Jean H.P. Paelinck*
George Mason University

SPATIAL ECONOMETRICS: A PERSONAL OVERVIEW

Introduction

The paper is written on the basis of my lecture given at the Academy of Economics, University of Katowice, June 2012.

Spatial econometrics is a fast-growing field in the series of quantitative disciplines, auxiliaries of economics and related social sciences.

The subject matter is all the more complex as it has a twin brother, spatial statistics, which in many aspects is complementary of today's subject.

We will essentially treat spatial econometrics as we have experienced it, and are still practicing, referring to other materials to cover spatial statistics proper; a recent paper with references is Griffith and Paelinck (2004), a condensed version appearing in Griffith and Paelinck (2011).

Next section is devoted to an obscure period of our discipline, when essentially "spatial econometrics without space" was practiced. Then, progressively, that space emerged, and fragments of real spatialized exercises could be excavated from dispersed articles and books, as section 3 testifies.

In 1979, with our colleague Leo Klaassen, we defined a number of principles that, we hoped, would guide future work along lines that tried to identify the specificity of spatial econometrics, totally respecting the teachings of general econometrics; the same applies to theoretical spatial economics, which integrates all the principles of general theoretical economics.

Looking ahead is a more dangerous undertaking, for which we will rely on our recent work; statements resulting from this exercise will probably be controversial, but we hope they will stimulate a fruitful discussion on some delicate points of the discipline.

Conclusions and references follow, as usual.

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* Distinguished Visiting Professor, Doctor honoris causa of University of Economics in Katowice.

1. Prehistory

Let us start with mentioning the fact that we entered in contact with spatial problems on the occasion of treating a problem in regional development. In those times, very little statistical material happened to be available, so reasoning had to proceed in a still theoretical way, the basis being a theory of polarized regional development. The concepts set out there (Paelinck, 1963) already invited a *joint* consideration of regional developments, which became later the principle of asymmetric inter-regional linkages.

Econometric exercises published over that period were of the most classical type, relating only variables possessing the same regional index. Examples are Thompson and Mattila (1959, see the comments on this study in Paelinck and Klaassen, 1979, p. 6; Vanhove, 1963, we used the latter in an exercise of calculating the parameters of an optimal multiregional policy (Paelinck, 1967), already noticing there that the underlying model used was inadequate to represent the correct spatial workings of the economy, which would be reflected in the policy outcomes. To quote from Paelinck (1967, pp. 57-58): "(…) les résultats de l'économétrie régionale, telle qu'elle est souvent pratiquée, sont fortement affectés par la négligence de deux facteurs essentiels:
- la localisation relative des régions faisant l'objet de l'étude;
- la localisation intra-régionale des activités sur lesquelles porte l'analyse.

(…) De statique et indifférenciée, l'économétrie doit devenir *dynamique et différenciée*; des modèles adaptés au *caractère spécifique de l'analyse régionale* doivent être mis au point".

The same criticism, levied against regional macro-models, was repeated in Paelinck (1973).

One can justifiably ask the question: why has no attention being given to spatially entwined activities? On the one hand, time series analysis knew the notion of serial correlation, reflected on in terms of lagged variables, exogenous and stochastic. On the other hand, input-output analysis was starting to develop multi-regional variants, though typical topological variables were absent. Furthermore, in studies of inter-regional and international movements (inter-regional migration or inter-zonal commuting, international trade) gravity models were in use, which implied the use of certain distance measures.

The answer lies probably in the fact that the bridge between spatial analysis and econometrics proper had still to be built. How progressively that has happened will become clear from the next section.

2. Interim period

Things would change in the late sixties and seventies. In 1966 (see also Lebart, 1969), a colleague of ours at the "Institut d'Etude du Développement Economique et Social" of Paris University, Ludovic Lebart, applied the Geary statistic (Geary, 1954) to French departmental data, generalizing it and studying spatial autocorrelation at different degrees of contiguity, in fact measuring distance effects, as the degree of contiguity is a fully-fledged metric.

