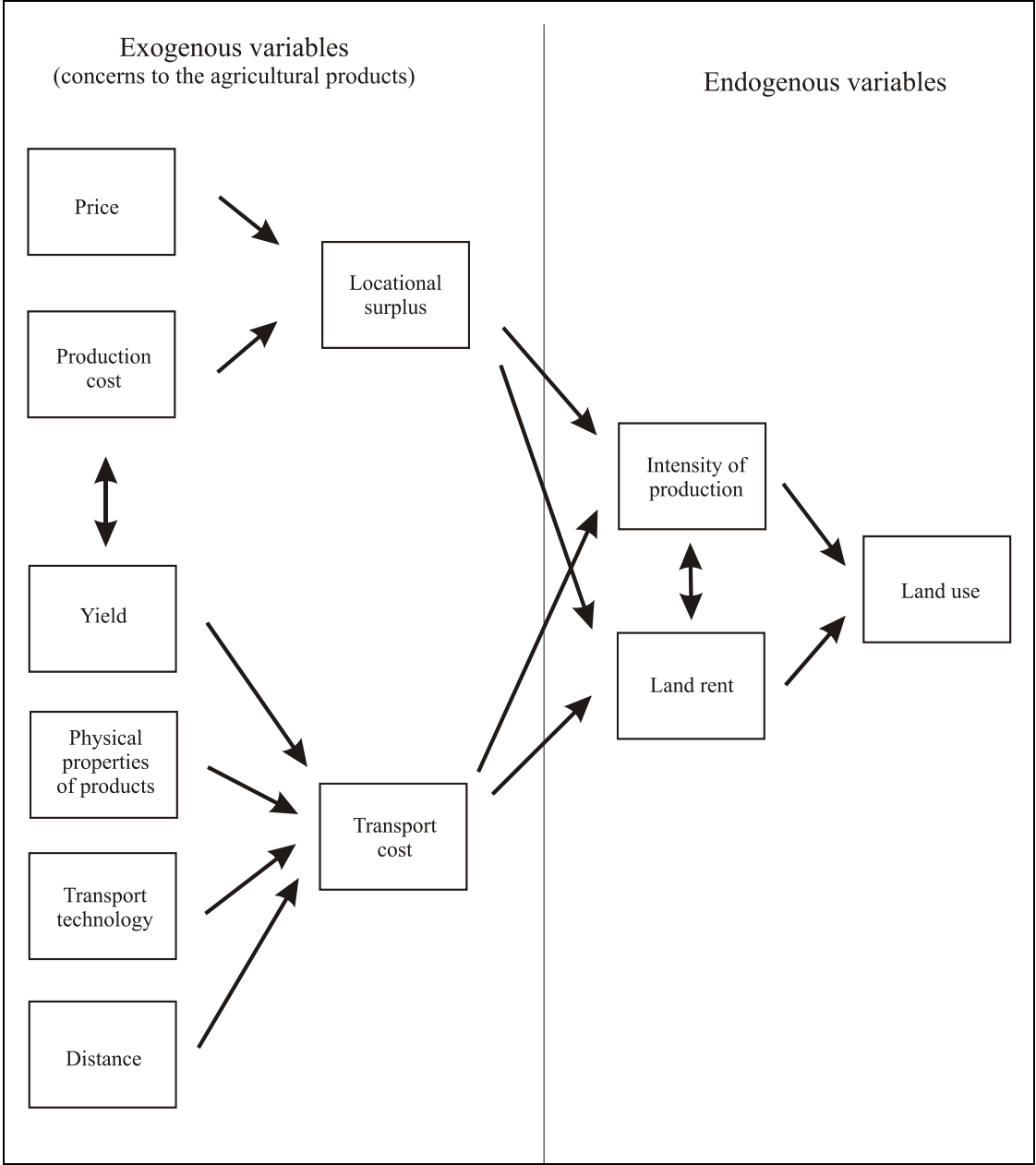
The English editions of the *Isolated State* do not cover the full, four volumes edition. The second volume is translated into English as part of Bernard W. Dempsey's *The Frontier Wage* (Chicago, Loyola University Press, 1960). The first volume and some parts of the third volume were published in 1966, with an introduction by the editor, Peter Hall (Pergamon Press, Oxford). However, the typical interpretation of Thünen's work concentrates only on the first two pages of his book which introduces the basic assumptions and the graphical presentation of the results on the page 387. It is altogether 3 pages of the book, less than three thousand part of it. Thünen's *Isolated state* became a practically almost unread, but often cited classics, similar to Adam Smith's *Wealth of Nations*.

