

DYNAMIC MODELLING AND CONTROL OF NATIONAL ECONOMIES

Edited by
T. BASAR and L. F. PAU

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DYNAMIC MODELLING AND CONTROL OF NATIONAL ECONOMIES 1983

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Edited by

T. BASAR

University of Illinois at Urbana-Champaign, USA

and

L. F. PAU

Battelle Research/CTI, Geneva, Switzerland

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INTRODUCTION

This Conference was the fourth in the series of IFAC/IFORS conferences on dynamic modelling and control of national economies, following the:

- 1st: Warwick, United Kingdom (1973)
- 2nd: Vienna, Austria (1977)
- 3rd: Warsaw, Poland (1980).

The 3rd conference, as well as the present one, was also co-sponsored by the Society for economic dynamics and control, serving as their annual conferences in 1980 and 1983. According to present plans, the 5th conference will be held in Budapest, Hungary, in 1986.

On behalf of the American Automatic Control Council, US National member of IFAC, the Conference was organized by the IEEE Control Systems Society. The event was held in Washington DC, June 17-19, 1983, and attended by about 100 participants.

The variety of contributions, and the depth of many of the some 60 papers, 20 parallel sessions, and 2 plenary sessions, were evidence of the strength and maturity of research in the areas of economic modelling, control techniques, and quantitative macro-economics.

The International program committee under the chairmanship of Prof. M. Aoki, had delegated out the organisation of altogether 8 invited sessions on:

- Game theory for planning (two sessions)
- General equilibrium modeling of national economies
- Model reliability
- Modelling languages (two sessions)
- Effectiveness of economic policies
- International finance and macroeconomics.

There were also discussants on most sessions, and the resulting lively discussions between these, the authors, and the audience, proved beneficial for the research exchanges. As opposed to the previous three conferences, the present one was not attended by policy makers or decision makers, thus emphasizing more fundamental issues.

Prof. L. Klein, University of Pennsylvania, Nobel Laureate, delivered a remarkable plenary lecture on "International modeling and coordination of economic policies". Dr. Anne Krueger, Vice-President, the World Bank, gave a lively luncheon address on the relevance of modeling in economic policy making for developing countries.

For various reasons, not all papers presented at the conference could be included in these proceedings. Other papers were included after minor or major revisions of the texts as originally submitted. The editors very much appreciate the cooperation of the authors in this matter, and in retyping their contributions. They hope that a reasonable balance has been attained between perfection, timeliness and accuracy.

MAIN TOPICS OF THE CONFERENCE

The papers covered a broad class of problems or notions arising both in economic theory, control applications to planning, and implementation issues.

Economic theory

The main issues discussed were:

- open economies, especially in view of inflation, monetary policy, and currency reserves
- equilibrium and disequilibrium models for flows and structures
- productivity, unemployment, inflation and stability phenomena analysis.

National models

Some national models, with estimated coefficients, were presented, including some developing countries, as well as Austria, Japan, USA, Italy, Cyprus, Germany.

Global modelling and international issues

Many presentations were dealing, at the theoretical or applied level, with issues of interdependence:

- global modelling methodologies and projects
- input-output multi-country or regional models
- foreign exchange markets and currency risk analysis
- N-country models combining financial, trade, and monetary flows
- interdependencies and coordinated policies.

Sectorial models

The presentations covered primarily energy models for oil-pricing and production, but also health, and other commodities.

Regional models

There were almost no regional models presented, except notions of multi-region input-output models.

Econometric estimation or control algorithms

In the area of estimation, the emphasis was on regression models for structural change. In the area of optimization and control algorithms, contributions were dealing with decentralized filtering and control procedures, as well as stochastic control and sensitivity analyses.

Economic competition and game theory

This conference gathered a rather large number of papers dealing with the analysis, and derivation of control strategies, in economic competition problems. The applications ranged from international to inter-regional and intersectoral competition. All facets of game theoretical research were represented, such as basic competitive processes, team problems, equilibrium computation, Lanchester and stochastic games.