A similar study was published in Paelinck and Nijkamp (1975, pp. 223-234 and 243-246) using five different variables (number of inhabitants per square kilometer, rate of growth of population, employment per square kilometer, per capita gross value added at factor prices, per capita available income); the first variable showed systematic positive spatial autocorrelation, the second and third ones a negative one, the last two variables again positive autocorrelation, except at order two. These findings, for 1960 and 1965, gave an acceptable insight in the spatial structure of the variables taken up in the study.

Moran's I (1948, 1950) gained popularity over the same period, the Cliff and Ord volume (1973) on spatial autocorrelation completing the picture.

What was missing though was a complete integration of theoretical spatial economics and econometrics proper; this was what "Spatial Econometrics" (1979) meant to do.

3. Recent times

The initial vision on what spatial econometrics could be was expressed in our General Address to the Dutch Statistical Association on the occasion of its Annual Meeting on May 2nd 1974, held at the city of Tilburg.

The integration just mentioned was laid down in the form of five principles which we would like to remember briefly.

The first one was already introduced by the previous considerations, to wit spatial interdependence. The new vision however was to derive that interdependence from the workings of spatial economies. Two models were essentially staged, an income generating model and a so-called attraction model; the first started from a spatial generalization of the Keynesian macro-economic consumption-cum-investment model, introducing spatial shopping behavior and so generating spatial consumption propensities, later to be estimated; the second was a generalized Weberian sectoral location model, based on locational choices as a function of expected profits. As an obiter dictum, let it be said that I still used those models to train Ph.D. students at the School of Public Policy of George Mason

University. Without going into detail, it should be mentioned that the classical econometric problems – specification, dimensional homogeneity, identification, estimation, testing – are systematically taken up.

The second principle was that of spatial asymmetry in the measures of spatial interdependence; this was already known to be the case for trade flows, but the idea had to be generalized to parameters. An example, modeled and estimated, was that of spatial consumption behavior in terms of urban and non-urban spatial unit within the spatial income generating model mentioned above.

Both these principles show a stark contrast with the simple measurement of spatial moving average or spatial autocorrelation process parameters.

Principle three was called "allotopy", from the Greek words αλλος and τοπος, meaning respectively "other" and "site"; it alludes to the influence at a distance of exogenous variables, the Weberian location model, already mentioned, being a perfect example of this.

Choice problems in space lead more than often to non-linear solutions, so this too should be reflected in our model specification, especially if the model intends to picture ex-ante choices; this is the case of locational models (see e.g. the European FLEUR-model: Ancot and Paelinck, 1983), though resulting ex-post behavior (for instance, transport flows) could still be treated linearly.

Finally, topological variables (locations, distances, densities, etc.) should not be absent; as said earlier, spatial models should not be "without space"! It should explicitly be said here that the choice of a distance measure is a strategic moment in the model specification, too little attention being often given to the problems of metric topology involved.

As spatial econometrics *is* about economics, much stress was laid on the specification of the underlying model, the first moments of the distributions, so to say (see: Paelinck and Klaassen, 1979, conclusions to chapter 2, pp. 42-43); we will come back to this important point in our further developments.

It was very fortunate that shortly afterwards a stormy evolution took place, of which we will only mention some recent volumes devoted to spatial econometrics, skipping but not neglecting the articles, and insisting also on the value of the contributions in the complementary field of spatial statistics (for references, see again Griffith and Paelinck, 2004); one is referred to Anselin (1988), Anselin and Florax (1995), Morena Serrano and Vayá Valcarce (2000), Anselin, Florax, and Rey (2004), Getis, Mur, and Zoller (2004), Lesage, Page and Tiefelsdorf (2004), Tivez a.o. (2005), Arbia (2006), Arbia and Fingleton (2008), Mur, and Lopez (2010), Lepage and Pace (2009), Griffith and Paelinck (2011). The crowding over the last years is, at the least, impressive.

No wonder that a Spatial Econometric Association (SEA) was founded at Rome, on May 26th 2006, on the occasion of another international workshop on spatial econometrics. Article 2 of its statutes stipulated that: ”The purpose of the Association is to promote the development of the theoretical instruments and practical applications of spatial econometrics – including spatial statistics and spatial data analysis. Spatial econometrics should be regarded in abroad sense and inclusive of the developments of statistic models and instruments to analyze externalities, interactions, etc. in different areas such as, without limitation, economics, geography and regional sciences. The mission of the Association is to disseminate and encourage knowledge and good practice among universities and research institutions and in the community in general, becoming a reference point for operators in the field”.