### *1.2 The aim of the Isolated State*

In building of any economic theory, a statement has to be made about which variables are to be treated as exogenous, or given, or independent, or cause, and which as endogenous, or dependent or effect or simultaneously determined in the theory. What is exogenous and endogenous depends entirely on the problem with which the theory is dealing. According to the number of endogenous variables there is a scale, which begins with only one variable. The other end of the scale cannot be determined exactly, because a theory cannot be imagine with solely endogenous variables. The theories with only one endogenous variable are called sometimes as partial theories, the theories with a lot of endogenous variables are called general theories. This naming is misleading. When the number of endogenous variables is increasing, the generality of theories are increasing and decreasing at the same time. The reason behind this contradictory tendency is that with the increasing complexity of the system more and more simplifying assumptions are needed. The simplifying assumptions reduce the generality, testability, validity and reality of the theory. This can be seen very well by comparing the partial location theory (only the optimal location of one company is endogenous, every other locations are given) and "general" location theory with the general equilibrium of "all" economic actors.

The main variables of Thünen’s theory can be seen on Figure 1. The Figure is simplified, because only the primary direction of causes is depicted. Thünen’s theory deals with the optimal use of land, the main endogenous variable will be the form of land use. The theory explains the following three interconnected phenomena: the land rent, the land use and the intensity of land use. However, there are a lot of other questions discussed in Thünen’s book.

Figure 1 The main exogenous and endogenous variables of Thünen’s theory



Thünen’s work is at the same time theoretical (abstract, general) and applied (concrete, historical, descriptive). The theoretical character is attributable to the systematic and general

examination of the influencing factors of the land use. Since these factors are general and eternal categories of the human economic activity, which are independent from the historical time and actual geographical space, the theory is applicable always and everywhere. Only the context, the actual manifestation of these general categories will be different in different time and space: the form of transport costs, the production technology, the products, the climatic circumstances, the relative prices and so on.

The applied parts of the book are based mainly on the data collected by Thünen himself in his real estate of Tellow. However, he refers to other sources also, to agricultural activity in Germany, England, Russia and other countries. The theoretical and applied parts are not detached inside the book, but Thünen make a clear distinction between the general form of the theory and the concrete, historically valid form of the theory. The latter is valid only with the data of his Tellow estate. Thünen writes that if someone examines another estate, which is not similar to Tellow, then the concrete calculation could lead to entirely different results; however, as regards the general conclusions expressed verbally, they remain the same (Thünen, 1930, p. 47).

According to Schumpeter, Thünen is a “patron saints of econometrics” (Schumpeter, 1981, p. 441). This was referred for example by Melamid (1955), Samuelson (1983) and Fujita (2011). However, it is important to mention, that the “econometrics” of Thünen and contemporary econometrics has almost nothing in common. Firstly, Thünen observed and gathered the analyzed data by himself – this is not common today, when the origin and quality of analyzed data is often uncertain. Secondly, Thünen expressed the connections of the variables with deterministic functions and he did not make any investigations about the homoskedasticity, normality or significance testing. He treated the data not as a description of a stochastic process, but as they are in reality: historical facts which help to describe a concrete historical situation, but there is not any reason to give a probabilistic estimation in connection with them. Nevertheless, as I wrote already, Thünen knew the incidental character of his calculation, but he did not mix up the epistemologically entirely different random and uncertain phenomena.

Thünen was fully aware of the fact, that his theory is an idealization, which describes the reality not in its concrete details. Originally he was planning to name the book the “Ideal State”. Ideal means here not utopian or perfect, but abstract (Petersen, 1944, p. 27-28). Isolation in the title of the book has two meanings: firstly, it means the concrete, geographical isolation of the state from the external world, and secondly it has a methodological meaning, namely the isolated examination of various influencing factors.

### *1.3 About the assumptions of the Isolated State*

Theory building begins with some basic statements and definitions and continues with a system of conclusions. The basic statements are called assumptions, the obviously true statements are called axioms or postulates. Axioms or assumptions must be independent and consistent, that is, they do not contradict themselves. Starting from contradictory axioms anything can be proved. For example, in a spatial theory, the existence of transportation cost and the same price level in the space would be two contradictory assumptions.

In the contemporary neoclassical economics there is some confusion about the role and types of assumptions. As Krugman writes “there is nothing wrong with simplifying assumptions – on the contrary, it is only through strategic simplification that we can hope to make any sense of the buzzing complexity of the real world” (Krugman, 1991, p. 2). The failure of this view lies in the fact, that Krugman and others do not make any distinction with the various types of assumptions and they forget to examine the effect of various assumptions on the applicability and validity of theories. In his important and clear paper Musgrave makes a distinction among three types of assumptions. One type is the negligibility assumptions. “Suppose a scientist is investigating some phenomenon and has the hypothesis that some factor F which might be expected to affect that phenomenon actually has no effect upon it, or at least no detectable effect” (Musgrave, 1981, p. 378). And one example from Musgrave: “Now suppose an economist ‘assumes that there is no government’, meaning thereby to assert that the existence of the government has negligible effects on the phenomena he is investigating. It would be plain silly to object that this assumption is ‘unreal’ because there is, in fact, a government” (Musgrave, 1981 p. 379). The second type of assumption is the domain assumption, which posits that the theory can be expected to depict reality accurately as long as certain conditions exist. The third type of assumption is what Musgrave termed a heuristic assumption. In this case, in the first stage the scientist takes “no account of factor F, or ‘assumes’ that it is negligible; in the second stage he takes account of it and says what difference it makes to his results” (Musgrave, 1981, p. 383). This typology by Musgrave can be extended with a fourth type of assumption, namely assumption, which is in accordance with reality. For example the existence of transport costs is an empirical fact, which we can use in the explanation without restricting the domain of our models.



