BANCA D'ITALIA
EUROSISTEMA

Albert Ando
A Bibliography of His Writings

edited by
Clara Dall'Osso, Valentina Memoli and Rosanna Visca

Collezioni e studi della Biblioteca Paolo Baffi

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Albert Ando, summer 1995 (photograph by Stefano Siviero)

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Contents

Preface

With this publication, the Bank of Italy honours the memory of Professor Albert Ando on the occasion of the twentieth anniversary of his death, on 19 September 2002.

Besides being an outstanding and authoritative economist, a multi-disciplinary scholar and an advisor to a number of institutions across the globe, Albert Ando was for many years a consultant to the Bank of Italy on a number of issues, primarily (but not exclusively) relating to econometric modelling. Publishing a revised and enriched version of his bibliography (which expands on the one published by the Bank of Italy in 2012, on the tenth anniversary of his death) seems an appropriate way to celebrate his remarkable contribution to the advancement of economic knowledge; despite the decades that have passed, many of his teachings and insights are still relevant, as the items included in this bibliography show.

As is usual in works of this kind, the bibliography only includes published material, with two exceptions: Professor Ando's PhD dissertation, dated 1959 (you can download a PDF version of the dissertation (excluding the Appendix) from the Bank of Italy's website; see the link at No. 3 in this bibliography), and his influential 1985 work on the determinants of Japanese households' saving behaviour (see No. 86 in this bibliography). Besides the works listed in the bibliography, Albert Ando left behind a wealth of unpublished manuscripts, including, among other things, the first draft of several chapters of a *magnum opus* on the structure of econometric models as he saw it.

The bibliography is accompanied by two essays, the first of which, by the Governor of the Bank of Italy, Ignazio Visco, outlines Albert Ando's contribution in several areas of economic research; the second essay, written by three Bank of Italy economists who closely interacted with Professor Ando, recalls his contribution to economic analysis and modelling activities at the Bank of Italy.

Although twenty years have gone by, his acumen, energy and creativity, and, on a more personal basis for those who interacted more closely with him, his friendship and advice, are still very much missed.

Acknowledgements

We would like to thank all those who have been involved in various ways in preparing the publication of this bibliography.

First of all, our thanks go to Stefano Siviero for his valuable comments and suggestions and to Professor Ando's daughter and sons for giving us access to some of his private photographs.

We are delighted to thank our colleagues in the Paolo Baffi Library: Roberto Marzinotto, Silvia Mastrantonio, Gabriele Moggi, Mariella Palese, Maurizio Serafini, Sergio Tommasi di Vignano and Egizia Torcè for their help in gathering information and material. We also thank Silvia Mussolin for her comments and editorial support.

Our special acknowledgements also go to our colleagues at the Historical Archives, especially to Anna Rita Gresta, for helping us to look for photos in the Bank's archives, and to Liz Bevan for editing the texts.

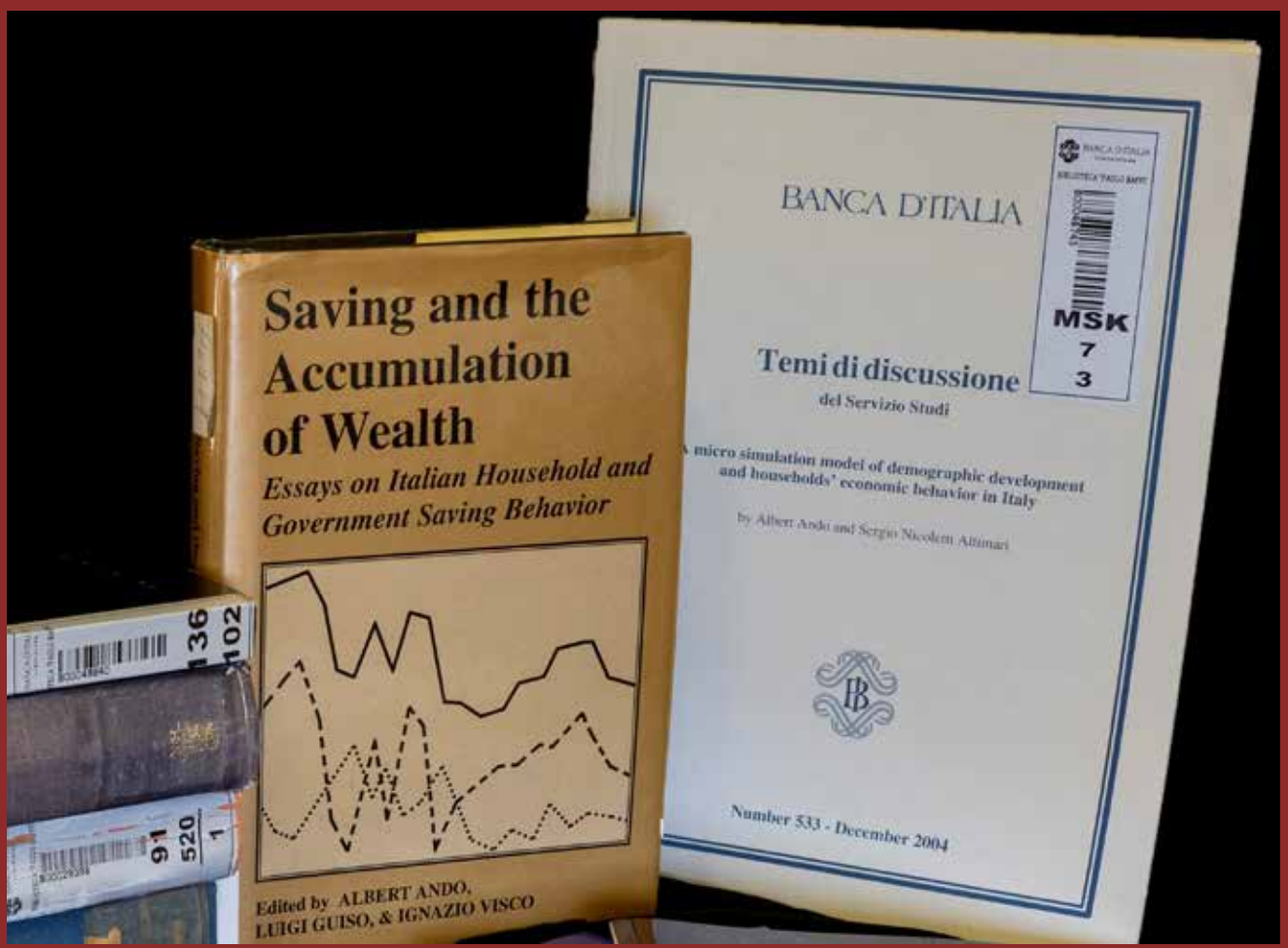
We would like to take this opportunity to express our sincere gratitude to the Delegation in Tokyo and to all the Italian and international libraries, central banks and research institutions that contributed to the retrieval of the material: without their cooperation, neither this bibliography, nor that of 2012, would have been so complete.

Last but not least, a heartfelt thank you goes to Maria Lucia Stefani, Head of the Paolo Baffi Library, for her constant support for our work.

The editors

In memory of Albert Ando, an introduction

Ignazio Visco



In memory of Albert Ando, an introduction (*)

Albert Ando (1929-2002) was a social scientist with wide interests, who made several important contributions to economic theory, macroeconomics and econometrics. He was a Fellow of the Econometric Society, a Ford Foundation Fellow, a Guggenheim Fellow, a Japan Foundation fellow, a recipient of the Von Humboldt Award.[1] His interests spanned from mathematical economics to public finance, from Bayesian probability and decision theory to national accounts and economic statistics, from macroeconomic modeling to optimal control, from systems theory to computer science.

After the Second World War Ando, who was born in Tokyo, moved to the United States to complete his education, first in Seattle, then in St. Louis, Missouri, and finally at the Carnegie Institute of Technology in Pittsburgh, where he graduated with a PhD in mathematical economics in 1959. His mentors and co-authors were Franco Modigliani and Herbert Simon.[2] At Carnegie, they interacted, producing high-level research in many fields, not only in economics, with scholars such as George Bach, William Cooper, Jacques Drèze, Charles Holt, Merton Miller, and John Muth. From Carnegie in the late 1950s Ando went on to teach at MIT and do research mostly, but not only, with Frank Fisher and Modigliani. In the mid-1960s he finally moved to the University of Pennsylvania, where he held joint appointments in the Economics Department and the Wharton School, frequently collaborating with Lawrence Klein and Irwin Friend, and advising the Federal Reserve Board and other public institutions on macroeconomic modelling.

In 2012, ten years after his premature death, the Bank of Italy organised an international conference in memory of Albert Ando and his role as a Bank consultant on several projects

* I would like to thank Massimo Sbracia, Stefano Siviero and Daniele Terlizzese for their useful comments to a preliminary version of this text and Rebecca Kelly for her help in revising it, while retaining responsibility for the views expressed herein.

1 For a short bio of Albert Ando see C.Y. Horioka, "Ando, Albert K. (1929-2002)", in S.N. Durlauf and L.E. Blume, *The New Palgrave Dictionary of Economics*, 2nd Edition, Palgrave Macmillan, London, 2008.

2 Ando, Herbert Simon's research assistant in the early 1950s, was greatly impressed, and influenced, by Simon's wide-ranging interests and contributions in several scientific domains. He was one of the two scholars (the other being William Baumol) who were asked to produce a survey of Simon's contributions to economics on the occasion of the award of the Alfred Nobel Memorial Prize in economics (A. Ando, "On the Contributions of Herbert A. Simon to Economics", *The Scandinavian Journal of Economic*s, 81, 1, 1979), see No. 71 in this bibliography.

for almost two decades. The papers presented at the conference can be found on the Bank of Italy's website.[3]

This is an updated version of the introduction I gave at that conference. In the 1970s Albert was, along with Larry Klein, my teacher, my mentor and supervisor of my PhD dissertation in economics at the University of Pennsylvania. Over the last three decades of the twentieth century, we had continuous and deep exchanges on various developments in economics and econometrics. I would like to start with a recollection of his contributions in three main areas: the representation of social systems, the development and testing of the life-cycle hypothesis of saving, and the project on macroeconomic modelling that spanned, in particular, from the mid-1950s to the mid-1970s. I will then say something about his consulting to the Bank of Italy, and conclude with a few personal reminiscences.

The analysis of social systems

In a series of articles written with Herbert Simon and Frank Fisher, Ando explored the relationship between the short- and the long-run effects of social actions. In particular, Simon and Ando considered two sets of simultaneous relations where the first had a strong impact on the second, which in turn had only a weak impact on the former. In this case, not only may the second set be safely ignored with regard to the short-term equilibrium, but we may also expect that, in the longer run, the relationships within the first set will remain substantially unchanged. This result has important applications in general economic equilibrium analysis, in identification in econometrics, in the assessment of causality in complex systems, with interdisciplinary applications in scientific research.[4] (An interesting application in the field of

3 See the Banca d'Italia's website: "Macroeconomics after the (financial) flood. Conference in memory of Albert Ando (1929-2002)", December 2012. After his death, Lawrence Klein edited a volume of essays in Ando's memory, with chapters produced by several of his former colleagues, associates and students, including several who were working or had worked in the Research Department of the Bank of Italy (L.R. Klein, *Long-run Growth and Short-run Stabilization. Essays in Memory of Albert Ando*, Edward Elgar, Cheltenham, 2006).

4 H.A. Simon and A. Ando, "Aggregation of Variables in Dynamic Systems", *Econometrica*, 29, 2, 1961 (No. 9). This is how Ando remembered the time when, as Simon's research assistant on the way to becoming his co-author, was assigned to work on the intuition behind the results proved in this paper: "He, in effect, placed an incredible trust in an untrained new student and devoted infinite patience to explain the complex idea to me at the time. We did succeed in showing that his intuition was right. In the process, he transformed me from a complete amateur into a professional." (A. Ando, in *Remembering Herbert A. Simon*, 19 March 2001, No. 131). See also A. Ando and F.M. Fisher, "Near-Decomposability, Partition and Aggregation, and the Relevance of Stability Discussions", *International Economic Review*, 4, 1, 1963 (No. 17) and F.M. Fisher and A. Ando, "Two Theorems on *Ceteris Paribus* in the Analysis of Dynamic Systems", *American Political Science Review*, 56, 1, 1962 (No. 10). These papers and others by the same authors on causal ordering, aggregation and approximate specifications are reprinted in A. Ando, F.M. Fisher and H.A. Simon, *Essays on the Structure of Social Science Models*, The MIT Press, Cambridge, Mass., 1963 (No. 19).

political science analysis is found in the paper by Ando and Fisher on arms races and the effects of bilateral conflicts between countries, such as that between India and Pakistan in the late 1950s, on the relations and risks of war between their sponsors, the USA and the USSR.)

We do not find much reference to these results in today's economic research, but they have shaped the way many of us think about social developments. They have also affected analysis in other fields such as physics and electronics, and this is one of the reasons why Albert was involved as a social scientist with the *advisory panel of the National Science Foundation Committee on Advanced Scientific Computing* during the 1980s.[5]

In a paper on stochastic data clustering published ten years ago, we read: "… a closed economic system, without any outside influences, is known to eventually reach a state of equilibrium, that is, after some initial fluctuations, the flow of goods and capital between any two industries will remain more or less constant. Rather than waiting for this economic equilibrium to occur, Simon and Ando tried to predict the long-term equilibrium by making only short-term observations. They proved that what happens in the short run completely determines the long-term equilibrium." Not bad as a summary by non-economists. Indeed. it goes on to observe (with several references) that: "Over the years scholars in a variety of disciplines have realised the usefulness of a framework that represents a number of tightly-knit groups that have some loose association with each other, and Simon-Ando theory has been applied in areas as diverse as ecology, computer queueing systems, brain organisation, and urban design. Simon himself went on to apply the theory to the evolution of multicellular organisms."[6]

The life-cycle of saving

In April 1959, when he was already teaching at MIT, Ando submitted his doctoral dissertation (*A Contribution to the Theory of Economic Fluctuations and Growth*) to the Faculty of Graduate School of Industrial Administration at the Carnegie Institute of Technology (No. 3). His main supervisor

5 I remember that the Bank of Italy staff working with our model were also conducting, at Albert's request, some "pioneering" real time stochastic simulations of the model on a supercomputer located in the US to help him gather supplementary evidence for evaluating its performance. The only material published of Albert's involvement at the time that I am aware of is A. Ando, P. Beaumont and M. Ando, "Efficiency of the Cyber 205 for Stochastic Simulations of a Simultaneous, Nonlinear, Dynamic Econometric Model", *International Journal of Supercomputer Applications*, 1, 4, 1987 (No. 94). By the way, it was interesting to hear in those years from Albert that it was this panel that recommended halting federal funding of supercomputers in order to favour that of networks linking spatially distributed computing power, a non-minor contribution to paving the way for the Internet revolution and the world of today.

