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New Tools of Economic Dynamics

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Dedicated to Richard M. Goodwin and Michio Morishima
Preface

Innovation and advances in the techniques of analysis of economic dynamics have been dramatic in recent years. Taken together, they have formed a sort of second wave following the wave that has revolutionised macro dynamics in the 80s. Impact has been relevant to both theoretical and applied work and it has involved also econometrics, of course.

On one side, we have witnessed the birth of families of what could be broadly defined new growth and development models. They are quite new in comparison to those of traditional approaches - the endogenous and exogenous types- and can be collectively characterised by the fact that their much richer internal structure is capable of producing a richer, and more interesting, variety of dynamics. On the other hand, econometrics and especially time series analysis began looking more closely at the finer structure of our economies, a greater number of variables being attributed to different agents and represented in the models.

In either case, the result was first that the models economists got used to work with, had (often, many) more dimensions than the traditional ones. Moreover, the main force driving the economy’s dynamics began to be identified with the various rules and forms of interaction among many heterogeneous agents (industries, firms, individuals). The engine of dynamics was seen to be fundamentally endogenous, rather than the the mere response to the exogenous shocks of New Classical dynamics. Thus, the whole analytical framework based upon the impulse-response mechanism had to be entirely overhauled, changing their relative weights: more was put into the internal structure of the economy, less in the complications of the shock profiles.

The emerging new modelling framework obviously demanded new analytical tools, too. These had to be (and have been) imported from elsewhere, this ranging over a very broad field, from statistics to mathematics to physics. Among such tools, more and more important became e.g. numerical simulations as an exploratory device with a theoretical dignity of its own. Sometimes, using simulations was a choice; more often, however, it was a necessity given the size of the model at hand. Taken together, at any rate, all those new tools
were employed, at times, to search out the capabilities and to explore the structure of a given model. On other occasions, they were to depict alternative scenarios for growth and/or for policy actions. Even when quantitative results were expected - as in all econometrics and time series studies - still, some part of the added value of the research was in the qualitative nature of the information provided by its results. This calls for a comparison with the way the qualitative approach to dynamics entered into economics, and how it fared in the field since its discovery by the economists.

Qualitative analysis has been a key approach to dynamics since Poincaré invented it at the end of 19th century and since its introduction into economics with the classical works of Frisch, Kaldor, Hicks and Goodwin, between the 30s and the 50s. It was born out of the incapability of handling certain non-linear dynamic models in a classical way, i.e. by explicitly finding their solutions. Going qualitative was a necessity, instead of a choice. It basically meant topological (hence, non-numerical) analysis of individual models and the fundamentally topological theory of classes of models.

The qualitative approach that has been emerging recently is quite different, though it complements the classical one. Differences can be appreciated in many ways, but they all refer either to the intensive use of new, sometimes simulation and numerical techniques and the construction of models with greater dimensions than before, and/or to the deeper integration between theory and empirical evidence.

The New Tools project (and network) was born out of this challenge and it reflected the variety and heterogeneity of its aspects. Emphasis was however placed on the common ground, the exploration of tools rather than the construction of models around specific economic issues. The New Tools network now links researchers in various countries and universities of Europe and Latin America.

Most of the chapters collected in this volume are revised versions of research papers read in four workshops held consecutively at UNISI in Siena (December 2000), UDLA in Cholula (State of Puebla, Mexico, September 2001), CIMAT in Guanajuato (State of Guanajuato, October 2002) and in Nowy Sacz Graduate School of Business in Poland (September 2003). All papers were subjected to intense discussions during the network’s meetings, with a varied public of researchers and students at different levels of their education. In fact, the purpose of the NT network is not only to promote research but also to enrich education, focusing on master and doctoral levels.

