ANNALES D'ÉCONOMIE ET DE STATISTIQUE. – N° 55-56 – 1999

1977–1997
Changes and Continuities in Panel Data Econometrics

Patrick SEVESTRE *

About 20 years ago was published the No. 30-31 of *Annales de l'INSEE*, a special issue devoted to panel data econometrics. This volume which brought together the contributions to the conference organized at Insee in August 1977 by Pascal MAZODIER, Jacques MAIRESSE and Alain TROGNON, remains a major reference on the subject. Ten years later, another conference was organized, on the same topic, at the University Paris XII–Val-de-Marne, on the ERUDITE research group [1] initiative. Even though this conference did not attract a participation as prestigious nor as numerous as the 1977 one, it inaugurated a series which goes on today and which, thanks to the efficient help of Pietro BALESTRA, Badi BALTAGI, Jacques MAIRESSE and Alain TROGNON inter alia, has passed from a "*workshop*" status to that of an "*international conference*" and has now become one of the privileged meeting places of the specialists in the field.

It is thus to celebrate a double anniversary, that of both the conferences of 1977 and 1987, that ERUDITE organized, in 1997, the seventh International Conference on Panel Data Econometrics. A large number of the 1977 conference participants were invited to present new contributions, among whom three deserve a special mention, namely Robert EISNER, Zvi GRILICHES and G.S. MADDALA, who unfortunately passed away between the Conference and this publication. In their different ways, all three made outstanding contributions to panel data econometrics. [2]

Twenty Years of Panel data Econometrics...

Reading this volume and the No. 30-31 issue of *Annales de l'Insee*, which elements of continuity, which changes can we identify in the evolution of panel data econometrics during these twenty years? A first brief answer can be obtained from the comparison of the two tables of contents. Even if one cannot totally exclude the existence of a "*slight*" selection bias, the frequency of names which are found in both issues can be considered as an indication of

* P. SEVESTRE : ERUDITE, Université Paris XII–Val-de-Marne.

1. Équipe de Recherches sur l'Utilisation des Données Individuelles-Temporelles en Économie.
2. For complete collections of the work of these three authors on these topics and others, see EISNER [1998], GRILICHES [1998a,b] and MADDALA [1994].

a certain continuity. This observation is more than anecdotal. It shows that the pioneers of panel data econometrics, who certainly had great expectations about its ability to improve our understanding of economic behaviors, considered this field fruitful enough to keep on working on it.

A second element of continuity can be found in the strong overlap of the economic questions and the econometric developments which they induce. Initiated by Pietro BALESTRA's and Marc NERLOVE's seminal paper [1966], this overlap continues more than ever. Most of the methodological papers in this issue find their origin in an economic question and contain an application which goes well beyond a simple illustration. Reciprocally, applied papers leave a significant room for methodological issues.

One can also observe some continuity in the list of topics dealt with. The two issues contain applied papers dealing with investment and production behaviors, as well as studies of the individual wages and income determination. In the same way, both volumes present a significant number of methodological papers, devoted to the estimation of dynamic models or to the problems of sample attrition and endogenous selection.

Which changes can be detected, on the other hand, from the comparative reading of these two special issues? The most obvious is the place taken recently by cross-country panels econometrics, and in particular by papers about economic growth and the possible convergence of economies. Including the methodological papers which are closely related to these questions, almost half of the articles in this special issue are devoted to cross-country econometrics. From a methodological point of view, this development starts to induce changes. Indeed, most of the current econometric methods were developed in relation to the characteristics of microeconomic panels used up to now. These samples generally have a small time dimension but contain a large number of individuals. Thus, the "*good*" asymptotic properties of the current methods generally rely on having a large number of individual observations. Unfortunately, cross-country panels generally have a "*limited*" number of periods and individuals, so that "*usual*" methods appear not to be well suited to these country panels. Moreover, as underlined by G.S. MADDALA in his article about cross-country econometrics, the important heterogeneity in countries' behaviors and the existence of inter-individual correlations are, in this context, two elements one should take care of.