The activity of SEA has led to further initiatives; the important fact is indeed hat a specific SE platform is now present, platform from which diffusion can proceed. And what has to come will probably be still more exciting.

4. Looking ahead

Some challenges the future will be faced with, can be grouped under five headings: spatial bias, spatial specification, spatial estimation, spatial complexity, isomorphisms; these themes will be taken up in succession in what follows. They lead straightforwardly to what we have called “non-standard spatial econometrics” (see again Griffith and Paelinck, 2011).

4.1. Spatial bias

Taking an econometric view of the MAUP (Modifiable Areal Unit Problem), Paelinck (2000) proved that in principle all spatial econometric models will inevitably show up an aggregation bias; his findings were summarized in the following terms: „The important result is that in general econometric aggregation, if only one macro-aggregate is considered, just one parameter bias is present in the macro-model; in meso-aggregation, as it took place here, every meso-area has its own specific aggregation bias, which leads to parameter variability between meso-areas, and this might result, in econometric estimation, in some sort of (biased) average value, depending on the characteristics of the sample being investigated and the particular spatial aggregation specification”.

The consequence of this is that there is an extra element to simple spatial heterogeneous behavior, and how to isolate the two aspects has to be seriously considered (Griffith and Paelinck, 2011, chapter 17). So only heterogeneity calls for extra treatments: composite parameters (Ancot et al., 1971), differential spatial regimes (Griffith and Paelinck, 2011, chapter 12); special attention is called for, and further fundamental investigation of this problem is highly advocated.

4.2. Spatial specification

Given the characteristics of spatial inter-linkages, special attention should be devoted to the specification of spatial models; scanning five collective volumes on spatial econometrics, we found out that only 14% of the papers were devoted to that problem (Griffith and Paelinck, 2004).

As an example we would like to mention here the well-known problem of spatial convergence. A simple beta-convergence model is, in our opinion, not the right tool to tackle the problem; in Arbia and Paelinck (2003 a and b) an alternative is proposed and presented, to wit a non-linear – this lon-linearity being recently refined (see: Griffith and Paelinck, 2011, chapter 11) – fully-fledged interregional model of the Lotka-Volterra type. It allowed to separate the problems of *mathematical* and *economic* convergence, and arrived at the conclusion that in a system of 119 European regions, if mathematical convergence was present, economic convergence was simply lacking, something in fact already confirmed by some theoretical and empirical studies.

But this is still not the end of the journey; indeed, an even more important problem is that of the algebraic structure to be given to the model under construction. For that we studied (Paelinck, 2001) the possibilities of model specification based on a so-called "min-algebra"; that algebra, in fact, generalizes the specification of the European FLEUR-model (Ancot et Paelinck, 1983), the latter being based on the idea of a "growth threshold". In a min-algebra, one (or several) explanatory terms (variables with their reaction coefficients) *of minimal value* determine the value of the endogenous variable(s). So, instead of considering a (linear or non-linear) combination of endogenous, exogenous or predetermined variables, one will only consider one (or a limited number) of explanatory variables in each equation; for instance, the development of a region could be hampered by the absence of a strategic factor, such as technologically highly trained manpower.

A bad specification of regional models becomes really dramatic when they are used to derive "baskets" of regional policy measures; indeed, the logic of the chosen algebra produces a linear programming solution with more non-zero decision variables than the number of constraints, whereas under a "classical" algebra would in general produce only that number of non-zero decision variable.

Still another specifications is that of a finite automaton, which can be seen as an "if"-specification, for example, it could read as follows: if $\alpha x_i + \beta < \gamma z_i + \delta$, the values of the left-hand terms obtains, otherwise those of the right-hand one. To submit such a finite automaton model to an empirical test in a well-documented case, gross regional product figures for the Netherlands have been investigated. They were divided in two macro-regional sets, one for the western provinces (Noord-Holland, Zuid-Holland, Utrecht, the so-called "Rimcity"), the other one comprising the data for the remaining provinces.