6 C.D. Meyer and C.D. Wessell, "Stochastic Data Clustering", *SIAM Journal on Matrix Analysis and Applications*, 33, 4, p. 1216, 2010.

was Franco Modigliani and it is therefore of no surprise that the first chapter of the dissertation was on the "Consumption Function". Following the work by Modigliani and Richard Brumberg, left unpublished for a quarter of a century after Brumberg's untimely death in 1955,[7] this chapter presented a thorough derivation ("a restatement") of the "life-cycle hypothesis of saving" (LCH or MBA, from the initials of the three authors) and the first direct test of the hypothesis against time series aggregate data. This was, *in nuce*, the backbone of the much richer article published by Ando and Modigliani in 1963 in the *American Economic Review* (No. 16).

Still at Carnegie, however, Ando and Modigliani had started working on cross-section tests of LCH/MBA, following the other pioneering article published by Modigliani and Brumberg in 1954. Following a first set of preliminary tests of Friedman's "permanent income hypothesis" and of Modigliani and Brumberg's LCH conducted by Malcolm Fisher on data from the Oxford Savings Surveys,[8] they participated in a Symposium on savings behaviour organised and published in 1957 by the Bulletin of the Oxford Institute of Statistics.[9] Notwithstanding the ingenuity of their analysis, their conclusions were "painfully meagre", even if the results from the surveys were not considered to be at odds with the LCH. Certainly more satisfactory, though extremely demanding, was what Ando considered his "first really large scale empirical analysis" conducted on the data generated by BLS Survey of Consumer Expenditure, within a major project organised by Irwin Friend at the Wharton School.[10] This work was so taxing (certainly given "the primitive nature of computers in those days" but also for the sheer amount of deep data analysis conducted on the "12,000 or so households covered by this survey") that Albert "did not feel inclined to work seriously with another cross section data set for 20 years after the completion of the project".[11]

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7 F. Modigliani and R.H. Brumberg, "Utility Analysis and Aggregate Consumption Functions: An Attempt at Integration", in A. Abel (ed.), *The Collected Papers of Franco Modigliani*, Vol. 2, The MIT Press, Cambridge, Mass., 1980. This (macro) paper remained unpublished for more than two decades, but was widely read in conjunction with its companion (micro) article: F. Modigliani and R.H. Brumberg, "Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data", in K.K. Kurihara (ed.), *Post Keynesian Economics*, Rutgers University Press, New Brunswick, 1954.

8 M.R. Fisher, "Explorations in Savings Behaviour", *Bulletin of the Oxford Institute of Statistics*, 18, 3, 1956.

9 F. Modigliani and A.K. Ando, "Tests of the Life Cycle Hypothesis of Savings: Comments and Suggestions", *Bulletin of the Oxford Institute of Statistics*, 19, 2, 1957 (No. 2). More than the quality of the survey data, it was the quality of the contributors to the Symposium that was truly impressive, a clear recognition of the significance of the issues involved. Participants in the debate included five future Nobel laureates (Milton Friedman, Trygve Haavelmo, Lawrence Klein, Franco Modigliani and James Tobin), as well as economists and statisticians of extremely high quality (i.e. Albert Ando, Irwin Friend, Peter Hill, Nissan Liviatan, Denis Sargan and Harold Watts, besides the author of the original article, Malcolm Fisher).

10 F. Modigliani and A. Ando, "The 'Permanent Income' and the 'Life Cycle' Hypothesis of Saving Behavior: Comparison and Tests", in I. Friend and R. Jones (eds.), *Proceedings of the Conference on Consumption and Saving*, Vol. II, University of Pennsylvania, 1960 (No. 7).

11 A. Ando, "Reflections on Some Recent Evidence on Life Cycle Hypotheses of Saving", *Studies in Banking and Finance*, 5, 1988, p. 7 (No. 100).

As this is not a contribution to the history of economic thought, there is no need to go into detail here on how these pioneering efforts subsequently developed. However, both Modigliani and Ando kept working on the LCH, jointly through the 1960s and subsequently each following different strands. Franco looked for confirmation of the main implications of the theory, in the United States and across different countries and areas around the world, and was pleased to find that it was a theory that held water satisfactorily. Albert, instead, was more inclined to examine the reasons for deviations from the simplest predicaments of "rational" behaviour, perhaps remembering some of the main suggestions advanced by Herbert Simon on adaptive behaviour and bounded rationality. He carried on producing a truly impressive amount of deep and meticulous statistical research work on cross-section and panel data for the United States, Japan and Italy, which still remains a benchmark for the analysis of saving behaviour conducted on household surveys to this day.[12]

There is very little to add to Solow's two conclusions on the work that Ando contributed to so impressively. The first is the proposition that "life cycle theory is secure", as long as we find "the notion that households may wish to achieve a pattern of lifetime expenditures rather different from earnings" useful for interpreting the real world. Indeed, the value of the theory is in its ability to be "a guide to interpreting behaviour rather than as a set of equations to live or die by". The second is the recognition of Albert's ability to combine "vast industry with a no-nonsense approach to the data", without attempting "to wish away damage to received ideas".[13]

Macroeconomic models (of growth and fluctuations)

As I have recalled, the first chapter of Ando's PhD dissertation was dedicated to the derivation of an aggregate consumption function based on the LCH. The dissertation, however, was much more ambitious in its scope. He explicitly described it "as a progress report on a project

12 See, among several others: A. Ando and A.B. Kennickell, "How Much (or Little) Life Cycle is there in Micro Data? The Case of the United States and Japan", in R. Dornbusch, S. Fischer and J. Bossons (eds.), *Macroeconomics and Finance: Essays in Honor of Franco Modigliani*, The MIT Press, Cambridge, Mass., 1987 (No. 95); F. Hayashi, A. Ando and R. Ferris, "Life Cycle and Bequest Saving: A Study of Japanese and U.S. Households", *Journal of the Japanese and International Economies*, 2, 4, 1988 (No. 99); the papers, also written with L. Guiso and D. Terlizzese, collected in A. Ando, L. Guiso and I. Visco (eds.), *Saving and the Accumulation of Wealth: Essays on Italian Household and Government Saving Behavior*, Cambridge University Press, Cambridge, 1994 (No. 119); A. Ando and S. Nicoletti Altimari, "A Micro Simulation Model of Demographic Development and Households' Economic Behavior in Italy", Banca d'Italia, Temi di discussione (Working Papers), 533, 2004 (No. 139).

13 R.M. Solow, "Comments on 'How Much (or Little) Life Cycle is there in Micro Data? The Case of the United States and Japan", in Dornbusch, Fischer and Bossons (eds.), op. cit.

whose major aim is to begin with the behavioral hypotheses for individual decision makers in the economy and construct, as an implication of these hypotheses, a relatively complete model that would explain the variation over time of aggregative economic magnitudes".[14] Over the course of the following twenty years, this project, conducted in close collaboration with Modigliani, gave rise to a substantial set of contributions to the field of applied macroeconomic modelling. The best known of these contributions was the building and use of what was initially dubbed the FRB-MIT model, for a while called FMP before finally being known as the MPS model.[15]

The starting point of the project was to use a systemic approach to combine an analysis of the evolution of the economy on a long-term growth path with a theory of short-term business fluctuations. In his dissertation, as well as in a previous article co-authored with Modigliani, Ando maintained that a common thread consisted in the observation that in both Keynesian-derived business cycles and growth models (a prototype of the former being Klein's pioneering econometric models and a representative of the latter being Harrod's dynamic contributions) "the price mechanism is conspicuously absent".[16]

The quantitative representation of the economy that would ultimately take the form of the MPS model is therefore the result of two fundamental points that characterise Ando and Modigliani's views of the working of the economic system they were interested in at the time. The first is the description of the long-term equilibrium as a dynamic version of a general economic equilibrium system, identified by the rational behaviour of economic agents and by the equilibrating mechanism of prices in different markets. The second is the recognition of the existence, in the real world, of frictions, adjustment lags, and market imperfections, which result in outcomes that may be removed from the general equilibrium, potentially for

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14 A.K. Ando, *A Contribution to the Theory of Economic Fluctuations and Growth*, unpublished PhD dissertation, Carnegie Institute of Technology, 1959, p. 1 (No. 3).

15 This is not the occasion to examine the history of this major project, which involved, under the direction of Ando, Modigliani and Frank De Leeuw (at the Federal Reserve Board), several talented young economists and econometricians. It started as a joint venture, when Ando was still at MIT (the "M"), with the Federal Reserve Board (the "F") that provided initial financing, jointly with the SSRC (the "S"). On the academic side it was "operated" at the University of Pennsylvania (the "P"), under Ando's direct supervision. For a thorough discussion of the history of the project, which starts with the 1950's contributions by Ando and Modigliani, see A. Rancan, "From Dynamics to Stabilisation: Albert Ando and Franco Modigliani's Contributions to the Theory of Economic Growth and Fluctuations (1959-1979)", *The European Journal of the History of Economic Thought*, 27, 4, 2020. A very interesting and thoughtful discussion of the apparent but reasoned "messiness" that characterised the development of the FMP-MPS project, see R.E. Backhouse and B. Cherrier, "The Ordinary Business of Macroeconometric Modeling: Working on the Fed-MIT-Penn Model, 1964-74", *History of Political Economy*, 51, 3, 2019.

16 A.K. Ando and F. Modigliani, "Growth, Fluctuations and Stability", *American Economic Review*, 49, 2, 1959, p. 501 (No. 4).

an extended period of time. In a sense, this is close in spirit to Modigliani's "interpretation" of the possibility of a (protracted) "short-term Keynesian" unemployment equilibrium, which was advanced in the celebrated article that followed his doctoral dissertation, one of the main cornerstones of the so-called "neoclassical synthesis".[17]

While in Modigliani's original interpretation it was mainly wage rigidities and frictions that determined a Keynesian "solution", Ando was more concerned with the length of the time lags required for the adjustment in consumption and investment decisions. He considered this to be the main factor in determining temporary (but of an undefined length, *a priori*) deviations from the longer run equilibrium (as summarised by Robert Solow's contribution to the theory of economic growth, with instantaneous price adjustments, market clearing and continuous full employment). Furthermore, the heterogeneity of consumers and firms turned out to be particularly relevant; special attention had then to be paid to the aggregation of their decision rules (with the life cycle hypothesis and the accelerator principle being the two crucial respective paradigms).

In order to understand the whole project that took root from Albert's dissertation and the joint paper he published in 1959 with Franco Modigliani, I find it particularly important to read the "methodological comment" that he includes as a footnote in the last pages of the dissertation:

> In economics, a theory that serves as a reference point, (as does the general equilibrium theory involving growth in this context) has a value of its own right, because it defines the conditions for existence of an ideal state of the world.
>
> When we depart from such a theory by either relaxing one of its assumptions or introducing additional constraints, the situation is somewhat different. For the convenience of our discussion, let us distinguish between the relaxation of assumptions or addition of constraints which do not affect the existence of the ideal state, and those which will affect the existence. We shall refer to the former as 'generalization' and to the latter as 'imperfection.' We are here concerned with the problem of introducing imperfections into the general equilibrium model involving growth.
>
> The theory that serves as the reference point must be an extremely idealized model of the real world, since it is meant to define the conditions under which the ideal state of the world exists.
>
> Economists are often interested in finding a set of imperfections which, when they are introduced into the general equilibrium model, would produce implications that resemble the real economy as they observe it. But, there often are a whole array of imperfections which may be introduced into the model, and the choice of a particular set of imperfections to be considered must be based on the knowledge of their relative empirical importance.

17 F. Modigliani, "Liquidity Preference and the Theory of Interest and Money", *Econometrica*, 12, 1, 1944.

> Unlike the original set of assumptions which define the existence of the ideal state, a particular set of imperfections does not have a value of its own apart from the empirical support which it may obtain through econometric research.
>
> Thus the contrast: in the case of the assumptions defining the existence of an ideal state, the more general and the more inclusive the assumptions are, the better the theory will be. It is not necessary that these assumptions have direct empirical support. In the case of the imperfections that are introduced into the general theory in order to fill the gap between the general theory and the real world, the more specific the assumptions, the more sensitive they are to empirical verification, the better the resulting theory will be.

To better understand the "reference point", in the early 1960s Ando modified Solow's growth model to construct a prototype of the economy functioning without frictions, which conformed to the characteristics of the real world in periods that could be identified as full employment equilibria. He considered this the necessary starting point to understand where and how to introduce real world "imperfections" (wage rigidities, time lags of adjustment, imperfect knowledge) into the model and study their consequences.[18]

The reference to an equilibrium solution was to remain a constant guideline in the development of the project of building of and experimenting with the MPS model as it tackled, one by one, the "imperfections", or deviations, from the "ideal state of the world". These included the heterogeneity and aggregation of various capital goods, the "putty-clay" nature of investments from different vintages, the presence of oligopolistic profits and their impact on capital formation, the non-neutral nature of corporate taxation, the impediments to long-term efficiency, the labour market adjustments, and so on. Institutional and technical factors that would slow or prevent the economy from proceeding along balanced growth paths were introduced appropriately. Klein, however, considered especially noteworthy and fruitful Ando's "insistence that statistically based and validated long-run properties provide significant targets", while at the same time distancing himself from the use of "non-validated assumptions, no matter how consistently used in a logical sense", something he thought Albert was at times willing to introduce.[19]

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18 A. Ando, "An Empirical Model of United States Economic Growth: An Exploratory Study in Applied Capital Theory", in NBER, *Models of Income Determination*, Princeton University Press, Princeton, 1964 (No. 22).

19 Klein, op. cit., p. 11. Indeed, Klein had also been "fascinated" with the "great ratios" as could be observed in the American economy, although maintaining a somewhat agnostic view of the possible theoretical paradigms behind their development (L.R. Klein and R.F. Kosobud, "Some Econometrics of Growth: Great Ratios of Economics", *Quarterly Journal of Economics*, 75, 2, 1961). While Ando certainly referred to golden age paths such as those that prevailed in the "ideal state" of the (neoclassical) growth theories of the time, my recollection is that, in a way, he too became rather agnostic as time passed by and regime changes led to revisions of the steady state paths he continued to consider necessary reference points for the real world descriptions of the economy.

The end result was a very complex construct, with many "imperfections" that, in the view of their authors, had their own justifications, but to an external eye would appear difficult to follow, somewhat "ad hoc" deviations from the neat derivation of decision rules under uncertainty. Both Ando and Modigliani felt then in the 1970s the need to highlight in an extensive monograph (*The MPS Model: its Theoretical Foundation and Empirical Findings*) the basic theoretical structure behind their (and the Fed's) macroeconometric model, a framework "so large and complex that its basic structure is obscured for all but a few who work with it intimately".[20] Many hand- and type-written pages (and doctoral dissertations analysing the short- and long-term theoretical and empirical properties of the model) have survived, but the planned monograph never saw the light of day, and therefore its closest approximation remains Ando's 1974 article from which the previous sentence was taken.

I will not elaborate any further on the MPS model, as I have already discussed the development of the project, and several of its contributions, in an article written for a conference in memory of Franco Modigliani, to which I refer.[21] I concur, however, with Antonella Rancan that over the years, while the dynamic general equilibrium had maintained its role as a point of reference in the model, the effective focus shifted to the short-to-medium-run course of the key variables.[22] Given the slowness of adjustments that emerged in the succession of empirical research, which is to say the weakness of the general equilibrium as a pole of attraction, the Keynesian properties of the model structure took centre stage. This led to the recognition of the importance of monetary and fiscal economic stabilisation policies, whose "design" cannot but be determined empirically – that is, in the framework of a macroeconomic model estimated on the basis of the available observations. The interaction between (conditional) forecasting and the design of policy response therefore was the main motivation for the staff of the Federal Reserve to make use of the model.