Finally, what can be said about what we have learnt in and from panel data econometrics in the last twenty years? At the 1997 conference, Zvi GRILICHES, who had to discuss Pascal MAZODIER and Alain TROGNON'S paper [1997] analysing the development of panel data econometrics during these two decades, wondered about what these data and techniques allowed us to learn in terms of economic knowledge. In an article published in this issue, G.S. MADDALA shares this questioning about what the cross-country econometric results can tell us about the determinants of economic growth. However, G.S. MADDALA emphasizes that econometric methods have, on the other hand, considerably progressed. These opinions, expressed by two of the "*founding fathers*" of the discipline, cannot be ignored. However, one can wonder whether these pioneers expected too much from this new kind of data and from the corresponding econometric methods. Panel data econometrics may have been less fruitful than anticipated, but it has for sure allowed us to learn quite a lot about economic behaviors. As an example, the empirical

highlighting of the importance (if not the need) of taking into account the economic agents (observed and *unobserved*) heterogeneity when analyzing their behaviors can be credited to panel data econometrics. To identify and evaluate its other contributions to economic knowledge would require a detailed inventory, much beyond the scope of this introduction.

An interesting indication of this contribution can nevertheless be found in the considerable development of the use of panel data in applied economics. This observation is taken from the bibliometric work carried out by P. MAZODIER and A. TROGNON [1997]: the number of citations of the two words "*panel data*" in the title or keywords of articles published in the reviews referenced in EconLit has been multiplied by 25 between 1975 and 1995! This shows, at least to a certain extent, the role played by panel data in the analysis of economic behaviors.

Indeed, in the first article of this issue, Jacques MAIRESSE, Bronwyn HALL and Benoît MULKAY conclude that, in the particular field of the firms investment behavior, panel data econometrics developments have allowed a better understanding of the investment relation, leading to improvements in modeling and interpretation, and to a better comprehension of what can, and cannot, be measured.

... have shown the Importance of Endogeneity and Selection Biases...

The objective of this paper by J. MAIRESSE , B. HALL and B. MULKAY is twofold. On the one hand, it seeks to assess whether advances in panel data econometric methods and practice have enabled economists to have a better representation, and a better understanding, of the firms investment behavior. In addition, the authors wish to identify possible differences in this behavior, between French and US firms as well as over two time periods: the 70's and the 80's. The authors have completed a considerable work, consisting of the analysis and comparison of the estimates of two models (a traditional "*accelerator-profit*" model and an error correction model) obtained by applying various methods ("*basic*" estimators, *i.e.* within and between-individuals, as well as generalized method of moments estimators) to four samples: two samples of American firms and two samples of French firms (covering the years 1968-1979 and 1979-1993).

The comparison of the estimates obtained by the generalized method of moments with those associated to the within – individuals estimator shows relatively slight differences. If the use of the former is supposed to reduce endogeneity and/or measurement error biases in particular (which the within estimator does not do), the price to pay is a lower precision, due to the well-known problem of weak instruments. The comparative analysis of investment behaviors shows that the profits, which played a significant role in the investment decision in the 70's, in France and in the United States, do not have any more impact in the 80's. A possible explanation of this result could be the liberalization of financial markets which occurred during the last period, in particular in France.

The article of N. COTE-COLISSON and F. LEGENDRE is to some extent an illustration of one of the tracks for future research mentioned by J. MAIRESSE , B. HALL and B. MULKAY in the conclusion of their paper. The authors aim at estimating the elasticity of substitution between capital and labor by

distinguishing firms with a large elasticity and those with a lower one. A two-regime model is estimated, allowing an endogenous classification of firms. The selection equation is simply composed of an individual specific effect and an idiosyncratic disturbance. The maintained assumption that firms always stay in the same regime is acceptable, given that the regimes refer to a deep structural parameter of production technology. The estimated model contains two other equations: one explaining the capital/labor ratio, the other one being a reduced form of a two equations model, namely a production function and a price-setting equation. To ground this specification, the authors argue that it allows them to get better estimates of the elasticity of substitution than those resulting from the estimation of the production function alone. The estimates, obtained from a sample of approximately 800 industrial firms observed over the period 1981-1987, lead to split the firms into two groups: the first one corresponds to firms having an elasticity of substitution about 0.6 while in the second group, this elasticity is about 0.9. The authors then look at the possible determinants of the value taken by this parameter. It appears to be positively correlated with firms size and with increases in the capital/labor ratio while it is negatively related to the skill level of workers. This last result is in accordance with the result of Z. GRILICHES [1969] stating that skilled labor is rather complementary to capital while unskilled labor is more substituable.