Thünen's assumptions belong to negligibility, heuristic or realistic types. He does not use domain assumptions, because the impact of each assumption is examined thoroughly.<sup>2</sup> He writes about the abstractions the following:

"The abstraction from reality without which cannot come to any scientific knowledge has several dangers, namely: (1) We separate in thought what is in fact mutually interrelated. (2) Our conclusions rest upon assumptions of which we are not clearly conscious and which we therefore do not make expressly, and we then consider as generally true what is true only under these specific assumptions. The history of economics gives us many striking examples.

Among the assumptions mentioned expressly in the first volume or quietly assumed, there are two which require special examination and clarification: (1) The soil in the plain of the Isolated State is not only originally of equal fertility but after cultivation, with the exception of the first circle, equal fertility remains in regard to the ability of soil to grow plants in all parts of the Isolated State howsoever different the prices of grain may be. (2) The diligence exercised in agriculture, in plowing, harvesting, or in anything else, is everywhere the same, whether the bushel or rye is worth one half or one and one-half talers. Now, we must put the rationality of economic activity in the first place, and subordinate everything else.

The question arises of itself: "Are both these assumptions consistent with rational management?" To that I must answer no. The reasons for this answer must be further developed. From this point of view, Volume 1, which does not justify this, could have been attacked and would have been attacked if the book had received criticism in the spirit of the work itself." (Thünen, 1930, pp. 407-408; translation from *The Frontier Wage*, 1960, pp. 197-198).

This is a comprehensive survey. Thünen's method is the successive approximation to reality. He studies one change, force or tendency at a time, whenever that is possible, even when usually, or perhaps always, acts in combinations, interrelations, and mutual influences of all the main changes, forces, or tendencies at work. He compare always the theory to reality, he continuously examine the effect of the assumptions on the theory, because for him the aim of science was to give a description and explanation of the reality.

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<sup>2</sup> Thünen's assumptions (Voraussetzungen) were translated by Wartenberg (in the 1966 English edition) as „hypotheses". This can be criticized, because those statements, about which immediately, without any investigation can be known its trueness or falseness, is not hypothesis. It is not an hypothesis, for example, that the soil in the area is homogenous in fertility or there are no other towns in the area (Thünen, 1930, p. 11)

## **2. Paul Krugman**

### *2.1 The method-oriented definition of economics*

When I deal with Krugman, I deal with a representative of the neoclassical formalist mainstream economics, therefore the conclusions will be valid not only to Krugman, but mostly to the New Economic Geography and the whole edifice of neoclassical mainstream also. It is useful to begin with the very starting point of all other mistake of Krugman. According to Krugman in our time mathematical formalism is the only scientific way in the investigation of economic questions. “A rise in the standards of rigor and logic led to a much improved level of understanding of some things, but for a time it also led to an unwillingness to confront those areas that the new technical rigor could not yet reach” (Krugman, 1995, p. 3). “Since economics as practiced in the English-speaking world is strongly oriented toward mathematical models, any economic argument that has not been expressed in that form tends to remain invisible” (Krugman, 1990, p. 3).

This statement is proofed by Krugman’s works, where the assumptions are determined by analytical tractability and not by empirical relevance. It is an unproved, very general statement as well, that a rise in rigor led to a much improved level of understanding some things. Krugman uses rigor and logic in a very restricted way. For Krugman, to be rigorous and logical, the usage of algebraic formulas is the primary condition. However, I prefer the original meaning of rigor and logic, namely that we use unambiguous concepts and we prove our statements by the help of logical rules. If someone substitutes an immeasurable, vague economical concept, such as utility, labor, capital, knowledge or well-being with an algebraic symbol, the economical concept does not become measurable and clear thanks to the substitution and the theory will not be more scientific or precise.

Krugman is quite critical against the critics of formal models. He accuses the critics of political bias and mathematical unskillfulness (while his applied mathematical apparatus is very elementary from a mathematical point of view). “Many of those who reject the idea of economic models are ill-informed or even (perhaps unconsciously) intellectually dishonest” (Krugman, 1995, p. 79). As Krugman repeats it many times, verbalism is archaistic, murky, boring, unscientific. However, verbalism and mathematical formalism are both only a form of expressing ideas. It is groundless to oppose the clarity of mathematical expression to the vague verbal one. The right way is to draw a parallel between mathematical and a sensible, intelligent verbal expression.