Model assessment

Much concern was shown about model assessment tools, and modeling reliability, or robust policy determination in presence of e.g. structural shocks.* Both basic statistical estimation behavior, as evaluation methodologies were presented.

Software tools for macro-economic modeling

Current developments of a number of estimation and control software packages were reported, besides modeling language tools, and new applications of artificial intelligence concepts.

CONCLUSION

This conference demonstrated the importance of dialogue and joint work between different schools in economic and control theory research, with due confrontation with the difficulties of real implementations of these techniques. Since economic analysis, planning and decision making, are an art built on diverse scientific fields, the multiplicity of approaches are essential for achieving results benefiting general welfare, cooperation and stability.

The Editors:

T. Basar L. F. Pau

REFERENCES

- 1st IFAC/IFORS Conference on dynamic modelling and control of national economies, Wm. Dawson and Sons, Falkestone, UK, 1974
- 2nd IFAC/IFORS Conference on decision making in national economies, North Holland Publ. Co., Amsterdam, 1979.
- 3rd IFAC/IFORS Conference on dynamic modelling and control of national economies, Pergamon Press, Oxford, UK, 1981.

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INTERNATIONAL MODEL BUILDING AND COORDINATION OF ECONOMIC POLICIES

L. Klein

Department of Economics, University of Pennsylvania, Philadelphia, PA 19104, USA

Keywords. Developing countries; economics.

SOME ANALOGIES

One of the celebrated articles about economic policy is entitled "The Economic Steering Wheel," by A. P. Lerner. The author distinguished between a well ordered situation in which a single driver had control of the wheel and a situation in which the car has no driver but the passengers each have access to the wheel to give it a twist, from time to time, on the basis of regulations that will keep them from fighting with each other over directional control. These are stylized analogies to make a point. I believe that the automotive example can be extended, as it often has, in order to indicate something about economic coordination.

The principal feature of economic policies within the United States in 1981 and 1982 is that they are uncoordinated. Fiscal policy was highly stimulative, what with tax cuts and military spending leading to large budget deficits, while monetary policy was highly restrictive, leading to high interest rates. This can be likened to driving a car with one foot on the brake and the other steadily applying the accelerator, a very poor way to drive a car or to run an economy, and we had the consequences — severe recession.

If a car is equipped with faulty brakes which grab unevenly, it will go into a skid when suddenly stopped, but if the brakes are adjusted to apply simultaneously, i.e., properly coordinated, stopping can be smooth and noncyclical.

Among nations, we should be looking for well coordinated policies that have been adjusted to apply synchronously so that the car does not go into a skid.

POLICY COORDINATION

Apart from the automotive example, what is meant by the coordination of economic policy? It does not mean that all governments agree on an identical policy with the same instruments being applied all over the world at the same time. It simply means that the policies

are applied so that they do not contradict one another. They might very well be staggered.

At the macroeconomic level, we are concerned with the following policy instruments:

Fiscal
Monetary
Commercial
Exchange rate

It is assumed that the main lines of macro-economic control are through public spending and taxation (fiscal policy), specification of money stock growth and interest rates (monetary policy), the setting or preventing of tariffs and nontariff barriers to trade, and, finally, it is assumed that the central governments will, up to a point, allow their currencies to float freely, but will eventually intervene in order to make the exchange rates differ from what would otherwise be prevailing.

In 1957-58 there was a synchronized, but unplanned, movement of all major industrial countries together. They went into recession for a few months, and all pulled out during 1958. After this period there was an era of great expansion, in which some countries had prosperous years while others went against the trend. There was no discernible world business cycle at that time. A staggered randomization of instrument choices and of corresponding performances gave the world an unprecedented era of expansion.

TABLE 1 Annual Growth Rates for the
World Economy
(percent)

	1950-60	1960-70	1970-80
GDP:OECD	4.1	5.3	3.5
Developing:			
oil exporting	4.9	5.6	5.8
oil importing	4.9	5.6	5.6
Centrally Planned	6.0	5.0	5.5
World Average	4.9	5.3	4.3
Trade volume: World	7.2	8.3	5.6
Inflation: OECD	2.9	4.6	8.2

When the oil shock of October-November 1973 hit the oil importing industrial countries together, we noticed an amplification factor in country adjustment patterns and we shifted from randomized movements across countries to a synchronized movement, in which all the major countries experienced a synchronized recessionary movement.