The question of endogenous sample selection is also a crucial issue in M. LECHNER's article, devoted to analyzing the impact of enterprise-related continuous vocational training on earnings and unemployment probabilities of workers in the former German Democratic Republic. The relevance of this question is evident given the drastic changes imposed to the former GDR economy by the unification and the required adaptation of its labor force, of which continuous training is obviously one of the essential vectors. M. LECHNER uses data about approximately a thousand of workers of the former GDR, drawn from the German Socio-Economic Panel (GSOEP), data covering the period 1990-1994. The difficulty one faces here is to get a correct evaluation of the impact of continuous training on wages and unemployment risk. It is well-known that simply estimating a wage equation including vocational training as one of the regressors leads to biased results. Indeed, the probability of an individual being trained is endogenous, in particular because of its likely correlation with some of the individual's unobservable characteristics, characteristics which can also affect his wage. Another source of bias is that, for his wage to be observable, the worker must stay in employment. In this article, the treatment of the selection problem is carried out using non-parametric methods previously developed by the author (LECHNER [1999]). The main conclusion which can be drawn from the estimates is that vocational training has a positive impact on wages but does not seem to have any influence on workers probability to keep their job. Several explanations are proposed for this last result: either the training received during the transition lost very quickly its value, or the wage increases which resulted led to an higher risk of being laid off, or finally, the firms were forced to fire massively, without taking account of their workers human capital.

The problem encountered by M. LECHNER in his evaluation of the vocational training impact on wages and unemployment risk presents some similarities with that analyzed by R. MOFFITT, J. FITZGERALD and P. GOTTSCHALK. Indeed, they are interested in the estimation of an econome-

tric model where the selection process is correlated with an endogenous (observable) regressor of the equation of interest. The most obvious example is when one wishes to estimate an autoregressive model using a sample of observations selected according to the value of the lagged endogenous variable, *i.e.* a sample subject to attrition. R. MOFFITT, J. FITZGERALD and P. GOTTSCHALK name this issue "*selection based on observables*", by contrast with the most often considered situation of selection based on unobservables. They propose a consistent estimator for this type of model, precisely a Weighted Least Squares estimator in which weights are computed from consistent estimates of the selection equation. Application of this method to the estimation of a wage equation, using a sample of US households extracted from the PSID (*Panel Study of Income Dynamics*) shows that an attrition bias does exist. However, this bias appears to affect the constant of the equation, much more than the coefficients of the "*true*" explanatory variables.

M. ROCHINA-BARRACHINA's article focuses on the more "*traditional*", but not necessarily easier, problem of estimating an econometric model when the sample is subject to selection based on unobservables. The difficulty of estimating such a model is well-known: the log-likelihood to be maximized is extremely complex, as well as the computations involved for getting the additional regressors associated with the generalization of HECKMAN's two-step estimator in the context of panels (*cf.* NIJMAN and VERBEEK [1996]). M. ROCHINA-BARRACHINA proposes such an estimator, which rests on assumptions differing from those considered up to now in the literature (WOOLDRIDGE [1995], KYRIAZIDOU [1997]). The proposed method first consists of estimating the model on two waves of consecutive observations by differencing the equation so as to eliminate the specific effects and by conditioning upon the presence in these two waves. This leads to the inclusion of two corrective terms whose exact form depends on the assumptions about the selection process and the joint distribution of the unobservables. In a second step, the various estimates corresponding to each couple of successive waves are optimally combined using a minimum distance estimator. Two versions of the estimator of the selection equation are presented, a parametric and a nonparametric one. The small sample properties of these estimators are compared with those of KYRIAZIDOU [1997] and WOOLDRIDGE [1995] estimators through a simulation study. They appear to be quite robust with respect to various types of specification error, in particular by comparison with KYRIAZIDOU and WOOLDRIDGE estimators. Nevertheless, their consistency requires regressors to be strictly exogenous, both in the equation of interest and in the selection equation. While the strict exogeneity of regressors in the equation of interest can be relaxed by resorting to instrumental variables methods, it has to be satisfied by the selection equation, which can be a rather strong assumption.

In the next article, L. LILLARD seeks to evaluate the impact of employment changes and of employment duration on US workers' wages. As in the above papers, the endogeneity of these determinants must be taken into account to get a correct evaluation of their influence. Indeed, it is difficult to ignore the possible correlation of these variables with some unobservable characteristics of either the workers or their job. Thus, a first originality of this article is the use which is made of the NLSY (National Longitudinal Survey of Youth) data, which contains information about the individuals (in particular their employment history and the corresponding wages) and about the job itself.