The curious thing, at first sight, was the behavior of the growth rate values for the non-Rimcity provinces: whatever the state of the location factors attractiveness, they follow the ups and downs of the Rimcity growth rates. This is completely in line with the fact that the Rimcity is indeed the "motor" of the Dutch economy (Paelinck, 1973, pp. 25-40, especially pp. 37-40), imposing its evolutionary rhythm to the other regions. This finding has recently been confirmed with a Lotka-Volterra finite automaton specification (Griffith and Paelinck, 2011, chapter 13).

A last remark is on the specification of spatial lags, in the endogenous and/or exogenous variables, the *W*-matrix problem to call it that way. Several suggestions have been made, some of them purely "mechanical"; again, as spatial econometrics is about economics in pre-geographical space, some economic background is desirable. One possibility is the use of a flexible potential function (Ancot and Paelinck, 1983); another one is the following procedure: estimate the model without spatial lags and without constant(s); inspect the residuals – the "doggy-bag principle" (Griffith and Paelinck, 2011, chapter 14) which should not add up to zero; relatively high and/or low, positive and/or negative instances should be inspected trying to generate assumptions (e.g., competition and/or cooperation could be present at short or long distances: distance can be "hampering" or "protecting"). Examples are known where mapped locations of residuals led to the right complementary variable missing in the model.

This does not end the list of relevant specification problems; the main point is that the model should correspond to the workings of the spatial economies investigated, and that the consequences for their ulterior use – or uses – should be explicitly considered.

4.3. Estimators

The fundamental structure of spatial models invites at developing different types of estimators adapted to the special situations encountered; indeed, the established software does not always fit the specific estimation problem encountered.

Paelinck (1990) proposes various estimators especially fit to treat particular circumstances.

A first example is a simultaneous dynamic least squares estimator (SDLS), perfectly well adapted for use in the type models treated above, i.e. models with simultaneous spatial and temporal interdependencies. Instead of minimizing residuals between observed endogenous values and values estimated from the latter – even if they are predetermined – it minimizes a norm between observed and *endogenously computed* values. This takes into account future uses of the model, like forecasting or computing policy impacts.

Originally the algorithm consisted of computation by iterative OLS, the method integrating the derivation of optimal – spatial and temporal – „starting points" for endogenous simulations. The estimator is consistent, and the probability limit of its variance-covariance matrix is known (in fact, it is the usual OLS matrix), but we will come back to this remark.

In recent research, the estimating procedure has been endogenized (again Griffith and Paelinck, 2011, chapter 11), resulting in the parameters and the estimated – endogenous – variables being produced in the same process; the method can be applied to spatial models – with their typical spatial lags – both static and dynamic. Recently also the method has been applied to the estimation of composite parameters; not implying an inverse, but resting on mathematical programming, the problem of non-identifiability could be side-stepped successfully.

As already mentioned, most spatial models are inherently non-linear, so that after appropriate specification adequate estimation methods should be used. Let only be mentioned here a recent estimation method for Box-Cox transformations (Paelinck and van Gastel, 1995; Griffith, Paelinck, and van Gastel, 1998), the estimation proceeding from the (partial) elasticities of the transformed function.

Some form of semi-parametric estimation should also be considered, by semi-parametric estimation being understood here that a second order differential expansion (derived from a second order MacLaurin expansion) is used, allowing of changing the coefficients of the linear terms by adding periodically the coefficients of the quadratic terms, which, in production functions e.g., express the changes in marginal productivities.

Applying this technique, originally developed for time series, to a problem in *spatial* econometrics, raises the difficulty originating from the difference between „time's arrow" and the non-oriented presentation of spatial data; a solution is presented in Griffith and Paelinck (2004). The specification does not privilege any direction in space, and allows for increases or decreases of the reaction parameter between couples of regions with the same separating distances.

Finally, min-algebraic and finite automata parameters can be estimated and the specification tested; one is again referred to Griffith and Paelinck (2011, chapter 13).

One important remark to conclude this topic: we consider the estimation problem not as one centering only around the parameters and their properties (see also Valavanis, 1959, especially p. 47), but on the whole model and its future uses, the parameters being in fact auxiliaries to allow us a relevant representation of the spatial-economic reality. An example is the SDLS-estimator treated earlier, with its recent specification and applications.