Simple two-country models of the world economy show that closed economy sensitivities (multipliers) are increased by adding trading relationships with the other country. The public expenditure multiplier, e.g., for a single country is:

$$Y_1 = \frac{1}{1-d_1(1-t_1)+e_2} G_1$$

where d_1 is the domestic marginal propensity to spend, t_1 is the income tax rate, and e_2 is the marginal propensity to import. In the extended (international) case, the formula for the open economy becomes

$$Y_1 = \frac{1}{1-d_1(1-t_1)+e_2 - \frac{e_1 e_2}{1-d_2(1-t_2)+e_1}} \cdot \left[G_1 + \frac{e_1}{1-d_2(1-t_2)+e_1} G_2 \right]$$

Here we add another negative term in the denominator, coming from the partner country, and also the expansion of the multiplier to allow for the impact effect of the other country's government expenditure, too. In this expression, d_2 , t_2 and e_1 are the corresponding parameters valued in country 2 for domestic marginal propensity to spend, the income tax rate, and marginal propensity to import.

It is evident that when a country's performance is changed, its imports change, and this induces a change in its partner's exports, which, in turn, induce an effect in the partner's level of activity. This feeds back on demand from the first country and sets a new chain of effects in motion. It is this interaction between countries that introduces added effects and puts more policy instruments for mutual coordination into the range of choice. These considerations generalize to many countries, simultaneously, in trading relationships. These sensitivity results are well known, but they have not been systematically exploited for the purpose of international policy coordination, at least in quantitative form.

The formulas presented here are simple and derive only from activity (income) effects, but in actual model building, more complicated relationships are used, which allow for effects from relative prices, inflation, interest rates, and exchange rates. These would be complicated enough in the two country model, but just manageable. When we extend the analysis to many countries in many dimensions, beyond activity effects,

the analysis gets too complicated for anything except general simulation study.

Using multicountry model of Project LINK (30 country or area component models), we can group simulation results into broad aggregates. Convenient groupings are OECD countries, centrally planned economies (CPE) and developing countries (LDC), with sometimes a split between OPEC and all other LDCs. Among these country or area groupings, there are some interesting relationships.

Economic change originating in the OECD area is transmitted to the LDC and CPE area. Principally, changes in the level of economic activity in the OECD area, as in business cycle swings, are felt in the LDC area and, to some extent, in the CPE area. When the OECD countries are prosperous, they import a great deal, much of it (about 30 percent) coming from the developing countries. This provides purchasing power for the latter, who then augment capital and enhance their growth. Every full point of added growth in the North, above a baseline growth path, results in about 0.25 points growth in the South. This finding is much like the case of an input-output system in which a single sector is perturbed. The resulting direct effects in that sector outweigh the indirect effects estimated for other sectors.

Study of the cyclical transmission mechanism has concentrated on the quantity effects, the transmission of real activity changes in the North to corresponding changes in the South, but more recently interest rate and exchange rate changes in the North have had the major effects shaping the economic progress of the South. High rates of interest in the United States imposed heavy debt burdens on many developing countries. They, in turn, had to curtail imports from the North drastically. This reduced the fixed capital flow into LDCs and put many of them into a state of serious recession. In some cases, it led to currency devaluation, followed by wage increases, and a round of inflation that soon reached levels of 100 percent or more. In a similar way, pure inflationary effects can be transmitted by trade relationships from North to South.

From the vantage point of the developing countries, if their growth rates are stimulated so that they gain as much as one full point above the baseline path then the feedback to the industrial countries is about 0.2 percentage points. This too is in accord with the fundamental property of input-output analysis. Some people believe that enormous gains in purchases from the North would ensue upon the slightest increment to Southern growth. When the numbers are worked through a model such as that used by project LINK, we find that some response is there but that it is by no means large enough to lift the OECD countries literally, by their boot-straps. Inflation and financing costs have effects that are

also transmitted from the LDCs to the OECD countries.