This makes it possible to identify, in the wage variations, the respective contributions of the individuals' specific characteristics, of employment changes and duration, and those of the job attributes. Another originality lies in the fact that these contributions are allowed to vary according to the values of other variables, thus making possible a better representation of the wage profiles heterogeneity. The estimates show a very strong heterogeneity of initial wages, both for workers and for jobs. Moreover, the respective impacts of experience (at the individual level) and of seniority (at the job level) on wages appear to be also very heterogenous.

... and the Need for New Methodological Developments

In their article, G. CHAMBERLAIN and K. HIRANO also look at wage profiles, but from a somewhat different point of view. They propose a method allowing to determine the conditional distribution of an individual's future incomes, based upon this individual's personal characteristics and upon sample data. An originality of the model, compared to other former work, is to allow for some heterogeneity in the variability of future incomes. An obvious example of the interest of the method is the empirical analysis of consumption behaviors. Indeed, within an multi-period framework, such an analysis requires to specify, *a priori*, both a particular form of the utility function and the conditional distribution of future incomes. In order to illustrate empirically their method, G. CHAMBERLAIN and K. HIRANO carry out estimates using data from the PSID including 813 young men. The results show the empirical importance of the future incomes variance heterogeneity, heterogeneity which induces an increase in the dispersion of the conditional distributions of these incomes.

J. ABREVAYA and J. HAUSMAN article focuses on the very different problem of estimating nonlinear econometric models (qualitative dependent variable models, duration models, censored variable models...) when the endogenous variable is measured with error. As they point out, the fact that, in linear models, measurement errors affecting the dependent variable do not induce any bias has led econometricians to almost ignore this difficulty within the more general framework of nonlinear models. J. ABREVAYA and J. HAUSMAN show that, in this type of model, the consistency of parametric estimators requires a correct modeling of the measurement error. Moreover, implementing these methods is extremely complex, except when the model to be estimated is a qualitative dependent variable model. As an alternative, they suggest to use a nonparametric estimator, namely the monotone rank estimator proposed by CAVANAGH and SHERMAN [1998], whose consistency only requires a stochastic dominance assumption, an assumption which is relevant for many measurement error processes. On the other hand, this estimator presents, in some cases, the drawback of providing estimates of the coefficients only up to a scale factor. This happens in particular with duration models, which are more thoroughly analyzed. Estimates obtained from the monotone rank method lead to the conclusion that unemployment benefits have no impact on unemployment duration, unlike what the results associated with other more traditional methods of estimation indicate.

In his article, B. BALTAGI shows how helpful "*augmented*" or "*artificial*" regressions can be for testing a rather vast set of assumptions in linear and

nonlinear panel models. The general principle of these methods consists in adding to the econometric equation of interest an additional variable (and/or an additional equation, in the "*the double-length regression*" context) whose role is to make it easier to get consistent and efficient estimates of the parameters and/or to implement hypothesis tests.[3] These methods generalize some well-known results such as HECKMAN's two-step estimator [1976] for dealing with selection biases, as well as that of GOURIEROUX and TROGNON [1988] who showed how the addition of an additional term to various types of econometric models makes it possible to obtain consistent and asymptotically efficient estimates. Another particular case of these methods, more specific to the panels context, can be found in MUNDLAK's suggestion [1978] for testing for the absence of correlated effects. Indeed, he showed that this can be done by testing the nullity of the coefficients of supplementary regressors defined as individual means of the original regressors. B. BALTAGI adapts these augmented regressions methods to panel models and shows in particular how to test the assumption of absence of individual effects both in linear and in qualitative dependent variable models, as well as how to test linear versus log-linear specifications of a model. He also shows that HAUSMAN's test, CHAMBERLAIN's π matrix method, as well as the tests of absence of selection bias suggested by WOOLDRIDGE [1995] constitute particular cases of these augmented regressions method.

By analogy with the difficulties one faces when estimating a time-series model with trended variables, C. GRANGER and N. HYUNG consider the problem of estimating a panel data model when the variables in the model are strongly correlated with the individuals' size. They show that if the size is not explicitly taken into account in the model, one then gets a spurious regression. In particular, they show that implementing unit root tests such as that proposed by LEVIN and LIN [1992] is likely to lead to a wrong decision, *i.e.* to accept the existence of a unit root when there is none. Moreover, if the size variable is slightly varying over time (such as for example, population or even, income), or if its distribution has thick tails, post-sample predictions are biased. An evaluation of these biases in various configurations is provided through a simulation study.