But why did Ando and Modigliani not complete and publish the monograph on which they had worked at some length? Two possible explanations may be plausible. They are related, respectively, to the "end" (or at least the "truce" between the major contenders) of the

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20 A. Ando, "Some Aspects of Stabilization Policies, the Monetarist Controversy, and the MPS Model", *International Economic Review*, 15, 3, 1974, p. 542 (No. 55).

21 I. Visco, "From Theory to Practice in Macroeconomic Models: Post-Keynesian Eclecticism", *BNL Quarterly Review*, 58, 233-234, 2005.

22 Rancan, op. cit., not only presents an excellent overview of the project but also discusses its transformation – I would say "evolution" – from a contribution to the literature on endogenous growth and fluctuations to the understanding of business cycles and the effectiveness of policy actions. See also A. Rancan, "The 'Place of the Phillips Curve' in Macroeconometric Models: The Case of the Federal Reserve Board's Model (1966-1980s)", *Journal of the History of Economic Thought*, 44, 2, 2022.

so-called "monetarist controversy" and to the more serious consequences stemming from the success of what was known as the "rational expectations revolution" and the macro theory and econometric developments that followed.

The monetarist controversy

In a nutshell, the monetarist controversy regarded the relative effectiveness of monetary vs fiscal policy in affecting the level of (nominal) activity. Basically, a strong reliance on the time-honoured quantity theory of money or on a Keynesian income expenditure framework were not only seen as alternative ways of characterising the working of the economic system, but also the schemes through which very different results on the effects of monetary and fiscal measures on the economy were derived. "Monetarists" like Milton Friedman originally argued that it was the supply of money that determines the level of nominal income and, except in the (very) short term, real variables tend not to be affected – in other words, that money is neutral. "Keynesians" on the other hand tended to argue that autonomous (public) expenditure had an effect on nominal income and was certainly relevant for the real final demand (through the working of fiscal multipliers). Among them, macroeconomists like Ando and Modigliani agreed that the monetary effects were undoubtedly important, but so too were fiscal ones. The controversy ended up becoming empirical, in what was called the AM/FM or "radio stations" debate, from the initials of four of the original participants in the debate.[23]

In particular, Ando and Modigliani appeared to suggest, also in a series of follow-up studies not limited to the estimation of simple "reduced-form" equations, that it would have been better not to engage in extreme long- or short-term views, be they in the form of the Keynesian multiplier or the effects of the level of money. They emphasised the need to make use of a systemic approach, such as the one characterised by a much more complex set of simultaneous equations.[24] The debate ended with a series of "recognitions" on both sides of the limitations of the empirical results and with the agreement that both fiscal and

23 The debate involved many American macroeconomists and econometricians. It originated with the article by M. Friedman and D.I. Meiselman, "The Relevant Stability of the Velocity of Money and the Investment Multiplier in the United States, 1897-1985", in E. Cary Brown et al., *Stabilization Policies: A Series of Research Studies Prepared for the Commission on Money and Credit*, Englewood Cliffs, Prentice-Hall. Among various articles that followed (with replies and rejoinders), a particularly noteworthy one was by A. Ando and F. Modigliani, "The Relative Stability of Monetary Velocity and the Investment Multiplier", *American Economic Review*, 55, 4, 1965 (No. 32).

24 Some of the empirical macroeconomics through which the debate was conducted up to the early 1970s is covered by A. Rancan, "Empirical Macroeconomics in a Policy Context: The Fed-MIT-Penn Model versus the St. Louis Model, 1965-75", *History of Political Economy*, 51, 3, 2019.

monetary policies were important. Even despite a certain amount of misunderstanding as to his original intentions, Friedman was reported to have said that "we are all Keynesians now", while Modigliani responded that "we are all Monetarists".[25] Perhaps more telling was Ando's conclusion that: "Without the possibility of constructing a general model that is acceptable to both sides except for well defined differences, the prospects of making progress towards meaningful analysis of relative merits of the two theories were very slight. Recent writings by Professor Friedman and others, however, suggest that the situation is not quite so hopeless."[26] To that, Albert added the consideration that the issue on the relevant importance of fiscal and monetary policies could be settled by means of an empirical macroeconomic model such as the MPS. On the one hand, therefore, it was deemed necessary to produce a well thought-out explanation of the model's structure, which was the purpose of Ando's 1974 paper. On the other hand, a more extensive analysis such as the one that was expected to be published in "the forthcoming book on the MPS Model" was probably not considered strictly necessary for the purpose of settling the debate, as the end result would essentially have been an empirical one.

It must be acknowledged, however, that the theoretical distance was not insignificant, and the empirical results would not have been able to settle it. Indeed, Modigliani and Friedman's apparent reconciliation was at odds with Friedman's idea that deviations from a full-employment (or "natural rate") equilibrium would most likely be relatively minor business cycle movements and therefore not worth the risk of destabilising interventions, as well as with Modigliani's (and Ando's) conviction that the case for active stabilisation policies would have been necessary to assure a speedy convergence to full-employment in an economy subject to business fluctuations. Once again the issue was therefore the time length and the costs of the adjustment.

Rational expectations and new classical macroeconomics

It is at this point in time that the rational expectations revolution, and the "new classical macroeconomics" associated with it, came about. As is well known, it initially saw Robert Lucas and Thomas Sargent as its main actors, with the former advancing an equilibrium theory of the business cycle, while both attacked the empirical macroeconomic models of the time, and in particular their use for the evaluation of the effects of economic policies. The fundamental argument was that these models lacked thorough "microfoundations", and therefore their

25 F. Modigliani, "The Monetarist Controversy or, Should We Forsake Stabilization Policies?", *American Economic Review*, 67, 2, 1977.

26 A. Ando, op. cit., pp. 541-42 (No. 55).

parameters, not being "structural", would not be policy-invariant. It therefore followed that they could produce misleading conclusions when the effects of policy changes had been calculated by means of model simulations that did not allow for the response by the optimal decision rules of individual economic agents to those changes (the "Lucas critique"). At the same time, an "equilibrium" explanation of business cycles might render the search for optimal stabilisation policies a rather pointless exercise.

From a theoretical point of view, Lucas's initial contribution was to advance a sophisticated theory that supported, with the assumption of rational expectations (i.e. the efficient use by economic agents of all the information available to them, as advanced by John Muth in a microeconomic context), the neutrality of money through the business cycle.[27] On the empirical side, Sargent and Lucas criticised existing Keynesian econometric models as being generally ill-suited to providing reliable guidance for policymaking. This conclusion was "based in part on the spectacular failures of these models, and in part on their lack of a sound theoretical and econometric basis."[28]

I am not going to detour here to discuss the exceptional developments that followed this dual offensive on the predominant macroeconomic theory, modelling and policy analysis of the time. We must, however, recognise that they gave rise to an impressive series of innovative research contributions to macroeconomics and econometrics. These included new ideas and concepts, as well as innovative revisitations, on subjects such as time consistency, sunspots, overlapping generations, cash in advance and the like. However, I also believe that the sharp divergence of so-called "freshwater theories" based on new classical macroeconomics, efficient markets or real business cycles from "saltwater theories", which allowed for market failures, imperfect competition, price stickiness and so on, was a most unfortunate development.

Indeed, I still find Ando's responses to both the theoretical and empirical attacks certainly worthy of wider attention than what he received at the time. On the empirical side, in a first paper published in 1981 Ando maintained that there was no real evidence that macroeconometric models such as the MPS had "spectacularly failed" in forecasting current economic developments, even if "extracting propositions from existing economic theory that are usable for specifying and identifying estimatable equations is an excruciatingly difficult task".[29] He began illustrating

27 R.E. Lucas, "Expectations and the Neutrality of Money", *Journal of Economic Theory*, 4, 2, 1972.

28 R.E. Lucas and T.J Sargent, "After Keynesian Macroeconomics", in *After the Phillips Curve*, Federal Reserve Bank of Boston Conference Series No. 19, Federal Reserve Bank of Boston, Boston, 1978, p. 69.

29 A. Ando, "On a Theoretical and Empirical Basis of Macroeconometric Models", in J. Kmenta and J.B. Ramsey (eds.), *Large-Scale Macro-Econometric Models*, North Holland, Amsterdam, 1981, p. 329 (No. 79).

his strategy "to make sure that all equations, or system of equations, which I use as the basis for empirical studies, have associated with them proper steady state solutions to which the comparative static propositions do apply, unless there is some persuasive reason to deviate from this principle". He then disputed "the impression recently created in the literature that specifications of macroeconometric models are almost entirely ad hoc" and concluded that "deviations from the general competitive equilibrium are results of deliberate decisions".[30]

The observations advanced in the same paper on the "theoretical basis" of macroeconometric models, and his scepticism of the "assumptions" of "new classical economists" as a credible basis for empirical specifications useful in real life applications, show a deep understanding of Lucas and Sargent's project. He advanced well thought-out, albeit at the time largely ignored, considerations on the relationship between the "ideal states" (the starting point of his dissertation, which perhaps had then taken on the form of the new theoretical constructs advanced by Lucas and others) and the complexities, imperfections and nonlinearities of the real world. Indeed, he was very sceptical of the value of an "equilibrium" business cycle approach to account for deviations from the dynamic general economic equilibrium possibly not limited to the very short term. Ultimately, without objecting to the validity in principle of the Lucas critique, he concluded that the invariance of the parameters of large-scale macroeconometric models could only be ascertained by means of empirical tests, not derived from a particular, even if well-articulated, theoretical construct.

At the same time, the discussion of the "empirical basis" of macroeconometric models, including the way he responded to Chris Sims's sceptical conclusions on identification and causality, is of particular interest, not only for its historical value. He was aware of the "defects of current statistical theory as a tool of empirical science", even if making substantial progress in the use of Bayesian procedures appeared to be extremely difficult and slow. However, "in the meanwhile economics and other empirical sciences must go on". If we must acknowledge that the "situation is very unfortunate because it appears to involve so much subjective judgment by the econometrician … and it takes so much time to develop a consensus among economists … the best we can do is to make the process as transparent as possible."[31]

30 Ibid., pp. 329, 339.

31 Ibid., pp. 356-57.

In a second paper, eventually published in the 1984 Festschrift volume in honour of Larry Klein, Ando directly addressed the theoretical basis of the macro equilibrium business-cycle models as described in the above-mentioned, celebrated 1972 article by Lucas.[32] Again, it is somewhat unfortunate that Ando's considerations did not receive sufficient attention at the time this paper was published. A possible reason is that, by that time, the new classical macroeconomics was already becoming somewhat, albeit temporarily, mainstream. However, it is nonetheless very much worth reading because it addresses two very serious issues.

The first is that, while Lucas' ingenious islands (overlapping generations) model provides interesting insights into the effects of imperfections on the "transmission of information by prices on supplies of factors of production" when stochastic disturbances are both real and monetary, his "analysis applies to strictly stationary state by design".[33] In fact, Ando observed that homogeneity between money and prices is assumed by construction, independently from realistic initial conditions and dynamic adjustment, and advanced an explicit consideration: "To suppose that the velocity is constant and unity per period under all circumstances is to assume away the essential problem of the role of money in an economy."[34]

The second issue concerns the microfoundation of the aggregate supply function that is at the heart of equilibrium business-cycle models. Essentially, Ando shows that this function cannot be obtained as an explicit aggregation of the individual optimal decision rules derived in Lucas' islands example. He also disputes the possibility of using the latter as a way to provide hints on the specification of the aggregate supply function. In fact, his response aims to counter "the claim by the new classical macroeconomists and equilibrium-business cycle theorists that their models are rigorously derived from the 'sound theoretical foundation' of the rational behaviour of individuals, whereas all other macroeconomic models are fatally flawed by partial reliance on arbitrary and *ad hoc* propositions".[35] As a matter of fact, he observes that the dynamic adjustments introduced into Sargent's aggregate representation of the model end up preserving *a priori* the short-run homogeneity between money and prices.

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32 A. Ando, "Equilibrium Business-Cycle Models: An Appraisal", in F.G. Adams and B.G. Hickman, *Global Econometrics. Essays in Honor of Lawrence R. Klein*, Cambridge, Mass., The MIT Press, 1983 (No. 81).

33 Ibid., p. 61.

34 Ibid., p. 48.

35 Ibid., p. 52.

The aftermath

These observations notwithstanding, as we know, in the United States in particular the prevailing response among academics was to distance themselves from large-scale macroeconomic modelling. At the same time, many interesting developments in the theory of economic policy took place in the 1980s and 1990s (from new discussions on rules and discretion, credibility and time inconsistency, flexible inflation targeting, and so on) as well as at the empirical level (with particularly noteworthy contributions such as those on vector autoregressions and cointegration analysis). For some time, academic progress actually appeared to be predominantly concerned with what once was considered the realm of "microeconomics". Given all this, I believe that it should be of no surprise that Ando left his notes on the foundations and empirical findings of the MPS model incomplete and unpublished.[36] It was not so much because he doubted the relevance of the work he had been engaged in, but most likely because of the perception that a different and more time-consuming approach would have been needed to keep pace with the new concepts and changes, even in language, taking place in the main academic economic centres at the time.

However, it is fair to ask ourselves what Albert's view of the developments in the theory and practice of macroeconomic modelling would have been. Indeed, a few years later a shift would take place, from the "new classical macroeconomics" of Lucas, Sargent and Barro to the models of the "real business cycle" of Kydland and Prescott to the "new Keynesian economics" of Mankiw, Rotemberg, Woodford and others. These shifts were obviously the consequence of major difficulties in allowing for intense business fluctuations, generated by the shocks of various kinds of "imperfections" in the real world that captured Ando's attention so keenly. At the turn of the century, the introduction of models of "dynamic and stochastic general equilibrium" seemed to be on the path towards replacing the large-scale econometric models still used by central banks, public institutions and international organisations, which were hard for anyone but insiders to master. However, the situation is such that several approaches now co-exist, and both small and medium-to-large DSGE models, with various degrees of complexities, intrinsic dynamics and free parameters, are used alongside the descendants of the large models Ando used to work with and compare.

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36 An issue of Economic Modelling was devoted to the presentation of the structure and properties of the Federal Reserve Board's MPS model, with the acknowledgment of the "substantial contribution made to this article by Albert Ando. [The authors] benefited from reading much of his published and unpublished work and from numerous discussions with him". See F. Brayton and E. Mauskopf, "The Federal Reserve Board MPS Quarterly Econometric Model of the US Economy", *Economic Modelling*, 2, 3, 1985.