If prices of primary exports are supported, this improves export earnings of the developing countries and enables them to buy more goods from the developed countries. It also contributes to inflationary pressure in the industrial countries as in the case of oil price rises, which became important factors in inflation in the industrial world.

The accompanying tables summarize some of the leading transmittals.

TABLE 2 Primary Impact OECD Countries
Coordinated Reduction of Interest Rates
(3 percentage points)
Deviation from Baseline

	1983	1986
Growth rate		
GDP OECD (%)	0.48	0.36
LDC (%)	0.06	0.17
Trade Balance OECD (\$bn)	-1.4	-24.1
LDC (\$bn)	0.8	16.4
Nonoil LDC (\$bn)	0.06	0.19
Inflation rate		
Consumer Price Deflator (OECD) (%)	-0.29	0.29

TABLE 3 Primary Impact Summit Countries
Monetary and Fiscal Stimuli
Deviation from Baseline

	1983	1986
Growth rate		
GDP OECD (%)	0.40	0.42
LDC (%)	0.07	0.14
Trade Balance OECD (\$bn)	-0.9	-6.8
LDC (\$bn)	0.3	4.0
Nonoil LDC (\$bn)	0.01	1.1
Inflation rate		
Consumer Price Deflator (OECD) (%)	0.17	0.11

TABLE 4 Primary Impact Summit Countries
Investment Tax Credit (Increased Investment)
Deviation from Baseline

	1983	1986
Growth rate		
GDP OECD (%)	0.24	0.11
LDC (%)	0.03	0.07
Trade Balance OECD (\$bn)	-0.5	-3.7
LDC (\$bn)	0.1	2.3
Nonoil LDC (\$bn)	-0.1	-0.8
Inflation rate		
Consumer Price Deflator (OECD) (%)	-0.20	0.17

Tables (2-4) show the impact of stimuli for industrial countries, which are then transmitted by the international trade network to developing countries. The first of these, coordinated interest rate reduction, is spread across most of the OECD countries at

once. The next two are confined to the seven Summit Countries (USA, Canada, Japan, U.K., Germany, France, Italy).

In Table 2, at the outset, the growth rate increase is eight times as large in the OECD countries as in the developing countries. After four years the ratio is little more than 2:1. It is not thought to be a very inflationary policy, adding no more than one-third of a percentage point to the inflation rate. The trade balance is expected to deteriorate for the industrial countries because their imports tend to rise when they have a demand side stimulus. Correspondingly, developing countries should experience an offsetting improvement in their trade balance, mainly through better oil exports. Oil importing developing countries have practically no change in their net trade position. They can export more to the OECD countries but they do have a high marginal propensity to import.¹

When the impact is confined to the Summit countries, the gain is more moderate. This is particularly true of the medium term effect of the (Summit) investment increase on the OECD countries' GDP growth rate, which is less than double the gain in the developing countries. In both Tables 3 and 4, the trade balance effects are quite small. The inflation effects are not large in these two tables, and they are negative in Table 4 because the higher levels of investment induce higher productivity growth.

TABLE 5 Primary Impact Developing Countries
Transfers to LDC for Commodity Export Earnings Shortfall
Deviation from Baseline

	1984	1988
Growth rate		
GDP OECD (%)	0.16	0.0
LDC (%)	0.55	0.03
Nonoil LDC (%)	0.62	0.04
Trade Balance OECD (\$bn)	8.9	8.6
LDC (\$bn)	-10.3	-9.3
Nonoil LDC (\$bn)	-10.4	-7.7
Inflation rate		
Consumer Price Deflator (OECD) (%)	0.02	0.01

¹The combined monetary and fiscal policies introduced in the Summit countries are based on quantitative estimates of the general proposals made in "Promoting World Recovery: A Statement on Global Economic Strategy" Institute for International Economics, Washington, DC, December 1982.