According to Krugman, formal mathematical models, which are built on highly unrealistic assumptions, can be used in practical political proposals. It is not a question, those formal models can be very useful in practice in that cases where an operational method can be given that permits us to examine the statements of the theory by means of observation. However, the internal consistency of a theory is merely a precondition and not a warranty of its applicability and validity. Theories without operational method which enables us to make a correspondence between theory and empirics, is not part of empirical science. Neoclassical theory building imitates often only the half of the methodology of mathematized natural sciences, namely mathematical formalism, but it disregards the importance of empirical contents of mathematical forms which has vital importance in physics.

The investigation on the effect of the various simplifying assumptions would be a primary task of the model builder, because it is a fundamental question, whether an assumption only simplifies the reality or limits and distorts it. The fact, that formal models without any empirical content and without any investigation concerning the effect of simplifying assumptions are used for practical political proposals is not proof of its usefulness. Quite the contrary, it is only a sign of intellectual confusion.

The acceptance of Krugman's interpretation about method leads to a system which is unassailable, beyond criticism and dogmatic from the point of view of method. The system can be criticized only in that case when someone accepts its basic tenets. This is unfamiliar to a truly scientific ethos. The method-oriented definition of economics has other specific shortcoming also, namely, it led to disregarding, misinterpreting or undervaluing the ancestors of scientific ideas, if it is not expressed in a formal way. Krugman's various superficial observations on the history of economic thought can be accepted only from his method-oriented, restricted interpretation of economics.

## *2.2 Krugman's treatment of space*

Krugman's most common definition of space is the discrete two-point-economy.<sup>3</sup> This is the space view of his famous "core-periphery" model. Why is this concept better than the "wonderland of no dimensions", the one-point-economy (punctiform economy)? The evident problem of this approach can be seen on Figure 1. The number of individual actors and their

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<sup>3</sup> It is an implicit approach. There is another possible interpretation, namely that regions are perfectly homogenous surfaces; inside the regions there aren't any differences, going over the border there is an abrupt changes in prices, costs and so on. The two-point-economy and two-homogenous-surface-economy approaches are inadequate to the same degree.

connections are much larger than those of the connections of aggregated regions, but these are not possible to depict. There can be legal, institutional, constitutional differences between intraregional and interregional flows, if regions are countries, or cultural, language, social barriers inside the same country. This was the real argument for a separate theory for international trade for classical economists, such as Ricardo and Cairnes. Only institutional factors would give reasons to treat regions as points, and the space between regions as vacuum.

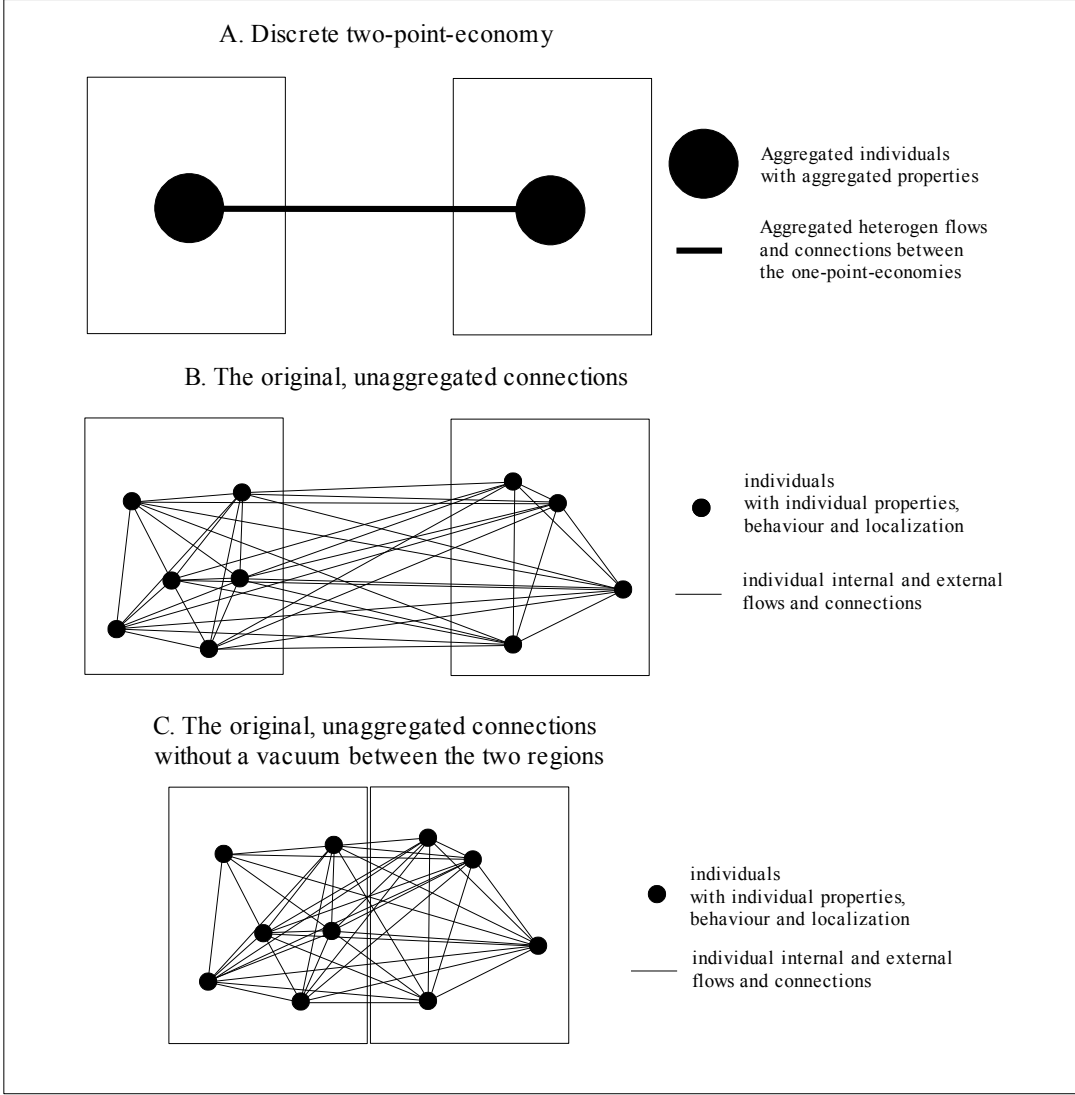
However, Krugman's models do not really deal with institutional (and language, custom, culture and so on) factors, neither with the geographical unevenness of space, but only with pure economical factors. Fujita et al. (1999) maintains that "We are really interested in all of the costs of doing business over geographical space. In other words, we want for the theory a measure of the full cost, including all the cost of doing business at a distance – lack of face-to-face contact, more complex and expensive communications and information gathering, and possibly also different languages, legal systems, product standards and cultures. These things are difficult to measure directly but are revealed in the trade data" (Fujita et al, 1999, p. 98). This remark does not substitute the real investigations of that factors which was mentioned in the quotation. In formulas of Krugman's models these factors do not play any role.