My educated guess about his opinion of these developments in modelling, in particular with respect to the DSGE models, would be that Albert might most likely have questioned the indiscriminate adoption of the main assumption of these models, that all economic agents display rational behaviour (i.e. their continuous dynamic optimisation in a well-defined stochastic environment). He may also have been wary of a generalised use of the rational expectations hypothesis to describe the way economic agents anticipate the evolution of the variables they are interested in, without objecting outright, however, to the assumption that financial markets use available information as efficiently as possible. At the same time, he might have had sympathy for the introduction of stints of bounded rationality *à la* Simon and for some suggestions from the behavioural economics field. Most importantly, he would undoubtedly have strongly disputed the figure of the representative agent that is still widely used in these new macroeconomic models of, even if we must recognise that recent progress in allowing for a (nonlinear) world populated by heterogeneous agents has been made. Indeed, the heterogeneity of households and overlapping of generations in a life cycle were the starting point of much of the work initiated by Modigliani, Brumberg and Ando about seventy years ago.[37]

Ando's consulting at the Bank of Italy

As the interest in building or contributing to the construction of large-scale macroeconometric models was fading in the academic research centres, they continued to be a relevant tool for public institutions, central banks and international organisations. Besides their support in forecasting, this is a recognition of the role they may play in providing and incorporating qualified information, as well as institutional features, to aid policymaking. Experienced model builders, and Albert Ando was certainly a master among them, understood very well that models could only be considered rough approximations, a kind of "linearisation" of the complex, dynamic, possibly unstable interrelations that characterise the world, in all its political, social, real and financial dimensions.

Obviously, given the nature of the approximations and their inevitable theoretical and empirical weaknesses, a continuous and laborious process of trial and error, learning from mistakes and adapting to unforeseeable shocks and regime changes, is called for. This is why

37 For further thoughts on developments in macroeconomics and in modelling and possible reactions by Ando (and Modigliani), I would like to refer to section 4 of Visco, op. cit.

models are tools to be "used", not idols to be worshipped.[38] However, I believe that we simply cannot do without a quantitative modelling of the economy, even if we must acknowledge that this is a difficult process to be engaged in. Indeed, the operation and maintenance of macroeconometric models require a good deal of ingenuity as well as the availability of relevant technical and skilled human resources. Their use as a tool for improving our understanding of the way the "transmission mechanism" of monetary policy decisions works makes them particularly useful for central banks.

This was the reason for their continuous success in centres like the Federal Reserve as well as the Bank of Italy from the mid-1960s onwards, even in the face of possible, although perhaps at times dubious, "revolutions" in macroeconomics. Franco Modigliani was, at the time, "the" scientific advisor and external motivator of the initial attempts at model building in the Bank.[39] Albert Ando was very much a "key factor" in helping us to succeed in the process of creating and implementing the Bank of Italy's quarterly model (BIQM) in the mid-1980s. On this subject, it would suffice to simply peruse some of our writings of the time,[40] as well as the recollections of Albert's legacy to economic research at the Bank of Italy, which is the subject matter of the next chapter in this volume, by Sergio Nicoletti Altimari, Stefano Siviero and Daniele Terlizzese. Here I would like to advance only two considerations.

The first regards the modalities through which Ando was asked to advise the Bank on the major new project undertaken from 1983 to 1986 and that, having obviously undergone modifications and updates, still stands the test of time. It just so happened that, while in charge of following the domestic short-term price, wage and supply developments in the Research

38 If anything, I stick to the words that I used in the aftermath of the global crisis, which reflected many years of experience, work on and with quantitative models, and many discussions with Albert Ando, as well as with Larry Klein: "Prudent policy choices can only be made on the basis of evaluations of future conditions and trends. Economic policy necessarily requires models that can produce reasonably reliable forecasts; that can aggregate and organize large, diverse quantities of data; and that can promptly signal any deviation from the behaviour that prevailed in the past. In this regard, I am still convinced that an econometric model, if used intelligently and not mechanically, constitutes a precious tool for making quantitative evaluations" (in I. Visco, "The Financial Crisis and Economic Forecasts", *BIS Review*, 49, 2009. See in particular the last two sections of this article).

39 For a detailed account of Modigliani's contribution to the Bank of Italy's modelling activities of the time, which produced the so-called "M1BI" model, see G.M. Rey and P. Peluffo, *Dialogo tra un professore e la Banca d'Italia: Modigliani, Carli e Baffi*, Vallecchi, Firenze, 1995. See also the recent recollections by A.L.F. Fazio, *L'inflazione in Germania nel 1918-1923 e la crisi mondiale del 1929. Con una Prefazione e Giustificazione (Autobiografica)*, Treves, Noventa Padovana, 2022.

40 I. Visco et al. (eds.), "Modello trimestrale dell'economia italiana", Banca d'Italia, Temi di discussione (Working Papers), 80, 1986, 2 v.; G. Galli, D. Terlizzese and Ignazio Visco, "Un modello trimestrale per la previsione e la politica economica: le proprietà di breve e di lungo periodo del modello della Banca d'Italia", *Politica economica*, 5, 1, 1989; G. Galli, D. Terlizzese and I. Visco, "Short and Long Run Properties of the Bank of Italy Quarterly Econometric Model", *IFAC Proceedings Volumes*, 22, 5, 1989.

Department of the Bank of Italy, in 1981 I was eventually able to complete my dissertation on the analysis of survey-based inflation expectations at the University of Pennsylvania.[41] A year later I was put in charge of a team to build what would, in time, become the Bank of Italy's BIQM. To this end, I thought that a preliminary investigation of model building activities in Europe and in North America was necessary.

We were especially interested in the "state of the art" not only in macro modelling, but also, if not especially, in developments in software, data management and computer infrastructure. It turned out to be a very rewarding exercise.[42] Almost by chance, when I then returned to Philadelphia to talk with Klein and visit the Wharton Econometric Forecasting Associates organisation, where various Wharton models were being developed and the Link model, also originated by Klein, resided, I had a long discussion with Albert. At the time he was very much involved with responses to the attacks on "Keynesian" macro models, in particular those raised by Lucas and Sargent, which I touched upon in the previous section. In the meanwhile, he was still working with the staff of the Federal Reserve on applications and refinements to the MPS model related to the working of the "price-wage" block (the Phillips curve) and the fiscal-monetary "policy mix".[43] I thought that we could benefit from his experience as well as his continuous interest in computer and software developments and therefore invited him to come to Rome to exchange views with the Bank's Research Department involved in the new project.

To cut a long story short, Albert's one-off visit ended up turning into a progressive involvement in our modelling activities. His knowledge and his suggestions were very helpful in overcoming several initial difficulties, from numerical analysis to the organisation of the database, from software applications to the practice of dynamic simulations and forecasting, all fields in which important contributions and substantial progress were made. We took particular advantage of his periodic visits to the Research Department to improve the organisation of

41 The dissertation, which concerned the measurement, analysis and formation of inflation expectations, was submitted to the Graduate Faculties of the University of Pennsylvania in 1981, with Alberto Ando, Lawrence Klein and Roberto Mariano serving on the dissertation committee. It was later revised and published as I. Visco, *Price Expectations in Rising Inflation*, North Holland, Amsterdam, 1984.

42 See, for a summary of this investigation, I. Angeloni, G. Galli, B. Sitzia and I. Visco, "Note di discussione sullo stato dei modelli macroeconometrici", Servizio Studi, Banca d'Italia, mimeo, 13 ottobre 1982.

43 On the latter, see A. Ando, R. Anderson and J. Enzler, "Interaction between Fiscal and Monetary Policy and the Real Rate of Interest", *American Economic Review*, 74, 2, 1984 (No. 83). The former was the subject of a series of mimeos, finally published as A. Ando, F. Brayton and A. Kennickell, "Reappraisal of the Phillips Curve and Direct Effects of Money Supply on Inflation", in L.R. Klein (ed.), *Comparative Performance of U.S. Econometric Models*, New York, Oxford University Press, 1991 (No. 106).

our efforts, with the aim to make it a true collective enterprise benefitting from all the wide and substantial repository of know-how distributed throughout the Bank. To this end, his acquaintance with Antonio Fazio, the member of the Board who, at the time, was most closely following the activities of the Research Department was particularly useful, as it gave legitimacy and recognition to the whole process.[44]

The second consideration concerns some of the "theoretical underpinnings" still visible nowadays. I will mention only three of these issues that appeared at the time to be, and still are, particularly important. The first regards the consistency between short-term developments and the "steady state" equilibrium growth path. I briefly mentioned this in the preceding section but, as I recalled, it has been a long-standing requirement of both Modigliani's theoretical constructs and Ando's contributions, right back to Albert's doctoral dissertation. Some have identified this with the "apotheosis" of the so-called "neo-classical synthesis", insofar as the price flexibility in all markets was considered a necessary condition for the existence of such a "general" dynamic economic equilibrium.[45] I would rather emphasise the need to make the model structure consistent with what Ando considered necessary reference points and Klein called "well-documented long-run statistical properties of the economy."[46] Not only could the uniqueness and stability of such an equilibrium be up for debate, but also the usual workings of prices and markets would in any case be altered by changes in regime, be they for technological, demographic or institutional reasons.

The investigation into the stability properties of the model structure and of the economy that it represented was the second issue requiring our attention. Apart from the consistency of mark-up oligopolistic pricing with a competitive long-term equilibrium, the role that positive public debt plays in the assessment of the existence, multiplicity and stability of a possible equilibrium path for the economy was investigated. The essential role played by inflation dynamics and expectations was also strongly emphasised. This was indeed one of the main tenets of Ando's (and Modigliani's) views on the representation and controllability of a monetary

44 Antonio Fazio, who was, along with Guido Rey, in charge of the Bank's first econometric efforts, had met Ando when visiting MIT following Modigliani's and Samuelson's graduate lectures on monetary economics and economic theory, the latter being co-taught by Albert.

45 See O.J. Blanchard, "Neoclassical Synthesis", in S.N. Durlauf and L.E. Blume, *The New Palgrave Dictionary of Economics*, 2nd Edition, Palgrave Macmillan, London, 2008.

46 Klein, op. cit., p. 9. See also footnote 18.

economy such as that summarised by the MPS (and confirmed by the economic structure of the BIQM).[47]

A third point relates to the modelling of inflation expectations. In this, Albert cast a sympathetic eye on the efforts of relying on survey-measured expectations to complement the impact of price indexation, via the "scala mobile", on the determination of wages in the Italian economy in the 1970s and 1980s.[48] As I have observed, while he was hesitant *a priori* to consider the possibility of "rational" expectations, even if separately from the notion of equilibrium business cycles introduced by the new classical macroeconomics of Lucas and Sargent, he thought, as did Modigliani, that efforts to fully and rapidly adjust to new information were better suited to modelling the workings of financial markets rather than, say, labour markets. In the latter case, adaptive-regressive specifications such as the ones characterising the survey expectations collected in Italy at the time seemed to add to the difficulties experienced in stabilising the economy.

Some personal recollections

The objective of these pages has not been to produce an overall evaluation of Albert Ando's contributions to the advancement of theoretical and empirical economics. Indeed, I have not even mentioned many of his works and proposals on a wide range of subjects. Among these, especially noteworthy are: the use, with Gordon Kaufman, of Bayesian techniques for the estimation and testing of economic relations; some original applications, with Alfred Norman and Carl Palash, of optimal control to large-scale econometric models; the analyses and suggestions related to the working of the U.S. Tax System advanced, *inter alia*, with Edgar

47 See, for the latter, Galli, Terlizzese and Visco, op. cit. On issues related to the stability of the MPS model (called "FRB" model in the version "maintained at the time at the Board of Governors of the Federal Reserve System), see A. Ando, "Comments on Federal Reserve Board Model Results Contained in the Appendix to the Klein-Adams Paper", in L.R. Klein (ed.), *Comparative Performance of U.S. Econometric Models*, Oxford University Press, New York, 1991, pp. 57-60 (No. 105). See also, in the same volume, the results described in I. Visco, "A New Round of U.S. Model Comparisons: A Limited Appraisal", and the conclusion that in response to shocks "the model tends to generate moderately unstable cyclical trajectories with long periodicity if monetary policy is defined as a fixed path for a monetary aggregate. Some type of countercyclical policy rule is needed, therefore, to keep the economy from eventually experiencing serious recessions or inflation" in Ando, Brayton and Kennickell, op. cit., p. 220 (No. 106). For an attempt at specifying a "realistic" reaction function of monetary policy within the MPS model, see R. Anderson and J.J. Enzler, "Toward a Realistic Policy Design: Policy Reaction Functions that Rely on Economic Forecasts", in Dornbusch, Fischer and Bossons (eds.), op. cit.

48 See G. Bodo and I. Visco, "La disoccupazione in Italia: un'analisi con il modello econometrico della Banca d'Italia", Banca d'Italia, *Contributi all'analisi economica*, 3, 1987, where the BIQM wage equation is discussed (derived from I. Visco, "Inflation Expectations: The Use of Survey Data in the Analysis of their Formation and Effects on Wage Changes", OECD Workshop on Price Dynamics and Economic Policy, mimeo, Paris, September 1984).

Cary Brown and Irwin Friend; the papers, with Alan Auerbach, on the corporate cost of capital in the U.S. and Japan. I have aimed, instead, to simply provide my own evaluation of his work and of the man and economist as I knew him.

Albert was indeed as much a man of culture as he was a dedicated researcher, with a very wide range of interests. They covered the working of the political cycle and long-term distributional implications of fiscal policy, developments in pure mathematics and advances in computer science, new contributions in literature, and a particular passion for the opera. He was also a man of high principles, contributing to several cultural initiatives, using the fees earnt from his lectures and consultancy to finance the dissertations of students who worked as assistants on his research endeavours or to purchase new computer equipment to ameliorate his office operations.

However, he was not an easy scholar to confront, he was not ready to mediate or compromise, his professional standards were very demanding, and he was at times rather difficult to follow. Those who had him as a teacher were often struck by what seemed to be a poorly organised use of his set of notes or a very tentative, and constantly evolving, list of reading material. Still, he was open to engaging in discussion with younger and less experienced colleagues, generous in counselling doctoral candidates and ready to support those he thought worthy of help in their efforts to produce relevant contributions on a wide range of topics. All this is well summarised by Nobuhiro Kiyotaki and Kenneth West, in one of the chapters of the book edited by Klein in memory of Ando: "[his] generosity of spirit was complemented by a keen mind and seemingly boundless energy… [his work] was theoretically rigorous, policy relevant, and scrupulous with data… [his] high standard remains a goal that we … aim to achieve."[49]

To conclude, then, in spite of his at times complex nature, Ando became a friend and a mentor for many students and colleagues "from his native Japan, adopted USA and Europe (especially 'adopted' Italy)."[50] For those of us who were lucky enough to share moments of our lives with him, outside those linked to our professional duties, memories of his storytelling, his cooking ability (foremost, but not limited to, Japanese cuisine), his family attachment, his interest in Italian culture, and his gratitude to the generosity of Padre Arrupe's Jesuits in WW2-devastated Japan, will stay with us forever.

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49 N. Kiyotaki and K.D. West, "Land Prices and Business Fixed Investment in Japan", in L.R. Klein, *Long-run Growth and Short-run Stabilization*, op. cit., p. 305.