4.4. Complexity

To get an idea of the relevance of one or another specification, one should look into the complexity of the problem, by which we mean *computational complexity* of the series to be explained (Chaitin, 1975; Wolfram, 2002, pp. 557--559); this complexity, which we will call *conditional complexity* – due to the presence of exogenous variables – can be expressed through the number of parameters necessary to fit to an endogenous variable a polynomial in the exogenous ones. An indicator on [0,1] is (Getis and Paelinck, 2003):

$$c = (n_p - 1)/(n_{pm} - 1),$$

where n_p is the number of non-zero parameters, and n_{pm} their maximum number (equal to the length of the series of endogenous variables, i.e. the size of the sample). Let it be said that we first considered the endogenous variables as void of measurement errors, as the observed values are the only ones of which we avail; but at the same time as spatial bias could be filtered out, those errors too can be treated appropriately (again Griffith and Paelinck, 2011, chapter 17).

Just to give an example, in such a pre-test of the model to be specified, a series of observations lead to a complete cubic equation, with a value $c = 1$, the ensuing test between a simple linear model and a finite automaton one selecting the latter; when errors and spatial bias were filtered out, the simple linear model submerged, the complexity of the data having been reduced by two thirds.

4.5. Isomorphism

Isomorphism, in the broad sense of specification similarity can be a serious help in solving some classical problems in spatial econometrics. Take the extended SAR model

$$\mathbf{y} = \mathbf{A}\mathbf{y} + \mathbf{X}\mathbf{b} + \boldsymbol{\varepsilon}$$

The first fact to be noted is that the y variables have all the same definition, GRP, for instance, contrary to the classical non-spatial model $\mathbf{A}\mathbf{y}+\mathbf{X}\mathbf{b}=\boldsymbol{\varepsilon}$, where the vector **y** consists of different variables. A second fact is that the model just presented is isomorphic to the classical input-output model

$$\mathbf{y} = \mathbf{A}\mathbf{y} + \mathbf{f}$$

where **A** is the input coefficients matrix, **f** the final demand vector.

The difficulty with the spatial econometric model, compared to the input-output one, is that the input coefficients are known from statistical observation, which is not the case of the **A** matrix in model in the extended SAR model; for instance, from the input-output equation total relative inputs can be computed as **a' = i'A**; and this has indeed ledto a useful suggestion for solving an identification problem of the spatial econometric model.

Conclusions

"Spacetime" economics – to borrow an expression from theoretical physics – is indeed characterized by great complexity; we only refer here to some studies in potentialized partial differential equations we did with a former Erasmus University colleague (Kaashoek and Paelinck, 1994, 1996, 1998 and 2002) which lead to unexpected spatial patterns, which have been empirically verified Coutrot et al., 2009). Interpreting those patterns start with theoretical spatial economics and should flow over into spatial econometrics, if we want our theories to confront the facts, possibly to be contradicted, at times to be relegated to the waiting room of theories pending there ever uncertain status.

Anyhow, the real challenge for the future is to create beauty from garbage, as the expression goes.

References

Ancot J.-P., Paelinck J.H.P. (1983): *The Spatial Econometrics of the European FLEUR-Model*. In: *Evolving Geographical Structures*. Eds. D.A. Griffith, A. Lea Martinus. Nijhoff Publishers, The Hague, pp. 220-246.

Ancot J.-P., Chevailler J.-Cl., Paelinck J.H.P., Smit H., Stijnen H. (1971): *Parameter Component Models in Spatial Econometrics*. The Econometrics of Panel data. Annales de l'INSEE, 30-4/31, Paris, pp. 53-98.

Anselin L. (1988): *Spatial Econometrics: Methods and Models*. Kluwer Academic Publishers, Dordrecht et al. loc.

Anselin L., Florax R.J.G.M., eds. (1995): *New Directions in Spatial Econometrics*. Springer, Berlin et al. loc.

Anselin L., Florax R.J.G.M., Rey S., eds. (2004): *Advances in Spatial Econometrics. Methodology, Tools and Applications*. Springer, Berlin et al. loc.