When working with implicit point concept, the usage of the word "region" is an unjustified custom. In the case of legally and mentally free movements of persons and goods, the sources of differences can mainly be traced back to the differences of cost distances. It is a common misconception not only by the advocates of New Economic Geography, but in international economics also, to treat the spatial units as individual behavioral units, without their own spatial extent, without their internal complexity. Regions, similar to countries, merge economical activities and factors, which are spatially, temporally, in their degree of quality, in quantity and in behavior, heterogeneous.

In the treatment of transportation costs various constrained unreal assumptions are used, such as there aren't transport costs of agricultural products (or the only *one* undifferentiated agricultural product), transportation costs depend only on physical distance, differences in weight and quality do not play any role, and, of course, there isn't intraregional transportation cost. The latest assumption (which is an implicit consequence of spatial aggregation) means that, for example, transportation costs are the same between California and Nevada, independent from the starting and end point of transport (for example transport costs are the same between the Californian and Nevadan part of South Lake Tahoe and between San Diego and Elko). It is an obvious fact for spatial researchers, that there are a lot of methods to count

average distances between two regions. However, averages are deceptive in the case of behavioral differences. Regarding the cost space and cost distances, there isn't only one exact cost distance (like geographical distance) but there are many different time and cost distances which create a non-metric cost space.

Figure 2 The two-point-economy



Other space definitions of Krugman are more specific, but similarly inadequate. The “racetrack” economy means that space is a bounded, one dimensional circle. This type of space is introduced in “Spatial economy” in a very encouraging title: “Many Regions and Continuous Space” (Sixth Chapter). However, in reality many regions mean that: “The R regions are equally spaced around the circumferences of a circle, with region r+1 next to region r, and with region R next to region 1. Agriculture is evenly divided among the regions. Transportation must take place around the circumference, with a constant fraction  $\tau$  of each manufactured good melting away per unit distance” (Fujita et al., 1999, p. 82). The title of the

chapter is misleading; under continuous space, I mean not such a restricted concept of space, but a two dimensional space without arbitrary delimitations and aggregations.

The third type of space is a continuous one dimensional line with one center or “city” (“Thünen Economy”). (“We consider a long, narrow economy – effectively one-dimensional – that stretches sufficiently far that we can disregard boundary conditions” (Fujita et al., 1999, p. 134). In the subtype of this space there are more than one center. The fourth type of space is defined in a fuzzy, vague way, namely, there is R region with various constrained assumptions concerning the movements of goods and factors. This means that there is R one-point-economies.