50 Ibid., p. ix.

I remember his words of grief well when his former teacher Herbert Simon died. He told me how important it had been for him to have visited his former student Steve Goldfeld sometime before his death. I myself was glad, although of course also very sad, to see him in Philadelphia a few days before his own passing. In spite of being very weak, he was still able to communicate, and willing to do so, even though it came at great physical cost to him. We exchanged expressions of gratitude, as well as some memories. And he told me, at the end, that he had greatly enjoyed and had found it very rewarding working with various generations of young (and, by now, less young...) Bank of Italy economists, after that autumn of 1982 when I was able to convince him to come to Rome for a "short" visit. He concluded with a dream: walking through the streets of old Rome with an Italian ice cream in his hand. There seems to be so little of Albert in this dream, and yet really there is so much!

I remember that he insisted with me and with his elder son Matthew that a message be sent to a rather long list of friends and colleagues that included some unexpected names. The message was simple and to the point. It seems to me a fitting way to conclude this introduction to the tribute to Albert Ando offered by the Bank of Italy on the twentieth anniversary of his death:

Message to friends and colleagues: Wednesday, 18 September 2002

Object: From Albert Ando

My dear friends, especially those who have communicated with me in the last few days, I am sorry that I have not responded because my physical disability proceeded so quickly.

I have appreciated your friendship and occasional heated arguments. I hope everyone will continue in the same spirit in the future.

Sincerely,

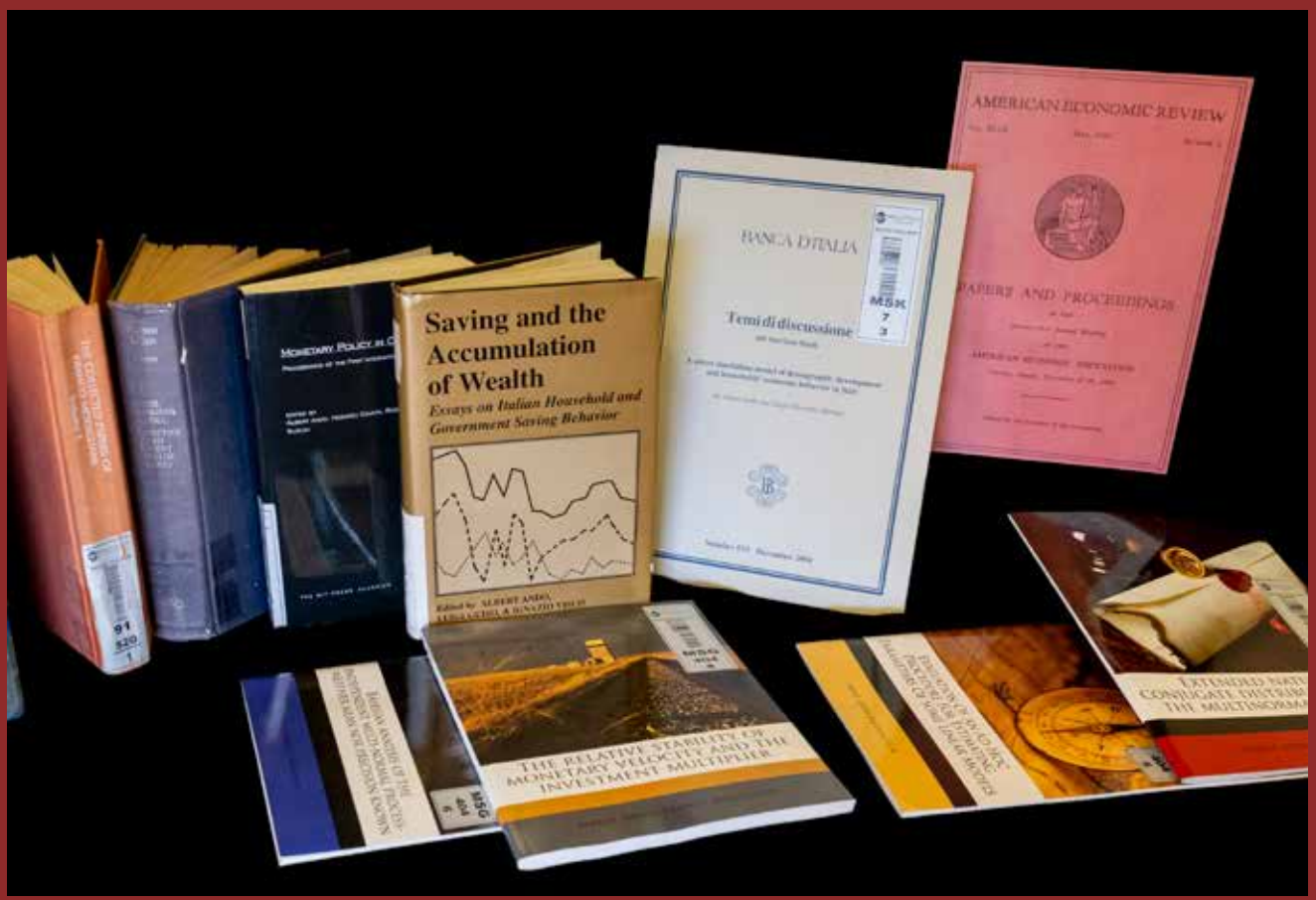
Albert Ando

Ignazio Visco

Rome, December 2022

Albert Ando's legacy to economic research at the Bank of Italy

Sergio Nicoletti Altimari, Stefano Siviero and Daniele Terlizzese



Albert Ando's legacy to economic research at the Bank of Italy[1]

When discussing one of Albert Ando's papers, Robert Solow started by saying: "This is a very Albert sort of paper".[2] This quote captures the distinctive, and yet hard to define, peculiarity of Ando's approach to economics perfectly: a mixture of theoretical consistency and flexible pragmatism, of abstraction and attention to institutional details, of disciplinary orthodoxy and thinking outside the box.[3] Throughout two decades of interactions, Ando's peculiar, quite unique approach shaped the work on modelling at the Bank of Italy and more generally how the Bank's economists conducted their research. This, we believe, is Albert Ando's true legacy. We were scarcely aware that we had absorbed it very early on in our career as economists, as PhD students or as fresh recruits to the Bank of Italy's economic research department (which in those days was called the 'Servizio Studi'). With the passing of time, we saw it embodied in the models that were built and used, as well as in the analyses supporting policy decisions. It is with gratitude, therefore, that in what follows we revisit Albert's contribution to economic research and analysis at the Bank of Italy.

1. Albert Ando and the Bank of Italy

While Albert Ando's contribution spanned a wide range of areas, it was of paramount importance in the field of modelling, and more specifically macro-econometric modelling. For about twenty years, the Bank of Italy's (main) macroeconomic model was the focus of Albert's constant attention, suggestions and criticisms, improving under his wise guidance. We will shortly describe how the Bank's quarterly econometric model (henceforth, BIQM) reflects Albert's vision of the working of the economy and his peculiar mix of rigour and flexibility.

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1 We would like to thank Filippo Altissimo, Michele Caivano and Ignazio Visco for their helpful comments on a previous version of this paper.

2 See R. Solow, 'Comments on Ando and Kennickell (1987)', in R. Dornbush, S. Fischer and J. Bossons, *Macroeconomics and Finance. Essays in Honor of Franco Modigliani*, Cambridge, MA, The MIT Press, 1987, p. 224.

3 The lines that follow Solow's quote above make similar points: "It combines vast industry with a no-nonsense approach to the data. It makes no attempt to wish away damage to received ideas."

Before we do that, let us briefly retrace the history of econometric modelling at the Bank of Italy and how Albert came into the picture.

Experimenting with econometric modelling at the Bank of Italy dates back to the early 1960s, when Antonio Fazio, later to become Governor, visited MIT, where both Franco Modigliani and Albert Ando were teaching at that time; upon his return to Rome, Fazio contributed to developing the Bank's first econometric tools.[4] It would be improper to call those tools a 'model', for several reasons.[5] While a number of equations were indeed estimated, they were, so to speak, unconnected to one another, as several of the equations and identities needed to 'close' the model were missing. Furthermore, the rudimentary software then available at the Bank did not allow the model to be simulated, making it impossible to use it for forecasting and policy analysis.

In the late 1960s, a first 'full' model was put together (dubbed M1BI),[6] followed in 1979 by a new version, M2BI.[7] Both models benefited from the collaboration of Franco Modigliani. While M1BI and M2BI were fully specified models, the software then available was still preventing them from being simulated, and hence their usefulness for forecasting and policy analysis was limited.

Reflecting changes in the structure of the Italian economy, progress in computing power and software, improvements in the availability of statistics and advances in econometrics, in the early 1980s, the Bank's senior management asked Ignazio Visco, who had earned his PhD from the University of Pennsylvania under the supervision of Ando and Larry Klein, to head a team tasked with the construction of a new model. Visco accepted the challenge, but insisted on having Ando (who had recent experience in the building of the MIT-Pennsylvania-Social Science Research Council (MPS) model for the US economy, used by the Federal Reserve

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4 The first partial econometric model of the Italian economy was developed in 1964 and refined in the following years. Guido Rey and Paolo Peluffo offer an interesting insider's view of the interaction between Franco Modigliani and the then Governor Guido Carli, Director General Paolo Baffi and members of the economic research department, as they moulded the Bank's econometric toolbox according to its decision-making needs; see G.M. Rey and P. Peluffo, eds., *Dialogo tra un professore e la Banca d'Italia*, Florence, Vallecchi, 1995.

5 As remarked by Luigi Guiso, the rudimentary nature of that first econometric tool was largely the inevitable result of very limited computing power. The bulky mainframes available back then were several thousand times less powerful than any of today's smartphones. The whole process of running a single regression took hours if not days. This, as Guiso puts is, was at least a 'strong deterrent against data mining'. See L. Guiso 'La funzione del consumo nei modelli econometrici della Banca d'Italia. Passato, presente e un po' di futuro', in *Ricerche quantitative per la politica economica 1993*, Rome, Banca d'Italia, 1993.

6 See Banca d'Italia, *Un modello econometrico dell'economia italiana (M1BI)*, Rome, Banca d'Italia, 1970.

7 See A. Fazio and B. Sitzia, *The Quarterly Econometric Model of the Bank of Italy. Structure and Policy Applications*, Rome, Banca d'Italia, 1979.

Board) on board as a consultant. Besides his specific expertise in modelling issues, Visco counted on Ando's academic reputation and personal acquaintance with Antonio Fazio – who was a member of the Bank of Italy's Board at that time, then chaired by Governor Ciampi, but still very much interested in the activities of the research department – to smooth out any possible conflicts in resource allocation that setting up a new team would likely involve.

The modelling group was indeed composite, including both a small 'core' team of full-time modellers and a larger number of economists from several different units of the research department, working part-time on the model. This choice, though more complex from a managerial viewpoint, meant that knowledge of the model structure, its potential uses, as well as its limits, was not confined to a close group of econometricians working 'under the hood', but instead became widespread in the research department. Rather than being a somewhat mysterious tool run by a clique, the model therefore 'belonged to' and was trusted by the entire department.

This approach survived the initial build-up phase, which was largely completed by 1986;[8] over the years, several generations of economists have developed confidence in the model, appreciating what it could and could not do. The model has been widely used, not only for forecasting but also for policy analyses that, had the model building been confined to a specialised group of econometricians, would arguably have been carried out with other ad hoc tools.[9]

More importantly from our viewpoint, the partially decentralised organisation of modelling activities meant that Albert Ando ended up interacting with almost all the economists who worked in the research department in the 1980s and 1990s.

Until the advent of internet and email – which happened at the Bank of Italy in the mid-90s[10] – most of the interactions occurred mainly by fax: not unfrequently, one of us would

8 See I. Visco, 'In memory of Albert Ando, an introduction,' in this volume; I. Visco et al. (eds.), 'Modello trimestrale dell'economia italiana', Banca d'Italia, Temi di discussione (Working Papers), 80, 1986, 2 v.; G. Galli, D. Terlizzese and I. Visco, 'Un modello trimestrale per la previsione e la politica economica: le proprietà di breve e di lungo periodo del modello della Banca d'Italia', *Politica Economica*, 5, 3-52, 1989.

9 Indeed, if we were to list the policy analysis notes and the research papers that have been written based on the work carried out with the BIQM, such a list would extend over many pages.

10 In fact, the core group of econometricians in charge of the model had been given access to internet and e-mail, on an experimental basis and on dedicated (and isolated) computers, at the beginning of the 1990s. Soon afterwards, some hackers left threatening messages in the group's inbox. Although there was no real breach of security and no access to the Bank's internal network, the Bank's senior management became extremely worried about possible reputational concerns, and the availability of internet and e-mails was immediately withdrawn. It ended up being postponed altogether for a few years. Albert was incensed by this development, but not even his vibrant protests were enough to reverse the decision.

receive lengthy fax messages – sometimes even more than one per day – in which Albert worked out the details of the functioning of this or that block of the model, or elaborated on the philosophy underlying its main mechanisms, with his characteristic style, rich in details, involved and incredibly insightful. These communications, while disorganised and far from organic, provide a comprehensive view of Albert's thinking about the functioning of the economy and its modelling, all the way from the full picture to the tiniest little detail.

While faxes and, in due time, emails made it possible for Albert to contribute to the modelling activities on an almost daily basis, the highlights of his consultancy were his visits, typically twice a year, which were a very effective disciplining device. Although the work on the model during the build-up phase was constant and intense, the anticipation of one of Albert's visits meant a further, often frantic stepping-up of the efforts. These were directed to documenting the work done since his last visit, refurbishing the model as much as possible, and more generally showing that no energy had been spared in the endeavour to incorporate his suggestions. Moreover, his visits meant that the whole modelling team, and a fortiori its core, was basically on call 24/7 for one or two weeks in a row.[11] Albert would sit in an empty office and summon all the modellers one after the other, delving into the details of their work, filling page upon page with formulae, often resorting to numerical calculations by hand (in the end, he trusted paper and pencil more than anything else, despite being an unmatched fan of electronic computing, as we recount elsewhere in this note). He was never fully satisfied with the results achieved (at times, he could be very vocal in expressing his dissent; on those occasions, his voice could be heard at a considerable distance), and constantly thought of ways to further improve on them. At other times, he would instal himself in the computer room – a room with five or six terminals, connected to the mainframe, in which the core group of econometricians often worked together, side by side – and simultaneously directed the work of various small teams, asking one to run a simulation of specific model blocks, instructing another to try an endless stream of ingenious estimation tricks on a particularly uncooperative equation, and commanding yet another to explore the reasons underlying identities that did not match. Days were long and often extended over dinner and beyond. At the end of these visits, everyone needed a few days' rest to recover, except perhaps Albert himself, who never looked tired. Yet a lot was accomplished in those weeks: although the modelling work progressed almost daily,

11 One of the authors of these notes had mistakenly planned his wedding just before one of Albert's visits. As a result, he had to cut short the fifteen days of holiday that the generous Italian legislation allows for honeymoons to just one day. His wife, although fond of Albert, complains about it to this day.

those visits no doubt led to major leaps forward. Even so, no matter how much had been accomplished during his visit, on the day before his departure, Albert would assign yet more homework to everyone. He was a seemingly inexhaustible source of new ideas.[12]

2. Albert's footprint[13] in the Bank of Italy Quarterly Model

Albert had strongly-held ideas about the functioning of modern market economies. One of these was that, in agreement with Lawrence Klein and Richard Kosobud's seminal contribution,[14] over a sufficiently long period, one could observe some reasonably constant 'great ratios' in these economies, such as the household saving rate, the wage share of national income and the capital-output ratio. These statistical constructs could be different in different economies, but they tended to be stable over time in any given economy, when abstracting from short-term fluctuations. Moreover, in those cases in which a secular trend could be discerned, technological evolution of some kind or demographic changes were often the underlying cause. Another of Albert's tenets was that, although the general equilibrium of the economic interactions implied that in theory almost everything depended on everything else, in practice the economy decomposes into block-recursive sub-systems, with the interactions being strong inside each block, but relatively weak and hierarchical among blocks.[15] A third deep-rooted idea was that technological progress was slowly reflected in the working of the economy, as new machines, embodying the new technology, replaced old ones when the latter reached the end of their economic life, but not before then.