C. MEGHIR and F. WINDMEIJER propose in their article a generalization of the basic dynamic error components model in which the conditional variance depends, in a multiplicative way, of individual specific effects. They derive orthogonality conditions allowing to get consistent estimates of the parameters in several configurations, in particular when the disturbances follow a MA process and when the individual effects in the equation of interest interact in a multiplicative way with time fixed effects "*à la HOLTZ-EAKIN, NEWEY and ROSEN* [1988]". The results of the simulation study carried out by the authors show that, although the estimation of the model parameters is feasible, obtaining good estimates of these parameters requires a very large number of observations in the individual dimension.

---

3. A presentation of these methods, which cover the "*GAUSS-NEWTON regressions*" , the "*double-length regression*" and the "*binary response model regression*", can be found in DAVIDSON and MACKINNON [1993].

The article of T. J. WANSBEEK and T. KNAAP is also devoted to the estimation of dynamic panel data models. The model they analyze corresponds to the kind of regressions one meets in the analysis of economic growth and of the possible convergence of economies: it includes individual specific effects as well as individual trends. These parameters being considered as nuisance parameters, they are discarded through a double differentiation of the model. Obviously, applying OLS to this differentiated model leads to inconsistent estimates. Several solutions are then considered: the first one is a "*Modified Ordinary Least Squares*" estimator. It relies on the computation of the OLS estimator asymptotic bias under the assumption of stationarity of the data generating process. This "*modified OLS*" estimator, which is a function of the sole OLS estimate, takes values between – 2/3 and – 1/2 (for a true value of the parameter ranging between 0 and 1). This makes it quite useless. The authors thus propose to resort to other methods, such as Instrumental Variables and Generalized Method of Moments estimators. They also introduce a "*Limited Information Maximum Likelihood*" estimator that appears, in the simulation study undertaken, to have a better behavior, in small samples ($N <= 200$, $T <= 15$), than the other estimators considered. Unfortunately, the asymptotic distribution of this estimator is unknown, which makes somewhat delicate the implementation of statistical tests. However, a "*sub-optimal*" generalized method of moments estimator, *i.e.* one using only a subset of orthogonality conditions, whose asymptotic variance is known, appears to have a quite satisfactory behavior.

R. CERMEÑO is also interested in the estimation of dynamic panel models. He shows how the median-unbiased estimator, proposed by ANDREWS [1993] for the estimation of time-series autoregressive models, can be extended to the case of autoregressive models with fixed effects. The idea is similar to that underlying the "*Modified OLS*" estimator considered by T. J. WANSBEEK and T. KNAAP: here, one corrects the within-individuals estimator in such a way that the median of its distribution (obtained by simulation) coincides with the point estimate. The value of the parameter for which these two quantities coincide is called the median-unbiased estimator. R. CERMEÑO studies the performances of this method via a simulation study. He shows in particular that this estimator is robust to heteroskedasticity and serial correlation in the individual dimension. This property is important since one of the privileged domains of application of this method is the analysis of convergence. Indeed, country panel data models are likely to exhibit this kind of problems. There is, however, an important limitation to this method: it is rigorously justified only for pure autoregressive models. In practice, the bias correction can then be too important since it is known that the presence of exogenous regressors induce, if the model is correctly specified, a reduction in the bias of the within individuals estimator. Applying this method to analyze countries' convergence leads to the conclusion that convergence seems only to hold for States in the USA and for OECD countries.

In his article, M. NERLOVE also considers dynamic panel data models, but its focus is different from those of the previous articles. He develops a convincing argumentation to show that studying the likelihood associated with a model and dataset by only considering the maximum likelihood estimates can