Arbia G. (2006): *Spatial Econometrics*. Springer, Berlin-Heidelberg.

Arbia G., Fingleton B., eds. (2008): *New Spatial Econometric Techniques and Applications in Regional Science*. Special issue of „Papers in Regional Science", Vol. 87, No. 3.

Arbia G., Paelinck J.H.P. (2003a): *Economic Convergence or Divergence? Modeling the Interregional Dynamics of EU Regions, 1985-1999*. „Journal of Geographical Systems", Vol. 5, No. 3, pp. 291-314.

Arbia G., Paelinck, J.H.P. (2003b)*: Spatial Econometric Modeling of Regional Convergence in Continuous Time*. „International Regional Science Review", Vol. 26, No. 3, pp. 342-362.

Chaitin G.J. (1975): *Randomness and Mathematical Proof*. „Scientific American", Vol. 232, No. 5, pp. 47-52.

Cliff A.D., Ord J.K. (1973): *Spatial Autocorrelation*. Pion Press, London.

Coutrot B., Sallez A., Paelinck J.H.P., Sutter R. (2009): *On Potentialized Partial Finite Difference equations: Analyzing the Complexity of Knowledge-Based Spatial Economic Activities*. „Région et Développement", No. 29, pp. 201-228.

Geary R.C. (1954): *The Contiguity Ratio and Statistical Mapping*. „The Incorporated Statistician", Vol.5, pp.115-145.

Getis A., Mur J., Zoller H.G., eds. (2004): *Spatial Econometrics and Spatial Statistics*. Palgrave-Macmillan, Basingstoke.

Getis A., Paelinck J.H.P. (2004): On *Analytical Descriptions of Geographical Patterns*. „L'Espace Géographique", No. 1, pp.61-68.

Griffith D.A., Paelinck J.H.P, van Gastel M.A.J.J. (1998): *The Box-Cox Transformation: New Computation and Interpretation Features of the Parameters*. in D.A.

Griffith D.A., Amrhein C., Huriot J.-M., eds. (1998): *Econometric Advances in Spatial Modeling and Methodology*. Kluwer, Dordrecht, Advanced Studies in Theoretical and Applied Econometrics, Vol. 35, pp. 45-58.

Griffith D.A., Paelinck J.H.P. (2004): *An Equation by Any Other Name is Still the Same: Spatial Statistics and Spatial Econometrics*. Paper Presented at the Annual Meetings of the NARSA, Seattle, November.

Griffith D.A, Paelinck J.H.P. (2011):, *Non-Standard Spatial Statistics and Spatial Econometrics*. Springer, Berlin and Heidelberg.

Kaashoek J.F., Paelinck J.H.P. (1994): *On Potentialised Partial Differential Equations in Theoretical Spatial Economics*. In: Special issue of *Chaos, Solitons and Fractals* on „Non-Linear Dynamics in Urban and Transport Analysis". Ed. D.S. Dendrinos. Vol. 4, No. 4, pp. 585-594.

Kaashoek J.F., Paelinck J.H.P. (1996): *Studying the Dynamics of Pre-geographical Space by Means of Space and Time-Potentialised Partial Differential Equations*. „Geographical Systems", Vol.3, pp. 259-277.

Kaashoek J.F., Paelinck J.H.P. (1998): *Potentialised Partial Differential Equations in Economic Geography and Spatial Economics: Multiple Dimensions and Control*. „Acta Mathematica Applicanda", Vol. 51, pp. 1-23.

Kaashoek, J.F. Paelinck J.H.P. (2001): *Potentialised Partial Differential Equations in Spatial Economics: Some Further Results on the Potentialising Function*. „The Annals of Regional Science", Vol. 35, No. 3, pp. 463-482.

Lebart L. (1966): *Les variables socio-économiques départementales et regionales*, I, Méthodes statistiques de l'étude, IEDES, Paris.

Lebart L. (1969): *Analyse statistique de la contiguité*. Publications de l'Institut de Statistique de l'Université de Paris, 18, pp. 81-112.

LeSage J., Page R.K., Tiefelsdorf M., eds. (2004): Special Issue on Methodological Developments in Spatial Econometrics and Statistics of *Geographical Analysis*. Vol. 36, No. 2.