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12 Though working with Albert was intense and demanding, it was also fun, as he was, in his own understated, tongue-in-cheek way, a humorous man. He had many funny anecdotes to share: for example, on a visit to explore a hiring opportunity, he accompanied John Muth to a meeting with the department chair at MIT, an old-style industrial economist who asked Muth what a firm was, in his opinion. When Muth drily replied that a firm is a subset of a Hilbert space, Albert knew that this was not the answer the other man expected, and tried to lighten the mood by jokingly adding: "Well, Jack, for greater generality you might as well have said that a firm is a subset of a Banach space". To which, according to Albert, Muth grumpily replied: "Albert, I was just trying to be practical!"

13 Albert's footprint was disproportionately large in the literal sense, as he suffered from gout and wore oversize shoes. Those black, always shiny, big shoes, dangerously sticking out from the side of the motorbike as some of us drove him through Rome's narrow alleys, are one of the cherished little memories of the years we spent with Albert.

14 See Klein, L.R., and R.F. Kosobud, 'Some Econometrics of Growth: Great Ratios of Economics,' *The Quarterly Journal of Economics*, 75(2), 173-198, 1971.

15 The decomposability of complex dynamic systems into smaller, more manageable sub-systems was among the issues that Albert tackled early on in his career. The papers collected in the book edited by Albert Ando, Franklin Fisher and Herbert Simon in 1963 derive a number of very important (and in our view still insufficiently influential) results pertaining to the analysis of decomposable dynamic system; see A. Ando, F.M. Fisher and H.A. Simon, eds., *Essays on the Structure of Social Science Models*, Cambridge, MA, The MIT Press, 1963 (No. 19).

He also had strong views on the methodological aspects of model building. One of these was a pragmatic insistence on a theoretical framework underlying the behaviour represented by the various equations. By 'pragmatic insistence' we mean that he would never accept a totally data-driven specification – he would never deem an econometric equation whose theory had not been spelled out in detail as acceptable – but at the same time he was not a 'religious fanatic' about it, as he considered a theory to be a benchmark, not a straightjacket. He was deeply wary of the unrealistic constraints imposed by postulating an omniscient, continuously optimising representative agent. He allowed for a certain leeway, reflecting the often fuzzy link between the theory and the empirics.

Another characteristic feature of Albert's methodological approach was his willingness to include data on realistic expectations obtained from surveys,[16] but also to explore the steady-state implications of the hypothesis of rational (meaning model-consistent) expectations.

A third view was that the solid skeleton of a well-specified model is provided by the various accounting identities and equilibrium conditions that link the variables in the system. He often insisted that getting identities and budget constraints right was more important for the proper functioning of the model than specifying a satisfactory behavioural equation.

All these ideas, and many others which we do not have the time to go into, are reflected in the BIQM.

In the absence of shocks and when all the short-term adjustment processes have run their course, the BIQM converges to a well-defined balanced-growth path in which expectations are fulfilled, all real variables grow at the same rate (given by the sum of the growth rates of population and productivity, both exogenous), relative prices are constant and therefore all of Albert's cherished 'great ratios' are constant.[17] The model included the full flow of funds in the economy, and had a fairly detailed description of financial decisions. However, consistently with a near block-recursive structure, the main drivers of the dynamics were real decisions, while the feedback effect of financial decisions on the real ones was relatively weak.[18] The capital stock

16 This point was also one of Ignazio Visco's methodological tenets.

17 A large part of the PhD dissertation that one of the authors of this article wrote under the supervision of Albert is devoted to recovering the 'great ratios' that the model would generate in different steady-growth paths. See S. Siviero, *Deterministic and Stochastic Algorithms for Stabilization Policies with Large-Size Econometric Models*, unpublished PhD dissertation, Philadelphia, University of Pennsylvania, 1995.

18 This feature, which characterised most models of that generation, was partly amended by the revamping that took place in a hurry at the start of the great financial crisis of 2008-9, when it became clear that certain phenomena could not be properly mapped without a description of the various two-way feedback mechanisms that link real and financial variables.

was (and still is) 'putty-clay' – malleable when the new investment is made but rigid once the new machines have been put to work – and the vintage structure in the accumulation of capital is fully consistent with the dynamics of potential output.

The model has about 750 equations; of these, about 100 are behavioural – i.e. they describe the agents' behaviour determining the corresponding endogenous variables – another 60 are technical or purely statistical relationships, endogenising less important variables; the rest, about 580, are accounting identities and equilibrium conditions. Clearly, the latter are a key component in the model structure.

Both households – in their roles as consumers, savers, financial investors and labour suppliers – and firms – in their roles as producers, labour demanders, investors, price setters and exporters – are 'rational', given their expectations, liquidity constraints, transaction costs and the like, and are assumed to solve optimisation problems. The theoretical framework, however, is not pursued to the point of considering a single optimisation problem for each type of agent, which would imply cross-equation restrictions on the estimated coefficients, and therefore the simultaneous estimation of the whole model. Instead, preference is given to incorporating institutional details and empirically relevant adjustment mechanisms (the 'free parameters') into the various equations, which are estimated separately. Achieving the appropriate balance between full theoretical consistency – which would increase the efficiency of the estimation, but would be more susceptible to the risk of widespread misspecification – and empirical accuracy – which allows institutional details relevant for policy analysis to be taken into account, but might rely on dubious identification assumptions – is arguably more art than science, and we were lucky to be helped in the BIQM by an 'artisan' as good as Albert Ando was.

In fact, besides the model specification, Albert's guidance was essential for using the model in forecasting. He taught us to combine the model simulations with soft information about the economy and its outlook that, at each point in time, is available but difficult to encode in the estimated equations. This involves a delicate balancing act in order to prevent the subjective adjustments introduced in the model from disrupting the carefully designed equilibrium properties that discipline the model specification.[19] Once again, Albert's key lesson

19 For a taxonomy of these adjustments and an analysis of their impact on the short- and long-term properties of estimated equations see S. Siviero and D. Terlizzese, 'Macroeconomic Forecasting: Debunking a Few Old Wives' Tales,' *Journal of Business Cycle Measurement and Analysis*, 3(3), 287-316, 2007.

was to avoid naïve and uncritical reliance on a theoretical construct, no matter how carefully put together, and to be ready to adjust it to relevant new information: after helping us to build the 'machine', Albert gave us an intensive course on 'how to drive it'.[20]

3. Albert's footprint beyond the Quarterly Model

The work on the BIQM was not confined to the specification and estimation of the model's equations and identities. A very important, if seemingly obscure and less glamorous part, was the building of a complete and well-organised quarterly database (with about 4,000 variables, each one with easily accessible metadata), and the development of a new software, building on the version that had been created by the Federal Reserve, starting from the computing package developed by the Speakeasy Corporation. This very user-friendly and powerful software had its estimation and simulation capabilities considerably expanded by work conducted inside the Bank of Italy since 1976 under the guidance of Ignazio Visco, together with colleagues from the research department (Ufficio Studi) of Banca Commerciale Italiana (Comit), headed by Vittorio Conti.[21]

Both the construction of the database and the development of the software to estimate and run the model were only possible thanks to the technological progress in the computer industry. Albert was a very early admirer of this and arguably perceived, before many others, what the ongoing revolution in the information and communication technology meant, and what its potential future developments were.

Indeed, Albert had been a very early fan of the ICT revolution and had an intuition of what it could have in store, particularly as regards modelling and simulation tasks. Throughout his career, he took a strong interest in all facets of electronic computing; his focus was mainly on algorithms and related software,[22] but his incursions into the realm of hardware were not

20 During the forecast exercises, the need to incorporate pieces of information not considered in the estimation has also been a tool for cross-validating the model specification and, at times, has suggested adjustments to reflect changes in the underlying structure of the economy that the model is supposed to mimic.

21 In particular, Flavio Capra and Sergio Calliari for Comit and Andrea Cividini for the Bank of Italy.

22 The time required to run model simulations improved dramatically between 1980 and 2000, also thanks to the adoption of more efficient algorithms for model solutions; it was Albert that pushed for adopting a particularly efficient combination of Gauss-Seidel and Newton-Raphson methods for the solution of large linear systems, originally championed by Manfred Gilli and Henk Don, among others.

infrequent either.[23] Generally speaking, he was alert to everything new that was on offer, and eager to try any new solutions that would enable him, and us, to shorten computing times and rely on a richer and more reliable toolbox.

At about the same time as he started cooperating with the Bank, he became part of a National Science Foundation (NSF) committee that advised the NSF while it was setting up the NSFNET[24] and a collection of national supercomputer centres (Princeton, Cornell, Carnegie, Urbana-Champaign, and San Diego).

At the Bank, Albert was always very demanding about the possibility of taking advantage of new technological breakthroughs, and pushed (some would say nagged…) the Bank's computer people at least as much as he did the economists. He kept insisting, both at technical level and in his relationship with the Bank's senior management, that the latest computing tools be adopted as quickly as possible. Nothing could make him more intractable than feeling that the Bank's toolbox was falling behind the technological curve (we have already mentioned Albert's disappointment over the delays in adopting an efficient electronic mail system). Even though he did not always get what he wanted, there is little doubt that his constant pressure was instrumental in keeping the Bank's IT equipment and, more generally, its technological culture up to date.

Besides the construction of the database for the quarterly model, Albert played a somewhat indirect but nonetheless important role in the development of the micro-level database available at the Bank. He was aware, before many others, of the need for micro-data in order to better understand and validate macro relationships and to conduct policy-relevant analyses (see below). He therefore kept a watchful eye on the various surveys conducted by the Bank, and offered suggestions on the details for data collection and storage.[25]

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23 Albert was an early supporter of abandoning bulky mainframes and adopting more agile workstations; his soft spot for the latter hardware solution most likely reflected his preference for a technological set-up that would render the modelling group virtually self-sufficient.

24 The NSFNET was a 'program of coordinated, evolving projects sponsored by the National Science Foundation (NSF) from 1985 to 1995 to promote advanced research and education networking in the United States.[…] Initially created to link researchers to the NSF-funded supercomputing centers, […] it developed into a major part of the Internet backbone. The National Science Foundation permitted only government agencies and universities to use the network until 1989 when the first commercial Internet service provider emerged. By 1991, the NSF removed access restrictions and the commercial ISP business grew rapidly' (from Wikipedia). Albert was the only economist on a committee that mostly included computer experts, physicists and mathematicians, probably in recognition of his early intuition of how useful and powerful it would be to link computers to one another, already included in his work with Herbert Simon. This link paved the way for the momentous development of the World Wide Web as we now know it.

25 He was very vocal when the person in charge of one of the surveys conducted by the Bank, faced with data-storage constraints, decided to drop some of the variables surveyed, including age. After Albert's complaints, the responsibility for managing the surveys was given to a professional statistician.

3.1. The microsimulation model

The microsimulation model of households' economic behaviour, developed at the Bank of Italy during the 1990s, is another example of Albert's relentless efforts in matching theoretical rigour with strong empirical and data-driven evidence. In the early 1960s, his seminal work with Franco Modigliani had greatly contributed to the success of the life-cycle theory, perhaps one of the most enduring accomplishments of the economic profession. Albert, however, was never completely satisfied with the simple, streamlined version of that theory. In its basic formulation, the theory predicts that the aggregate savings rate of a society is mainly a reflection of its age structure.[26] As he used to stress, however, when looking at micro-data, many characteristics of individuals (other than age) matter. In particular, the structure of the household they belong to (e.g. whether the individual is single or member of a family with children, whether the household includes multiple income earners and so on) is key to understanding their planning horizon and economic decisions. Moreover, the distribution of income and wealth in society may influence aggregate consumption and savings. In other words, the heterogeneity of households has to be fully factored into any realistic economic analysis.

On these topics, by using the Italian data collected through the Bank of Italy's 'Survey on Households, Income and Wealth', and comparing them with the results obtained on Japanese data, Albert helped to sharpen our understanding of the saving behaviour of the young and dissaving by the elderly, formulating theories to rationalise apparent anomalies and carefully analysing the micro-data available.[27]

Albert saw that the increasing availability of survey data and the exponential increase in computing power provided the opportunity to tackle the problem at its root, by directly modelling behavioural choices at a highly disaggregated level. As part of this line of research, he launched and supervised the building of the microsimulation model for Italian households at the Bank of Italy.

The project entailed constructing a very large sample of individuals and households directly derived from survey data – using several waves of the Survey of Household Income

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26 See A. Ando and A.B. Kennickell, 'How Much (or Little) Life Cycle Is There in Micro Data? The Cases of the United Stated and Japan', in Dornbusch, Fischer and Bossons, op. cit. (No. 95).

27 See A. Ando, L. Guiso and I. Visco, *Saving and the Accumulation of Wealth: Essays on Italian Household and Government Saving Behavior*, Cambridge-New York-Melbourne, Cambridge University Press, 1994 (No. 119). The book collects the papers presented at a conference, held at the Bank of Italy in 1992, that Albert helped to organise.

and Wealth conducted by the Bank of Italy – by means of re-sampling techniques. A direct link from micro to macro data was then derived by adjusting the demographic characteristics of the sample to match the corresponding characteristics of the entire population and rescaling the observed economic data (income, consumption and so on) in order to make their aggregate values consistent with the national accounts. In this way, the final data replicated the Italian population and Italy's main macroeconomic aggregates, while preserving the distribution across households and individuals as in the original survey.

A demographic model was then constructed, capable of simulating the evolution of the population in several dimensions, including the creation, destruction, size and other relevant characteristics of households and their members. Finally, the demographic model was combined with a specification of the processes generating the income, wealth, consumption and retirement behaviour of households, along the lines of the life-cycle theory.

The resulting microsimulation model could then be used to study the relationship between the demographic structure and the saving rate as the result of the aggregated behaviour of heterogeneous households. It was also used to analyse a variety of policy-relevant questions, such as the impact of changes in the tax or social security systems.[28] The project was extremely ambitious and Albert devoted much of his last years to it, with his usual passion and ability to extract the best from his collaborators, who learned and grew professionally during their many interactions with him.

4. Summing up: Albert's legacy at the Bank of Italy

Albert's legacy to the Bank of Italy's research department is still visible in many ways, despite the fact that, since his death twenty years ago, many things have changed and several generations of economists, with different academic backgrounds, mindsets and toolkits, have come and gone.