lead to a too optimistic vision of these estimates precision. He argues in favor of a more complete study of the likelihood of estimated econometric models. Indeed, he shows that if the likelihood is flat in some directions, *i.e.* for some parameters, the precision of the estimates, evaluated at the maximum of the likelihood, provides a misleading view of the reliability of these estimates. In order to analyze the shape of the likelihood in the different directions corresponding to the parameters of the model, M. NERLOVE proposes to concentrate it with respect to a subset of parameters and to study the "*slices*" thus obtained. Another interesting, and important, aspect of this article relates to the treatment of the initial observations in dynamic panel models. M. NERLOVE develops conditional and unconditional likelihoods both for the basic dynamic error components model and for a model including individual specific trends. He shows how, by differentiation, estimation of the latter can be brought back to that of the former. He then analyzes the ML estimates of a growth convergence equation based on the SOLOW-SWAN model. Two conclusions can be drawn from this empirical exercise: although the likelihood is rather flat in the direction of the parameter defined as the ratio of the individual effect variance over the total variance of the disturbances, its estimated precision, at the maximum of the likelihood, is rather good, thus giving a misleading idea of the real precision of this estimate. The other conclusion refers to the convergence speed of countries. The estimates of the model with specific trends lead to an evaluation of the convergence speed which is notably higher than that derived from the error components model estimates.

Similarly, G. GAULIER, C. HURLIN and P. JEAN-PIERRE are interested in the convergence issue. They propose a generalization of the method suggested by EVANS and KARRAS [1996] to test this hypothesis. EVANS and KARRAS elaborated a unit root test, in which the null hypothesis corresponds to the existence of a unit root for all countries, *i.e.* to the absence of convergence of any of these countries. The proposed generalization mainly consists in allowing for a different serial correlation order of the disturbances for each country. The implementation of this testing procedure on several samples leads the authors to accept the assumption of convergence with regard to the OECD countries but to reject it for a set of more heterogeneous countries, *i.e.* a set including less developed countries. The analysis of the estimated country specific effects leads to the conclusion that investment explains the GDP per capita differences across countries.

The previous articles induce a double observation: on the one hand, recent years have seen a significant development of cross-country panel data econometrics, in particular about the question of convergence of country economies. However, the difficulties encountered for correctly testing this assumption are numerous. This shows all the interest of G.S. MADDALA's article, who provides a critical evaluation of this literature. Indeed, G.S. MADDALA compares the recent cross-country econometrics to "*looking for a black cat in a dark room*". He first emphasizes the poor quality of the available statistical data. For many countries, in particular the developing ones, these data are not very reliable, which renders rather delicate the direct implementation of panel data econometric techniques to samples including such countries. In addition, problems caused by the growth paths heterogeneity, or by cross-country correlations, are generally ignored, while they can significantly affect the results. In fact, the results proposed in the literature are extremely varied and

sometimes lead to surrealist conclusions in terms of economic policy. Like C. GRANGER and N. HYUNG, G.S. MADDALA is somewhat circumspect about the robustness of the conclusions which can be drawn from panel data unit root tests. In particular, he points out an often made mistake, consisting in erroneously considering that rejection of the null hypothesis (of no convergence) allows one to conclude that all countries converge. This conclusion is obviously false since one will reject the null hypothesis as soon as some (not necessarily all) countries converge. G.S. MADDALA nevertheless concludes that the problems raised by cross-country econometrics have led, from an econometric point of view, to some advances. If the search for the "*Black cat*" did not succeed in itself, it nevertheless allowed us to find something!

The article of P. HULTBERG, M. NADIRI, and R. SICKLES constitutes, to some extent, an answer to one of the criticisms made by G.S. MADDALA about cross-country econometric work. Indeed, the authors aim at taking into account some of the interactions which can exist between countries, namely here the interactions based on technological spillovers. They propose a neoclassical growth model in which, through the catch-up of a technological gap, a country can experience faster growth. However, countries ability to take advantage of this "*catch-up potential*" can be limited due to countries institutional or social particularities. The model proposed by P. HULTBERG, M. NADIRI and R. SICKLES allows one to estimate a "*technological rate of adoption*", measuring the capacity of different countries to adapt the technology of the United States, considered as the leader country. This model is estimated on three samples covering respectively Europe, Latin America and South-East Asia. The estimates of the technological rate of adoption are the highest for Latin America countries. However, the low level of investment in these countries explains the persistence of their economic lag. On the contrary, South-East Asia countries have taken advantage of these technological diffusion effects. European countries do not seem to have strongly benefited from such effects, which can be due to the strong proximity of European and North-American technology levels.