The broad areas in which the network’s research activity fell so far, are reproduced in the volume’s structure with the three sections: large interactive models of the economy; econometrics and time series; growth, development and structural change. Each section contains both theoretical and applied chapters as, in general, papers have been written with the need to look for such intersection in the authors’ minds. In fact, it is a key hypothesis in the NT project that time is ripe for a reconciliation between the more theoretical and the more applied research lines in economic dynamics, ending thus a
divorce and recomposing a unity that was at the birth of macro dynamics as envisioned by Ragnar Frisch and the founders of the Econometric Society. We believe it is important to try in this direction by picking up the bits and pieces left from that divorce, in particular reconsidering the different tools that were developed then from the vantage point of the new ones. We now briefly go over the three sections, trying to highlight the novelty that is in the various applications of tools. Such novelty can often be appreciated more by the economists than by the practitioner of these disciplines from which those tools have been imported. The main common ground can be identified with the study of various aspects of so called complex dynamics. As anticipated earlier, these aspects are hereafter investigated under the hypothesis that they spring from the endogenous mechanism more than from the characteristics of some exogenous forces. In other words, without denying the importance of the latter, often stochastic forces, it is the structure of the model economy, which is seen as the site of the basic explanation of its dynamics. Structure can be looked at in a variety of ways as shown in the various papers, and can also be seen in its evolution, dramatic or catastrophic as sometimes its discontinuous change is called (after the mathematical theory).

Thus, 6 out of 9 chapters in Section I are devoted to the analysis of the various effects and tools to analyse settings with heterogeneous agents, and to derive characteristics of the resulting (aggregate) dynamics. Thus, Aoki’s Chapter 1 introduces the notion of classes or types of agents and deals with the issue of how to consider the uncertain appearance of new types along the economic trajectory. By looking at various schemes of local interaction between nearby firms, in Chpt. 2 Andergassen et als discuss the emergence of fluctuating growth and technological patterns shared by firms (trajectories in the evolutionary sense). On the other hand, through an explicit neural networks approach, Chapter 8 considers the emergence of firms and firms’ networks as the result of processes of learning in an environments too complex to be handled efficiently by any individual, thus as the institutions adequate to solve the associated economic problems. Aoki’s paper has implications for simulation techniques, which are heavily implemented in many of the other chapters. Through simulations, Chapter 2 tackles the problems of the emergence of different groupings of agents that are heterogeneous in their initial endowments and via bilateral exchange have to reach through an evolutionary process, equilibria implying different schemes of benefits sharing. Chapter 3 looks at a similar problem of social aggregation, there with a genetic algorithm approach, within a setting where the assumption of bounded rationality is central and a learning process is modelled. Chapter 4, on the other hand, innovates the conventional description of macroeconomic performance by studying (among other things) the effects of parameter perturbation over a system of equations tracing the time evolution of the first and second moments of the firms distributions (in terms of a chosen index of financial robustness). (Many of the implications of these analyses on growth and in particular on growth irregularity and fluctuations will come up again in Chapters of Section 3, while the
statistical implications are practically dealt with in Section 2.) Finally, Chapter 9 reviews various easily available platforms for multi-agent simulations, thus providing a guide to the intriguing question of what to learn to do.

As said above, classical qualitative analysis basically meant topological methods applied to (classes of) models or of model predicted trajectories. This is very much the spirit in Chapter 6, where however the study of general equilibrium economics is carried on by means of much newer notions from Catastrophe theory. The point is the suggestion to focus upon the singular economies (that are structurally unstable) rather than on the structurally stables ones as is always the practice. (The theme of the importance of understanding instability comes up again in Section 3). But qualitative analysis can also be of a different type: an analysis where structural rather than functional dependence, and thus hierarchical and dominance relations are at the centre, as is in Chapter 7, where a pretopological approach is used to unveil the bare skeleton of an economy.

Virtually, all of the chapters mentioned above bear implications for observable dynamics, most of them do look also at empirical evidence. While this is a feature common with Section 3, empirical evidence and how to handle it is the very focus of Section II; as its title suggests. Here too, the common framework is one where effects of multidimensional economies and complex time evolution (including, uncertainty) are studied. This is the realm of econometrics, time series analysis and of course broadly defined simulation based-econometrics, a field fast growing specially in a version married with micro simulation.