To start with, the models he contributed to building are still in use.

Not only has the skeleton of the BIQM remained very much the same as it was at the time of Albert's death, but the 'philosophy' that drives its revisions (it has been and keeps on

28 See A. Ando and S. Nicoletti Altimari, 'A Micro Simulation Model of Demographic Development and Households' Economic Behavior in Italy,' Banca d'Italia, Temi di discussione (Working Papers), 533, 2004 (No. 139).

being revised, if only to reflect the changing institutional landscape[29]), has also resisted over time. Economic theory must guide one's modelling choices, but as a benchmark rather than as a straightjacket. The data must be allowed to speak (though not 'by themselves', as would be the case in purely statistical models), and knowledge of institutional details is as important as knowledge of the latest theoretical or econometric development. In short, today's BIQM[30] still very much carries the footprints of the joint efforts of Albert Ando and Ignazio Visco and, like the ship of Theseus, remains basically the same, despite the incessant passing of time and the replacement of this or that piece.

The work on the microsimulation model spurred a number of similar initiatives aimed at systematically exploiting the richness of micro-data. A number of tools that are still routinely used at the Bank took direct inspiration from Albert's original ideas.

More generally, a sort of reverential respect for data is a pervasive feature of the way economic analysis and research are carried out at the Bank of Italy.[31] This is so ingrained in the way the Bank's economists work that it is actually hard to say whether it reflects Albert's legacy, or whether it was there before Albert started consulting at the Bank, and it was one of the reasons why he, and not somebody else, was approached in the first place. Whatever the case, we believe that the Bank of Italy's research department (the Economics, Statistics and Research Directorate General, as it is now called) remains in part, even twenty years after Albert's death, 'a very Albert sort of department.'

Sergio Nicoletti Altimari, Stefano Siviero, Daniele Terlizzese

Rome, December 2022

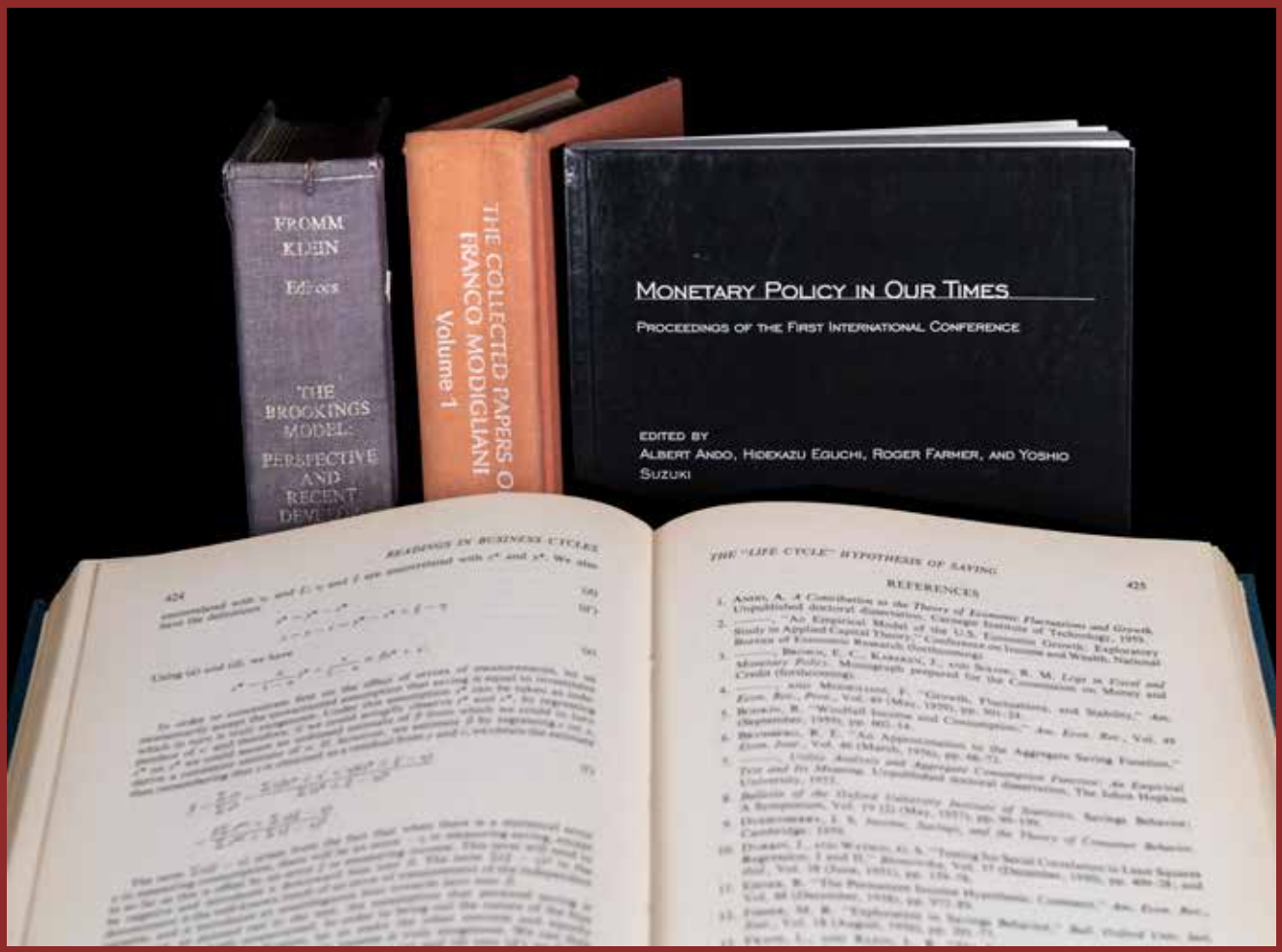
29 To mention just the most prominent example, the introduction of the single monetary policy in the euro area in 1999.

30 See G. Bulligan, F. Busetti, M. Caivano, P. Cova, D. Fantino, A. Locarno and L. Rodano, 'The Bank of Italy Econometric Model: an Update of the Main Equations and Model Elasticities', Banca d'Italia, Temi di discussione (Working Papers), 1130, 2017.

31 So much so that the department's motto could easily be William E. Deming's famous sentence: 'In God we trust; all others must bring data.'

Note to the reader

Rosanna Visca



Note to the reader

The work that follows is the fruit of a survey conducted to produce a systematic, analytical bibliography of Albert Ando's works, published over a span of more than five decades. It is based on a previous version, prepared for '*Macroeconomics after the (financial) flood. Conference in memory of Albert Ando (1929-2002)*', the event organised by the Bank of Italy in Rome, on 18 December 2012, to give the participants an overview of the economist's intellectual legacy. Ten years later, the bibliography is presented again with some additions and new photos, to commemorate Albert Ando on the twentieth anniversary of his death.

While not claiming to be exhaustive, this work follows certain bibliographical criteria.[1] The organisation and description of the material conform to the guidelines set out below.

Guidelines

The sources

Albert Ando was an adviser to the Bank for two decades, from 1982 to 2002. The starting point of this survey was therefore set of writings held in the collection of the Paolo Baffi Library at the Bank of Italy. This core body has been steadily supplemented by later works held at other libraries, research centres, central banks, international financial institutions and organisations, listed in electronic catalogues and databases, or directly available online. Each bibliographic description is based on the analysis of the original sources found both in the collections of the Library of the Bank of Italy and those held somewhere else. Some works containing valuable sources of information for our research are mentioned in the note below.[2]

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1 Here we list the works identified as at 5 August 2022.

2 NBER, [*Curriculum vitae of Albert Ando*], (accessed December 2022); Charles Yuji Horioka, *Albert K. Ando (1929-2002)*, The Institute of Social and Economic Research, Osaka University, ISER Discussion Paper, 644, 2005 (accessed December 2022). In addition, we would like to mention Lawrence R. Klein (ed.), *Long-run growth and short-run stabilization: essays in memory of Albert Ando*, Cheltenham-Northampton, MA, Edward Elgar, 2006 and Magnus Blomström [et al.] (eds.), *Structural impediments to growth in Japan*, Chicago-London, The University of Chicago Press, 2003.

The works surveyed: selection criteria and bibliographical approach

This bibliography covers works published either in printed form or online.[3] Its approach is analytical: there are descriptions of monographs, collections of essays, articles in scholarly journals, essays published as part of collections, comments and remarks made as a discussant, articles, reviews of other authors' works, and volumes edited by Ando.

Identification of the works and style of references

The structure of this volume and the style of the references are the same as in the 2012 edition.

Reprints under the same title in the same year have been indicated in the notes; those from subsequent years or under different titles have separate entries.

A cross-referencing system makes it possible to link the bibliographical citations of the various editions, reprints and translations. In line with the chronological order used, the publishing history of each work is given in the note to the first one published on a given subject (e.g. working paper). This will also allow students and scholars to find the year when Albert Ando's ideas were presented to the scientific community for the first time.

The vast majority of the works are in English; nevertheless, some writings have been translated into Italian, Spanish and even into Czech.[4] One article from the periodical *Keizai Bunseki* is in Japanese (see No. 91 in this bibliography).

Organisation and order

The bibliography is ordered chronologically, based on the year of publication. Each work is numbered consecutively. Within each year, the titles are in alphabetical order, except for works edited and reviews by Ando, which are listed separately.

For works written with co-authors, the co-authors are cited immediately after the title. The names of the other authors are cited as they appear on the title page.

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3 There are two unpublished works: Professor Ando's PhD dissertation, dated 1959 (see No. 3 in this bibliography), and his influential 1985 work on the determinants of Japanese households' saving behaviour (see No. 86 in this bibliography).

4 *Poměrná stabilita rychlosti oběhu peněz a investiční násobitel*, with Franco Modigliani, přeložil R. Dobruský, [Praha], Státní výzkumný ústav ekonomiky ve spotřebním průmyslu, [1965]. Czech edition of No. 32 in this bibliography.

Hyperlinks

This edition of the bibliography has hyperlinks, shown in blue, to the PhD dissertation and to the two works belonging to the Bank of Italy's research series known as Temi di discussione (Working papers), available on the Bank's website.

Indexes

The bibliography has two indexes:

a) By title: alongside the title is the number identifying each separate entry. The index also specifies whether the work is an edited volume.

b) By author's name for reviewed works.

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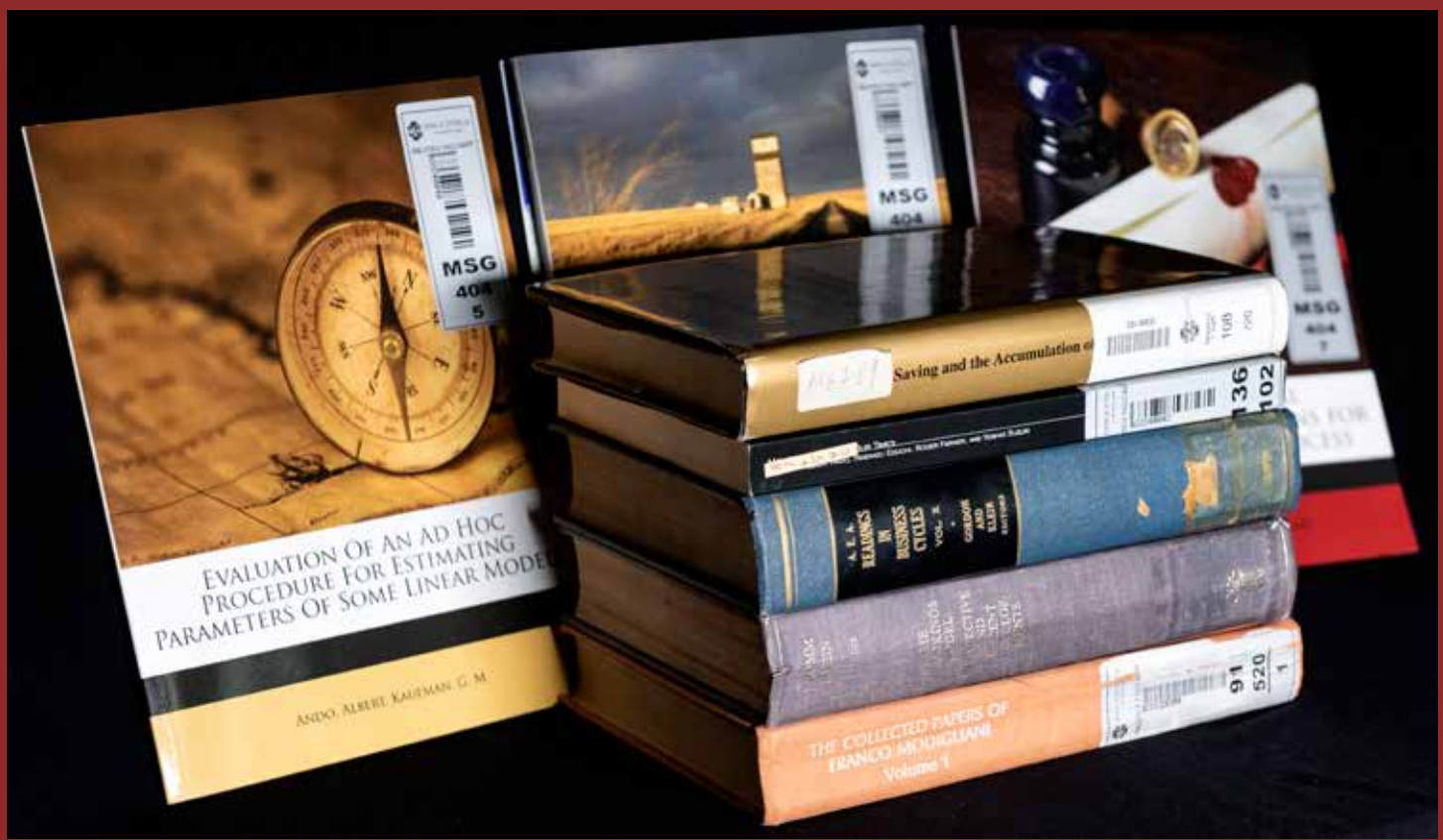
edited by
Clara Dall'Osso, Valentina Memoli and Rosanna Visca



Albert Ando, around 1933 (kindly provided by his family)

1957

1.

"The redistributional effects of inflation", with George L. Bach, *The Review of Economics and Statistics*, 39, 1, 1957, pp. 1-13.

2.

"Tests of the life cycle hypothesis of savings: comments and suggestions", with Franco Modigliani, *Bulletin of the Oxford University Institute of Statistics*, 19, 2, 1957, pp. 99-124.

1959

3.

A Contribution to the Theory of Economic Fluctuations and Growth, Carnegie Institute of Technology, [Pittsburgh, PA], April 1959, unpublished.

Albert Ando's PhD dissertation. On the title page: "Submitted to the Faculty of Graduate School of Industrial Administration, Carnegie Institute of Technology, in partial fulfillment of the requirements for the degree of Doctor of Philosophy". The appendix of the dissertation was published in *The American Economic Review* (No. 4).

4.

"Growth, fluctuations, and stability", with Franco Modigliani, *The American Economic Review*, 49, 2, 1959, pp. 501-524.