The fundamental mistake of all conceptions of space is that practically it treats regions as a natural given behavioral unit. In reality, the boundaries of regions are modifiable, the economic regions are not separated sharply from each other, but they have an overlapping character. Beside the modifiable areal unit problem, it is only partially examined, what is the effect of various restrictive assumptions concerning transportation and space. The generalization and the applicability of results to any real problem is an uninvestigated issue. I do agree with Martin: “The fundamental and complex question of how “regional” and “local” economies can be meaningfully conceptualized, and how such conceptions can be translated into empirical terms, is not considered at all. Instead, there is an ontological slippage between regions as abstract points and spaces, on the one hand, and the uncritical use of whatever administrative units happen to be convenient for illustrative and empirical purposes, on the other” (Martin, 1999, p. 77-78).

Krugman’s declared program, namely to trace back the spatial arrangement of economy to the interaction of decisions by individuals, do not come about not only since the simplicity of his space view, but because there isn’t differences in behavior (same size of firms, same “Cobb-Douglas” tastes etc.). With these homogeneity assumptions only a pseudo micro-foundation can be attained.

Most parts of criticism concerning dimensionless aggregated one-point-economy is valid to two-point-economy, one-dimensional line economy, monocentric economy and network of one-point-economies. In the adequate analysis of spatial phenomenon one has to think about regions as overlapping entities and to use zoning-system-independent continuous space view, which is built by individual locations and individual actions and movements. I admit that these characteristics of space make difficulties for creating simple models. However, the selection of the type of space to be analyzed cannot be made on the basis of its suitability for analysis by simple models.

### 2.3 Modeling techniques of Krugman

In several articles and in their book, the *Spatial Economy* (1999) also, Fujita, Krugman and Venables mention four modeling tricks, which are used in NEG in order to manage the “technical difficulties” involved in trying to deal with the subject. These tricks have been repeated in every Krugman paper about the topic. “Everyone recognizes that these are strategic simplifications, which is to say intellectual cheap tricks; but they do allow us to get past the technical issues and tell stories about the real economics” (Krugman, 2000, p. 51).<sup>4</sup> These tricks are in short: Dixit-Stiglitz model of monopolistic competition, icebergs, evolution and the computer. Firstly I present Krugman’s opinion about them, then I will demonstrate their weakness.

It is a permanently recurring thought in Krugman, that previous works in spatial analysis was based on constant returns and perfect competition. “Now of course the von Thünen model, like the bulk of economic models between 1820 and 1970, focused on the case of perfect competition and constant returns” (Krugman, 1995, p. 76). However, the question is a little bit complicated, because Krugman is not entirely unambiguous in this topic. “New trade theory is an approach to international trade that emphasizes precisely the features of the international economy that traditional trade theory leaves out: increasing returns and imperfect competition” (Krugman, 1990, p. VII). It can be known from other parts of Krugman’s book that “traditional trade theory” means for his neoclassical trade theory à la Samuelson that is pre-Krugman neoclassical trade theory. However, Samuelson’s trade theory is for Krugman, equal to classical trade theory from the increasing returns and perfect competition point of view, the only difference is that the former is superior to later because of formalism. I think this is a gross misinterpretation, because classical trade theory is not based on perfect competition. As Machovec demonstrates in his excellent book, rooted in Walrasian static equilibrium, “the perfect competitor is entirely a creature of the modern neoclassical mind” (Machovec, 1995, p. 242)<sup>5</sup>. It is highly unhistorical, indeed nonsense to say about Thünen and every other spatial researcher, that his model was based on neoclassical perfect competition. There is a great difference between neoclassical and classical interpretation of

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<sup>4</sup> The weakest point of this argument is that it disregards the types of assumptions (or simplifications). As it was mentioned, it is a fundamental question, whether an assumption only simplifies or limits and distorts the reality. This important distinction was ignored by Friedman (1953) whose argument that hypotheses do not require realistic assumptions is used often to legitimate that models which are based on whatever type of unreal assumptions.

<sup>5</sup> Beside Machovec’s comprehensive survey there are many other papers which deal with the origin and consequences of this popular misinterpretation in the history of economic thought. See for example Blaug (1997), Hutchinson (1999).

competition. For neoclassicals, competition is a static end state, an equilibrium situation based on several obviously unreal assumptions, while for classicals (and for the man in the street) competition means an ongoing dynamic process, a rivalry between entrepreneurs, which facilitates discovering that information, which is assumed to be known in the model of perfect competition (Hayek, 1978).

For classicals the idea of division of labor and the principle of comparative advantages is only expressing the idea of increasing returns in another way. In the Introduction of “Rethinking International trade” the phrase increasing returns can be found 27 times. On page 11 Krugman is more cautious, he restricts this assertion to *formal* trade models: “Nonetheless, increasing returns as a cause of trade has received relative little attention from formal trade theory. The main reason for those neglect seems to be that it has appeared difficult to deal with the implications of increasing returns for market structure” (Krugman, 1990, p. 11). This shortcoming, according to Krugman, can be managed with the help of the Dixit-Stiglitz model of monopolistic competition: “The remarkable model of monopolistic competition developed by Dixit and Stiglitz (1977) has become a workhorse in many areas of economics. In the new economic geography, it has one especially appealing feature: because it assumes a continuum of goods, it lets the modeler respect the integer nature of many location decisions – no fractional plants allowed – yet analyze the model in terms of the behavior of continuous variables like the share of manufacturing in a particular region. In effect, Dixit-Stiglitz lets us have our cake and cut it into arbitrarily small pieces, too. The price of that convenience is, of course, that Dixit-Stiglitz is a very restrictive, indeed in some respect, silly model” (Krugman, 1998, p. 164).