TABLE 6 Primary Impact Developing Countries
Transfers to LDC for Commodity
Export Earnings Shortfall
Financed by OECD Expenditure
Reduction

Deviation from Baseline		
Growth rate	1984	1988
GDP OECD (%)	0.05	-0.01
LDC (%)	0.55	0.03
Nonoil LDC (%)	0.62	0.04
Trade Balance OECD (\$bn)	9.1	8.7
LDC (\$bn)	-10.3	-9.3
Nonoil LDC (\$bn)	-10.4	-7.7
Inflation rate		
Consumer Price Deflator (OECD) (%)	0.03	0.01

TABLE 7 Primary Impact Developing Countries
Primary Commodity Price Support
Deviation from Baseline

Growth rate	1984	1988
GDP OECD (%)	0.11	-0.01
LDC (%)	0.25	0.02
Nonoil LDC (%)	0.28	0.03
Trade Balance OECD (\$bn)	4.0	8.0
LDC (\$bn)	4.1	-7.6
Nonoil LDC (\$bn)	-1.2	-1.4
Inflation rate		
Consumer Price Deflator (OECD) (%)	0.13	0.02

TABLE 8 Primary Impact Developing Countries
Transfers to LDC Financed by
Disarmament
Deviation from Baseline

Growth rate	1983	1988
GDP OECD (%)	0.18	0.01
LDC (%)	1.55	0.14
Trade Balance OECD (\$bn)	22.9	23.9
LDC (\$bn)	-26.3	-25.7
Nonoil LDC (\$bn)	-26.4	-26.9
Inflation rate		
Consumer Price Deflator (OECD) (%)	0.06	0.01

Tables 5-8 look at economic policy from the viewpoint of the developing countries. In these tables the LDC effects from GDP growth are larger than for the OECD because the changes originate, as far as impact is concerned, in the LDC area.

In Tables 5, 6 and 7, we are dealing with a particular kind of North-South transfer — one that is aimed at making up for a shortfall in the export earnings in certain specific lines of activity. These shortfalls amount to about \$55 billion spread over a five year period. It is later to be repaid, but during the simulation period, it is a transfer from North to South. The assumption in Table 5 is that the transfer needs no special financing. By contrast, in Table 6,

we examine a case in which the same transfer is fully financed by the industrial countries, where domestic spending is correspondingly reduced. This seriously cuts the gains to the industrial countries. As donors, they may expect to have better export sales in the developing world, but the gains are not large enough to prevent a slight drop by 1988 in the table. Their slightly improved trade balances come about because they import less when they grow more slowly.

In Table 7, the results are different, because there is no direct transfer, only a support of export prices for commodities at a higher level, high enough to bring gains corresponding to the amount of transfer. A main aspect of these results is that there is more inflation among the industrial countries because their import prices rise for primary inputs.

The scenarios in Table 8 are different from the others. It too traces the effects of transfers from North to South, but the funds are rationalized by, and come from, a release of funds in the armament programs of the industrial countries, including the U.S.S.R. as well as the USA and other Western countries. The U.S. and Soviet arms reductions considered here were adopted in other countries on the basis of their size. This scheme allows highly favorable growth in the developing countries. Corresponding to the high growth there are big increments in the net trading positions.

All the scenarios considered thus far concentrate on policies that would show up primarily in either the OECD countries or the Developing Countries. In Table 9, we have an entirely different situation in which oil prices are assumed to fall by 20 percent below the baseline case. The oil importing developing and developed countries stand to gain much. The OPEC and oil exporting industrial countries are losers, at least at the beginning of such a scenario.

TABLE 9 Simulation Effects of a Cut in
World Oil Prices by 20 percent, 1983
Deviation from Baseline

Growth rate	1983	1986
GDP OECD (%)	0.17	0.06
LDC (%)	0.6	0.1
Nonoil LDC (%)	0.7	0.14
Trade Balance OECD (\$bn)	27.7	26.9
LDC (\$bn)	-26.2	-27.5
Nonoil LDC (\$bn)	1.1	1.4
Inflation rate		
Consumer Price Deflator (OECD) (%)	-0.38	-0.01

There is a comfortable favorable majority in the developing countries, following upon a cut in oil prices. These results, at 20%, are fairly symmetric between an oil price rise and a fall. If the fall were larger,