Special issue *Papers and Proceedings of the Seventy-first Annual Meeting of the American Economic Association. Chicago, Illinois, December 27-29, 1958*. Also included in the PhD dissertation (No. 3), as an appendix. Published in Italian in the same year (No. 6).

Albert Ando, 1954 (kindly provided by his family)

5.

The 'Permanent Income' and the 'Life Cycle' Hypothesis of Saving Behavior: Comparison and Tests, with Franco Modigliani, Massachusetts Institute of Technology, Publications in Social Science Series, 52, [1959].

Paper presented at the conference on *Consumption and Saving*, held on 30-31 March 1959 at The Warton School of Finance and Commerce, University of Pennsylvania. Published in 1960 (No. 7).

6.

"Problemi scelti della teoria economica: sviluppo, fluttuazione e stabilità", with Franco Modigliani, *Rassegna della letteratura sui cicli economici*, 1, 1959, pp. [17-47].

Italian edition of No. 4.

1960

7.

"The 'permanent income' and the 'life cycle' hypothesis of saving behavior: comparison and tests", with Franco Modigliani, in Irwin Friend and Robert Jones (eds.), *Proceedings of the Conference on Consumption and Saving*, Vol. 2, [Philadelphia], University of Pennsylvania, 1960 (Study of Consumer Expenditures, Incomes and Savings), pp. 49-174.

Previously published as a working paper (No. 5) and partially reprinted in 1980 (No. 76).

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8.

Review of Moses Abramovitz [et al.], *The Allocation of Economic Resources; Essays in Honor of Bernard Francis Haley*, Stanford, Stanford University Press, 1959, in *Journal of the American Statistical Association*, 55, 292, 1960, pp. 764-765.

1961

9.

"Aggregation of variables in dynamic systems", with Herbert A. Simon, *Econometrica*, 29, 2, 1961, pp. 111-138.

To quote from the footnote: "An earlier version of this paper was the result of the research undertaken in the Graduate School of Industrial Administration, Carnegie Institute of Technology, for the project *Planning and Control of Industrial Operations*, under contract with the Office of Naval Research and was circulated as O.N.R. Research Memorandum, No. 31, December, 1956. Reproduction of this manuscript in whole or in part is permitted for any purpose of the United States Government. Contract N ONR-7600 1, Project NR 047001. It was also read at the meetings of the Econometric Society, December, 1956." Reprinted in 1963 (No. 11) and in 2003 (No. 134). Published in Spanish in 1970 (No. 44).

1962

10.

"Two theorems on *ceteris paribus* in the analysis of dynamic systems", with Franklin M. Fisher, *The American Political Science Review*, 56, 1, 1962, pp. 108-113.

Reprinted in 1963 (No. 18) and in 1971 (No. 50).

1963

11.

"Aggregation of variables in dynamic systems", with Herbert A. Simon, in Albert Ando, Franklin M. Fisher and Herbert A. Simon (eds.), *Essays on the Structure of Social Science Models*, Cambridge, MA, The MIT Press, 1963, pp. 64-106.

Reprint of No. 9.

12.

"Discussion", *The Journal of Finance*, 18, 2, 1963, pp. 355-357.

Comment on Karl Brunner and Allan H. Meltzer's article "Predicting velocity: implications for theory and policy", in the same volume, pp. 319-354. The paper and Ando's discussion were presented at the joint meeting of the American Finance Association and the Econometric Society in Pittsburgh, 29 December 1962.

13.

"Introduction", in Albert Ando, Franklin M. Fisher and Herbert A. Simon (eds.), *Essays on the Structure of Social Science Models*, Cambridge, MA, The MIT Press, 1963, pp. 1-4.

14.

"Lags in fiscal policy", with E. Cary Brown, in E. Cary Brown [et al.], *Stabilization Policies, Englewood Cliffs, Prentice-Hall*, 1963 (CMC Supporting Papers), pp. 97-163.

Contributors on the title page: E. Cary Brown, Robert M. Solow, Albert Ando, and John Kareken; Milton Friedman and David Meiselman; Lawrence E. Thompson; Arthur M. Okun; Merton H. Miller; Allan H. Meltzer; Oswald Brownlee and Alfred Conrad. Volume prepared for the Commission on Money and Credit as part of its research programme leading to the publication in June 1961 of its final report *Money and Credit: Their Influence on Jobs, Prices, and Growth*. Published in Italian in 1967 (No. 35).

15.

"Lags in fiscal and monetary policy: introduction and summary", with E. Cary Brown, Robert M. Solow and John Kareken, in E. Cary Brown [et al.], *Stabilization Policies*, Englewood Cliffs, Prentice-Hall, 1963 (CMC Supporting Papers), pp. 1-13.

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16.

"The 'life cycle' hypothesis of saving: aggregate implications and tests", with Franco Modigliani, *The American Economic Review*, 53, 1, Part 1, 1963, pp. 55-84.

See also No. 25. Reprinted in 1965 (No. 30, with some changes), in 1968 (No. 40), in 1980 (No. 74) and in 2005 (No. 140). Partially reprinted, under the title *The Life-cycle Hypothesis*, in 1976 (No. 62). Published in Italian in 2000 (No. 128).

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"Near-decomposability, partition and aggregation, and the relevance of stability discussions", with Franklin M. Fisher, *International Economic Review*, 4, 1, 1963, pp. 53-67.

Also published in Albert Ando, Franklin M. Fisher and Herbert A. Simon (eds.), *Essays on the Structure of Social Science Models*, Cambridge, MA, The MIT Press, 1963, pp. 92-106 (see No. 19).

18.

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Reprint of No. 10.

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Essays on the Structure of Social Science Models, Cambridge, MA, The MIT Press, 1963, iv-172 p.

Volume edited with Franklin M. Fisher and Herbert A. Simon.

1964

20.

Bayesian Analysis of Reduced Form Systems, with Gordon M. Kaufman, Massachusetts Institute of Technology, Alfred P. Sloan School of Management Working Paper, 98-64, 1964.

Reprinted in 2015 (No. 149).

21.

Bayesian Analysis of the Independent Multinormal Process: Neither Mean nor Precision Known, with Gordon M. Kaufman, Massachusetts Institute of Technology, Alfred P. Sloan School of Management Working Paper, 41-63, 1964.

On the title page: "Revised, September, 1964." Published in 1965 (No. 27) and in 2011 (No. 146).

22.

"An empirical model of the United States economic growth: an exploratory study in applied capital theory", in *Models of Income Determination: A Report of the National Bureau of Economic Research*, Princeton, Princeton University Press, 1964 (Conference on Research in Income and Wealth. Studies in Income and Wealth, 28), pp. 327-374.

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23.

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1965

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29.

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1966

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"Evaluation of an ad hoc procedure for estimating parameters of some linear models", with Gordon M. Kaufman, *The Review of Economics and Statistics*, 48, 3, 1966, pp. 334-340.

Previously published as a working paper (No. 23).

1967

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"Ritardi della politica fiscale", with E. Cary Brown, in *Sviluppo economico e stabilità negli Stati Uniti d'America*, Milano, Cassa di Risparmio delle Provincie Lombarde, 1967 (Collana internazionale di saggi monetari creditizi e bancari, 10), pp. 501-579.

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Albert Ando, 1960s (Photograph. MIT Museum, Cambridge MA. https://collections.mitmuseum.org/object2/?id=GCP-00000986)

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37.

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1968

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41.

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1969

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Partial reprint of No. 15 (pp. 2, 7-13). Published in Spanish in 1971 (No. 49).

46.

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Partial reprint of No. 15 (pp. 7-13).

1971

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"On a problem of aggregation", *International Economic Review*, 12, 2, 1971, pp. 306-311.

48.

On the Role of Expectations of Price Changes and Technological Change in an Investment Function, with Franco Modigliani, Robert Rasche and Stephen J. Turnovsky, Center Operations Research and Econometrics-Université Catholique de Louvain, CORE Discussion Papers, 7112, 1971.

Published, with some changes, in 1974 (No. 54), in 1976 (No. 64) and in 1980 (No. 75).

49.

"Retrasos en la política fiscal: un resumen", with E. Cary Brown, in Francisco Domínguez del Brío (ed.), *La política fiscal en acción: selección de lecturas sobre política fiscal moderna*, [Madrid], Instituto de Estudios Fiscales, [1971], p. 305-316.

Spanish edition of No. 45. Reprinted in 1973 (No. 52).

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1972

51.

"Equations and definitions of variables for the FRB-MIT-Penn econometric model, November, 1969", with Franco Modigliani and Robert Rasche, in Bert G. Hickman (ed.), *Econometric Models of Cyclical Behavior*, Vol. 1, National Bureau of Economic Research, distributed by Columbia University Press, New York-London, 1972 (Conference on Research in Income and Wealth. Studies in Income and Wealth, 36), pp. 543-598.

Albert Ando, 1970s (kindly provided by his family)

Appendix to part one *Business-cycle Simulations*. The volume contains the paper presented at the conference on *Econometric Models of Cyclical Behavior* held at Harvard University, 14-15 November 1969, under the joint sponsorship of the Social Science Research Committee on Economic Stability and the NBER Conference on Research in Income and Wealth.

52.

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Contributors on the title page: Albert Ando, Cary E. Brown, Gerhard Colm, Council of Economic Advisers (US), Francisco Domínguez del Brío, Enrique Fuentes Quintana, John M. Keynes, Richard A. Musgrave, Paul A. Samuelson, James Tobin. Reprint of No. 49.

1974

53.

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"On the role of expectations of price and technological change in an investment function", with Franco Modigliani, Robert Rasche and Stephen J. Turnovsky, *International Economic Review*, 15, 2, 1974, pp. 384-414.

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55.

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1975

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"Appendix: demand for money in a general portfolio model in the presence of an asset that dominates money", with Karl Shell, in Gary Fromm and Lawrence R. Klein (eds.), *The Brookings Model: Perspective and Recent Developments*, Amsterdam-Oxford, North-Holland and New York, American Elsevier, 1975, pp. 560-563.

58.

On the Application of Optimal Control to a Large Scale Econometric Model, with Alfred Norman and Carl Palash, Federal Reserve Bank of New York, Research Paper, 7517, 1975.

To quote from the footnote: "This paper is being circulated for purposes of discussion and comment only. The contents should be regarded as preliminary and not for citation or quotation without permission of the author." Revised edition in 1976 (No. 63) and in 1978 (No. 69).

59.

"Some reflections on describing structures of financial sectors", with Franco Modigliani, in Gary Fromm and Lawrence R. Klein (eds.), *The Brookings Model: Perspective and Recent Developments*, Amsterdam-Oxford, North-Holland and New York, American Elsevier, 1975, pp. 524-560.

60.

"Tax cut: why it must be quick and big", with Lawrence R. Klein [et al.], *The New York Times*, 26 February 1975.

Letter, dated 20 February 1975, published in the column *Letters to the Editor*. Reprinted in 1979 (No. 72).

1976

61.

"Impacts of fiscal actions on aggregate income and the monetarist controversy: theory and evidence", with Franco Modigliani and the assistance of J. Giangrande, in Jerome L. Stein (ed.), *Monetarism*, Amsterdam-New York-Oxford, North-Holland, 1976 (Studies in Monetary Economics, 1), pp. 17-42.

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Reprint of No. 55.

66.

"Some stabilization problems of 1971-75, with an application of optimal control algorithms", with Carl Palash, *The American Economic Review*, 66, 2, 1976, pp. 346-348.

To quote from the footnote: "This is a summary of a longer paper on the same subject which is scheduled to appear in *Frontiers of Quantitative Economics*, Vol. III, edited by Michael Intriligator, North-Holland Publishing Co., Amsterdam 1976, where data and analytical results that support statements made here are presented." See No. 68.

1977

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68.

"Some stabilization problems of 1971-75, with an application of optimal control algorithms", with Carl Palash, in Michael D. Intriligator (ed.), *Frontiers of Quantitative Economics: Papers Invited for the Presentation at the Econometric Society Third World Congress, Toronto, 1975*, Vol. 3b, Amsterdam-New York-Oxford, North-Holland, 1977 (Contributions to Economic Analysis, 106), pp. 783-804.

To quote from the footnote: "Ando was asked to replace someone else on the panel on the role of econometric models in evaluation of stabilization policies at the World Congress of the Econometric Society at Toronto, Canada, in August, 1975, only a few days before the panel was to meet, and he did not had time to prepare an adeguate paper for the panel. The paper printed here was then under preparation, and it was subsequently presented orally at the meetings of the American Economic Association at Dallas, Texas, in December, 1975. Since the content of this paper has bearing on the topic discussed at the Toronto panel, we have requested the editor of this volume to accept this paper in place of a summary of Ando's oral discussion at the Toronto panel." See No. 66.

1978

69.

"On the application of optimal control to large scale econometric models", with Alfred Norman and Carl Palash, in A. Bensoussan, P.R. Kleindorfer and Ch.S. Tapiero (eds.), *Applied Optimal Control*, Amsterdam-New York-Oxford, North-Holland, 1978 (TIMS Studies in Management Sciences, 9), pp. 147-170.

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1979

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"Financial sector model building and their inclusion in econometric models of national economies", in *Modèles monétaires et financiers: VI^e Colloque international d'économétrie appliquée*, Vol. 1, [s.l.], Association d'Econométrie Appliquée, Roma, Banca d'Italia, [Nanterre], Groupe d'Analyse Macroéconomique Appliquée, 1979, pp. 1-32.

To quote from the footnote: "This is a preliminary draft of a paper meant to be a personal reflection on diverse sets of literature, making it very time-consuming to assemble and to select an appropriate bibliography. I was unable to complete this task in time, but it will be added to the future revision of this paper." Conference held in Rome, 7-10 February 1979. English parallel title of the conference proceedings *Monetary and Financial Models: VI^th International Conference of Applied Econometrics*.

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"On the contributions of Herbert A. Simon to economics", *The Scandinavian Journal of Economics*, 81, 1, 1979, pp. 83-93.

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"Tax cut: why it must be quick and big", with Lawrence R. Klein [et al.], in Robert L. Moore (ed.), *Economic Principles in Action*, Englewood Cliffs, Prentice-Hall, 1979, p. 30.

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1980

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"Impacts of fiscal actions on aggregate income and the monetarist controversy: theory and evidence", with Franco Modigliani and the assistance of J. Giangrande, in Andrew Abel (ed.), *The Collected Papers of Franco Modigliani. Vol. 1: Essays in Macroeconomics*, Cambridge, MA-London, The MIT Press, 1980, pp. 142-167.

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74.

"The 'life cycle hypothesis' of saving: aggregate implications and tests", with Franco Modigliani, in Andrew Abel (ed.), *The Collected Papers of Franco Modigliani. Vol. 2: The Life Cycle Hypothesis of Saving*, Cambridge, MA-London, The MIT Press, 1980, pp. 275-304.

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76.

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1981

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Indexes


THE COLLECTED PAPERS OF
FRANCO MODIGLIANI
Volume 1
READINGS
IN
BUSINESS
CYCLES
Saving and the Accumulation o
91
520
136
102
108
720

Index of titles

Index of the authors of the works reviewed by Albert Ando

In this series:

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