The problems arising from this interpretation can be divided into three parts: the problems of Dixit-Stiglitz model itself, the assertion that previous models were based on perfect competition, and the origin of the idea of increasing return. Stiglitz himself wrote about the model, that “it has become acceptable, even fashionable, to use particular parameterizations, for example, constant elasticity utility functions, often of the Dixit–Stiglitz (1977) variety, and Cobb–Douglas production functions. In using them, we should be aware not only of their special nature, but that they have empirical predictions that can be (and typically are) refuted. For some purposes (such as the analysis of behavior towards risk), these utility functions provide a *bad* description, and one should use such models with extreme caution. When Dixit and I used the particular utility function that has become fashionable, we chose it because it provided the benchmark case where markets traded off optimal diversity and firm scale. The diversity/quantity tradeoff was, we thought, the fundamental tradeoff in the theory of



monopolistic competition, and the partial equilibrium models that had been at the center of the theory of monopolistic competition until then simply could not even address this issue” (Stiglitz, 2011, pp. 594-595.). This model assumed to have a microfoundation, but in reality there are either only one representative consumer or all consumers have the same behavior. The source of increasing return in the Dixit-Stiglitz model is only the standardization of products, but not the division of labor, the technological efficiency, horizontal or vertical integration, mechanization. Nicholas Kaldor already in 1935 anticipated the problems of this approach: „This line of reasoning would only be permissible if consumers were actually confronted with the choice of having either a smaller range of commodities at lower price or a larger range at higher prices. In fact, they never are in a position to choose between these alternatives: they are offered either the one or the other, but never both. To expect the consumer to be so „far-sighted” as to concentrate on the purchase of a few varieties merely in the hope of thereby reducing prices in the future, is an assumption which even the highest level of abstraction should avoid” (Kaldor, 1935, p. 50).

As Fujita says in an interview with him and Krugman, “as is well-known in modern economic theory, scale economies are inconsistent with perfect competition on which von Thünen’s model of agricultural land use was based” (Fujita–Krugman, 2004, p. 155). This assertion is repeated several times in various papers of NEG. Ambiguous to state that Thünen’s model was based on perfect competition. On the one hand, Thünen’s basic model of concentric rings was based on a cost space in which there is only one transportation cost and everyone has a perfect knowledge about this. However, this is not equal to perfect competition. As I wrote, Thünen was aware of the fact, that his model is an idealization of the agricultural land-use pattern, he examines the differences between his idealization and reality (Thünen, 1930, pp. 264-324, but the whole book is a comparison between the theory and reality). On the other hand, it is a self-contradictory assertion about a spatial model to be based on perfect competition. One of the many unreal assumptions of perfect competition is non-spatiality. Space cannot be made consistent with perfect competition. One part of earliest critiques of perfect competition was expressed by spatial researchers, for example Palander in 1935 (Palander, 1935, pp. 275-278). If not earlier, at least from that time it should be the incompatibility of perfect competition and spatiality an worn out question.

As regards increasing returns, it is an ancient idea anchored in the first ancient writings about economy. Plato in his Republic clearly formulates this idea, writing about the origin of state. The possibility of increasing returns belonged to the category of evident facts until the

ascendance of neoclassical formalism.<sup>6</sup> Neoclassical general equilibrium framework is based on many dozens of unreal assumptions, only one of them is constant returns to scale. As this approach became the mainstream in economics, the previous general knowledge concerning increasing return together with other knowledge, sank into oblivion.

Krugman writes about icebergs, that “in location theory, transportation costs are of the essence; yet any attempt to develop a general-equilibrium model of economic geography would be substantially complicated by the need to model the transportation as well as good-producing sectors. Worse yet, transportation costs can undermine the constant demand elasticity that is one of the crucial simplifying assumptions of the Dixit-Stiglitz model. Both problems can be sidestepped with an assumptions first introduced by Paul Samuelson (1952) in international trade theory: that a fraction of any good shipped, simply “melts away” in transit, so that transport costs are in effect incurred in the good shipped. In the new economic geography models, melting is usually assumed to take place at a constant rate per distance covered” (Krugman, 1998, p. 165).