The latter is basically the object of the two coordinated Chapters 13 and 14, and it appears in the topically related Chapter 15. In all three chapters, the study case of retirement choices is tackled for its own right, but also to demonstrate a variety of techniques to econometrically construct, handle and validate models with many agents, thus capable of exhibiting alternative outcomes through micro-simulation experiments (in the former two chapters), or to endogenize choices (in this case, of retirement) as in the latter chapter. A critical review of outcomes of a bunch of econometric tools to evaluate monetary policy is presented in Chapter 16, with an application to a known difficult case, Mexico’s highly volatility behaviour. The chapter makes a case for an informed policy decision-making process, whereby different scenarios produced by alternative techniques are systematically taken into account. This is again a link to themes in chapters of Section III, with their multiple illustrations of applications of complex dynamics tools to Latin America (and possibly to more recent events elsewhere). But before turning to that, we recall that the chapters opening this section, are all devoted to issues associated with detection of the driving force behind seemingly irregular economic time series.

Thus, Chapter 12 reviews the recent advances of spectral analysis, a well-established technique in economics being associated with the still most favoured linear econometric framework, while in fact it has received major extensions through for instance the windowed filtering methods. The application to the well known Phillips’ curve is a good link to Chapter 10, where time
series are looked at as possibly embodying, next the more popular ingredients, also structural change. As a way to tackle such cases, the smooth transition formulation of an econometric model is exposed and some result shown. This is a rapidly expanding research in the filed of non linear econometrics, as much as is the modelling of financial markets, a sample to be found in Chapter 11 introducing an imported method of Value-at-Risk prediction (or VAR, not to be taken for the better known vector auto regression approach!), which promises to handle time series for which there are no multiple realizations, or it is safer not to assume it.

Section III deals with issues in what traditionally have been classified growth and development fields, until recently realm of well-defined theories with clearly understood predictions. The history of the last decades, and the theoretical reflections on it, has shown that the apparent consensus reached some time ago about their interpretation has definitely broken down. We are searching for an explanation, or more probably for various explanations for the series of events that have been happening in the various countries, explanations accounting of the variety of experiences and the evolution often dramatic shown by most of them. The so called convergence literature, enormously boosted by the growth debate and the availability of new statistical base in the mid of the 80s, has probably misled us by proposing the search for cross country uniform behaviours and long run stability towards some predicted equilibrium path. Neither prediction has proved to be reasonably tenable.

The critical implications of this failure are the common thread of the section, which opens with the revision of the notion of convergence in the light of its environmental implications. This leads to the unveiling of a double convergence hypothesis which is allegedly implicit in the growth re-interpretation of the so called environmental Kuznets curve, and to the rejection of the latter on the ground of the prevailing of different growth regimes across countries (the notion of regime recalls chapter 5 and 6 above). A re-examination of the growth findings in Chapter 18 focuses upon the much discussed issue of volatility in performance, an issue discussed by the authors resorting to distribution analysis with a Markov chain hypothesis. Chapter 19 re-examines in a detailed way a well known model of externally constrained growth, in the light of the Mexican and generally recent Latin American experiences, and it shows how it had to be to a large extent updated. The next two Chapters 20 and 21 dwell upon the uses of the notion of fractional brownian motion to explain, respectively, the time behaviour of indices of the Mexican stock market, where structural change is embedded as a result of the recent major organizational changes (including NAFTA), and the Argentinean high inflation before the parity with the US dollar as the evolution of self organized structures.

Optimisation is bread and butter for economists, and the intertemporal optimisation framework has become more so after the 80s. The book could not overlook this: Chapter 22 reviews the theory and various applications of a new
field called semi-infinite programming, not as easy as standard programming, not so difficult as day to day, real life one.

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Part I

Large Interactive Economies