Finally, in the last article of this special issue, Y. MUNDLAK, D. LARSON and R. BUTZER propose an analysis of agricultural productivity differentials across countries which presents some common points with that proposed by P. HULTBERG, M. NADIRI AND R. SICKLES. Indeed, they focus on getting a correct evaluation of the contribution of capital and employment to agricultural production, taking account of the differing technological levels across countries and of other country specific structural factors. The proposed evaluation rests on a decomposition of the total variability of the production. The between-period variability is supposed to account for technological progress. The between-country variability allows them to measure the influence of the structural variables, for a given technology level. Finally, the within-country-time variability accounts for the impact of changes in outputs, inputs and other state variables. The authors thus argue that the estimated elasticities of production to labor and capital obtained in the within-country-time dimension are more relevant, because they isolate the proper contribution of these factors, contrary to the estimates obtained in the other dimensions.

This article shows that an attentive analysis of results obtained by implementing rather simple estimation methods allows for a good evaluation of the

contributions of the various factors (inputs, technology, institutional and sociological factors, *etc.*) to the productivity differentials one can observe across countries. We can then conclude this introduction with a more optimistic vision of the contribution of panel data econometrics to our understanding of economic behaviors. ■

• References

ANDREWS D.W.K. (1993). – "Exactly Median-Unbiased Estimation of First Order Autoregressive/Unit Root Models", *Econometrica*, 61, pp. 139-165.

BALESTRA P., NERLOVE M. (1966). – "Pooling Cross-Section and Time-Series Data in the Estimation of a Dynamic Economic Model: The Demand for Natural Gas", *Econometrica*, 34, pp. 585-612.

CAVANAGH C., SHERMAN R.P. (1998). – "Rank Estimators for Monotonic Index Models", *Journal of Econometrics*, 84, pp. 351-381.

DAVIDSON R., MACKINNON J.G. (1993). – "Estimation and Inference in Econometrics", *Oxford University Press*.

EISNER R. (1998). – "The Keynesian Revolution, Then and Now" (Vol. 1), and "Investment, National Income and Economic Policy" (Vol. 2), Series: Economists of the Twentieth Century, Edward Elgar Publishing Company.

EVANS P., KARRAS G. (1996). – "Convergence Revisited", *Journal of Monetary Economics*, 37, pp. 249-265.

GOURIEROUX C., TROGNON A. (1988). – "Une note sur l'efficacité des procédures en deux étapes", in *Mélanges Économiques*, Essais en l'honneur d'Edmond Malinvaud, Economica.

GRILICHES Z. (1969). – "Capital-Skill Complementarity", *Review of Economics and Statistics*, 56, pp. 465-468.

GRILICHES Z. (1998a). – "R&D and Productivity: The Econometric Evidence", University of Chicago Press.

GRILICHES Z. (1998b). – "Practicing Econometrics: Essays in Methods and Applications", Series: Economists of the Twentieth Century, Edward Elgar Publishing Company.

HECKMAN J. (1976). – "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for such Models", *Annals of Economic and Social Measurement*, 5, pp. 475-492.

HOLTZ-EAKIN D., NEWEY W.K., ROSEN H.S. (1988). – "Estimating Vector Autoregressions with Panel Data", E*conometrica*, 56, pp. 1371-1395.

KYRIAZIDOU E. (1997). – "Estimation of a Panel Data Sample Selection Model", *Econometrica*, 65, pp. 1335-1364.

LECHNER M. (1999). – "Earnings and Employment Effects in Continuous Off-the-Job Training in East Germany after Unification", to be publisdhed in dans *Journal of Business and Economic Statistics*.

LEVIN A., LIN C.F. (1992). – "Unit Root Test in Panel Data: Asymptotic and Finite Samples Properties", UCSD *working pape*r n° 92-23.

MADDALA G.S. (1994). – "Econometrics Methods and Applications" (Vol. 1 and 2), Series: Economists of the Twentieth Century, Edward Elgar Publishing Company.

MAZODIER P., TROGNON A. (1997). – "20 Years of Publications: Panel Data on Panel Data?", *mimeo*, communication à la Septième Conférence Internationale sur l'Utilisation des Données de Panel.

MUNDLAK Y. (1978. – "On the Pooling of Time-Series and Cross-Section Data" *Econometrica*, 46, pp. 69-85.

NIJMAN T., VERBEEK M. (1996). – "Incomplete Panels and Selection Bias", chapter 18, in *The Econometrics of Panel Data*, A Handbook of the Theory with Application, second edition, Kluwer Academic Publishers.

WOOLDRIDGE J.M. (1995). – "Selection Corrections for Panel Data Models under Conditional Mean Independence Assumptions", *Journal of Econometrics*, 68, pp. 115-132.