In this short quotation several methodological weaknesses of model building technique can be observed. Krugman aggregates the economic actors into two sectors, agriculture and industry, thus there isn't space for a transportation sector. (There is neither space for the heterogeneity of products and firms. By the way, the aggregate treatment of industry in itself questions the whole NEG, because in the industrial agglomeration the industrial branches play a fundamental element and not the industry in general.) With this treatment of transportation the transport sector uses the same inputs as the transported goods. It is easy to demonstrate that this treatment of transport cost leads to convex delivered prices. However, every empirical result confirms that the concave form is typical (McCann, 2005). There is no room for the diversity of transportation modes, for the diversity of transportability and weight of goods. (Are the transportation costs the same for brick, cement and microchips?) Moreover, it implies that transport costs are directly proportional to the price of shipped goods, which is unrealistic also. Lastly, transportation costs are only a part of transaction (or exchange or interaction) costs. Transaction costs play a central element not only in divisions of labor and the theory of firm but in location decisions and the process of agglomeration.

“Evolution refers to how one thinks about how economy “selects” one of several (or many) possible geographical structures. It is typically true of new economic geography

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<sup>6</sup> Since Krugman himself made much for popularizing the mistake, namely that increasing returns have been recently discovered, writes also: “to those who imagine that increasing returns are something only recently discovered, it is startling to see how much attention is given in Marshall's Principles to local externalities” (Krugman, 1995, p. 50).

models that they have multiple equilibria” (Krugman, 2000, p. 52). The fundamental problem lies in the difference between historical time and the unspecified time of the models. The treatment of the connection between theory and history is also problematic. This question is also examined when this trick is discussed. In selecting the geographical structure, historical accident plays an important role. “To a remarkable extent, manufacturing industries within the United States are highly localized; and when one tries to understand the reasons for that localization, one finds that it can be traced back to some seemingly trivial historical accident” (Krugman, 1991, p. 35). “For at least insofar as the location of economic activity in space is concerned, the idea that an economy’s form is largely shaped by historical contingency is not a metaphysical hypothesis; it is simply the obvious truth” (Krugman, 1991, p. 100). It is useful to emphasize that the main aim and task of theories and models is not the prediction or explanation of concrete, individual events. Categorical difference between theory and history is not registered by Krugman. The previous statements are only true if we consider the pure historical explanation of spatial events. The key task of an economic historian is (in one of Krugman’s examples) to investigate the important elements, which are in the background of the establishment of the carpet manufacturing firms in Dalton after World War II. However, the task of theoretical explanation is the exploration of the reasons of industrial concentration in general. Any competent economist can explain by the help of theory why and how the agglomerations come into existence in various branches of industry. However, theoretical explanation has its *a priori* limitations, namely no theoretical economist can explain why a particular firm was organised in a certain location and time without converting himself a historian and investigating concrete events.

Krugman writes little about the “computer trick”: “despite the best efforts of the theorist, all but the simplest models of economic geography usually turn out to be a bit beyond the reach of paper-and-pencil analysis. As a result, the genre relies to an unusual extent on numerical examples – on the exploration of models using both static calculations and dynamic simulations” (Krugman, 1998a, p. 165). It is undeniable, that simulations with the help of a computer can help many complicated theoretical and practical problems, for example in technical, genetical or biological problems. However, simulations in “Spatial Economy” say nothing about real spatial questions. Simulations are used describing temporal processes without defining time scale (minute or millions of years).

It would be a hard task to decide which is the weakest trick. However, there are problems not only with these four modeling tricks. There are many other tricks as well. As regards to the main point, space itself, I dealt with it already. For example in Krugman’s book,

“Geography and Trade”, this implicit or expressed assumptions can be found: there are only two possible locations (without spatial extension), there are two products, the only agricultural good is homogeneous, all manufactured goods have the same transport costs, intraregional transport costs do not exist, the employers are homogeneous, the capital is homogeneous, migration choices base on current wage differences alone, and so on. Maybe this is not a problem in itself, as I mentioned, because every model simplifies reality. But it is always real problem that the type and effect of simplifying assumption is not examined.

While only one essential unreal assumption can invalidate the applicability of the whole model in any real world situation, the abundance of unreal assumptions forms a problem with a quantitative character also. Of course, unreal assumptions may be of negligible effect to the validity and applicability of the theory, but it is unlikely that the simultaneous effect of so many unreal assumptions is negligible in the systematically connected system of spatial relationship. If one of these restrictions is cancelled, this occurs only partially: one thin slice of reality is examined with many other restrictions.

### ***Conclusions***

There are two important differences between Thünen’s and Krugman’s method:

1. Krugman does not bother himself with the unreal assumptions, he does not examine their effects on the applicability, validity of the theory. Thünen carefully examines the effect of his assumptions.

2. There is not any contact between the concepts used in Krugman’s theory and the reality. The model cannot be operationalized: products are not homogeneous, consumers are not homogeneous, utility is immeasurable and so on. Of course, in the reality there are centrums and peripheries, agglomerations, and so on. These empirical facts render to Krugman core and periphery model some illusory support. Krugman’s theory is not wrong concerning to its starting points, but the starting point and method themselves is problematic. In Thünen’s theory the various concepts are observable and measurable quantities.

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