LeSage J., Pace R.K. (2009): *Introduction to Spatial Econometrics*. CRC Press, Boca Raton et al. loc.

Moran P.A.P. (1948): *The Interpretation of Statistical Maps*. „Journal of the Royal Statistical Society B", Vol. 10, pp. 243-251.

Moran P.A.P. (1950): *A Test for Serial Correlation of Residuals*. „Biometrica", Vol. 37, pp. 178-181.

Moreno Serrano R., Vayá Valcarce E. (2000): *Técnicas econométricas para el tratamiento de datos espaciales: la econometría espacial*. Edicions Universitat de Barcelona, UG44, Manuals, Barcelona.

Mur J., Lopez F.A., eds. (2010): *Modeling Spatio-Temporal Data*. special issue of „Journal of Geographical Systems", Vol. 12, No. 2.

Paelinck J.H.P. (1963): *La teoría del desarrollo regional polarizado*. *Revista Latino-americana de Economía* (Caracas), No. 9, pp. 175-229 (reproduced in *Cahiers de l'ISEA*, Série L (Economies Régionales), March 1965, pp. 5-47,with title: *La théorie du développement régional polarisé*, and in Italian with title: *La teoria dello sviluppo regionale polarizzato*, in A. Testi (a cura di): *Sviluppo e pianificazione regionale*. Giulio Einaudi, Torino 1977.

Paelinck J.H.P. (1967): *L'efficacité des mesures de politique économique régionale*. Rapport introductif, Faculté des Sciences Economique, Centre de Recherches, Namur.

Paelinck J.H.P. (1973): *Hoe doelmatig kan regionaal en sectoraal beleid zijn?* Stenfert Kroese, Series: Bedrijfseconomische Verkenningen, Leiden.

Paelinck J.H.P., Nijkamp P. (1975): *Operational Theory and Method in Regional Economics*. Saxon House, Farnborough.

Paelinck J.H.P., Klaassen L.H. (1979): *Spatial Econometrics*. Saxon House Farnborough

Paelinck J.H.P. (1990): *Some New Estimators in Spatial Econometrics*. In: *Spatial Statistics: Past, Present and Future*. Ed. D.A. Griffith. Syracuse University, Institute of Mathematical Geography, Monograph No. 12, pp. 163-181.

Paelinck J.H.P., van Gastel M.A.J.J. (1995): *Computing Box-Cox Transform Parameters: A New Method and its Application to Spatial Econometrics*. In: *New Dimensions in Spatial Econometrics*. Eds. L. Anselin, R.J.G.M. Florax. Springer, Berlin, pp. 136-155.

Paelinck J.H.P. (2000): *On Aggregation in Spatial Econometric Modelling*. „Journal of Geographical Systems", Vol. 2, No. 2, pp. 157-165.

Paelinck J.H.P. (2001): *A Multiple Gap Approach to Spatial Econometrics*. „The Annals of Regional Science", Vol. 36, No. 2, pp. 219-228.

Thompson W.R., Mattila J.M. (1959): *An Econometric Model of Postwar State Industrial Development*. Wayne State University Press, Detroit.

Trivez F.J. et al., eds. (2005): *Contributions to Spatial Econometrics*. Copy Center Digital, Zaragoza.

Valavanis S. (1959): *Econometrics, An Introduction to Maximum Likelihood Methods*. McGraw-Hill, New York et al. loc.

Vanhove N. (1963): *De doelmatigheid van het regionaal-economisch beleid in Nederland*. Gent and Hilversum.

Wolfram S. (2002): *A New Kind of Science*. Wolfram Media, Champaign (IL).

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Summary

The paper is based on the invited lecture given at the Katowice University of Economics in June 2012.

In the paper the beginnings of subdiscipline called spatial econometrics are presented. The history of spatial statistical analysis and its influence on economic surveys is considered. Author's contribution to this area is presented together with personal overview of the developments of the subdiscipline. Moreover, some future challenges connected with "non-standard spatial econometrics" are analyzed including spatial bias, spatial specification, spatial estimation, spatial complexity and isomorphisms.