MACROECONOMICS AND MICROELECTRONICS — RESULTS OF A STUDY ON APPLICATIONS, DIFFUSION AND EFFECTS IN AUSTRIA

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This paper presents details of the model and results of the Austrian macroeconomic study of the employment implications of information technology, Microelectronics: Applications, Diffusion and Effects in Austria. The inadequacies of conventional econometric modelling and the political problems of policy implementation are emphasised.

Keywords: employment, microelectronics, macroeconomic models, input-output models, Austria.

INTRODUCTION

In the 1970s most Western industrial countries experienced a dramatic set-back in economic growth with considerable unemployment. The underlying factors, their relative contribution to this development and prospects for the future have been the object of detailed scientific studies. Even though the scope, degree of aggregation and the mode of utilisation of scientific tools vary greatly, all these investigations agree in the finding that developments in the last decade have been predominantly due to two factors: the two energy-price shocks of 1973/74 and 1978/79 and the marked decline in labour productivity growth in the mid-1970s.

Most experts consider the two energy-price shocks to be exogenous development factors, though some reservations may well be justified. Over a period of three to four years these factors caused a reduction of growth rates by 2 to 3 per cent. A comparison with the 6 to 8 per cent actual reduction of the growth rate vis-a-vis the long term trend clearly shows that energy prices can explain only a minor part of the decline in economic growth.

The second factor is a technological one. At first sight it may come as a surprise that such significant productivity losses should have come about at a time when new basic innovations came to the fore, innovations of such proportions that authors speak variously of a 'third industrial revolution', 'information revolution' and 'the post-industrial society'. The decline of productivity resulted in lower demand and consequently in slower growth. The apparent contradiction, which considerations of space do not permit us to discuss here, has raised new questions and demonstrated the need for new analytical methods which constitute a departure from the traditional macroeconomic approach and rely increasingly on inter-disciplinary efforts. Scientists, and in particular economists with their customarily empirical orientation, have been compelled to venture into unexplored territory. It lies in the nature of the task to be accomplished that any first step in this direction will not remain unchallenged, the more so since the problem in hand has not only a scientific dimension but also great political significance.

Most quantitative methods yield results that are necessarily dependent on certain conditions. As soon as the attempt is made to apply them in practice these limitations are bound to be disregarded and the results thought absolute to an extent no longer justifiable on scientific grounds. The study in question was beset by these very problems, which are typical of most analyses of an empirical nature.

NEW TECHNOLOGIES AND ECONOMIC DEVELOPMENT

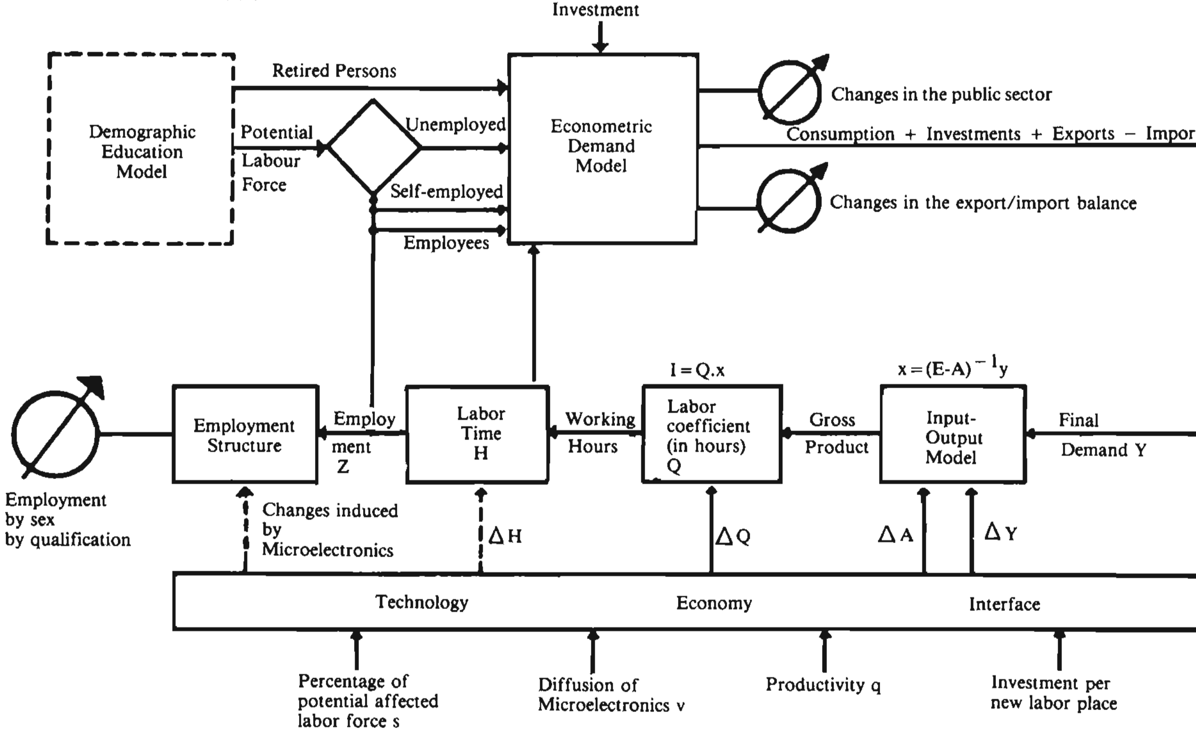
While the beginnings of microelectronics may be traced back to the last century, it was the development of the first micro-processor by INTEL in 1971 that had a lasting technological impact and can be regarded as a basic innovation resulting in decisive structural changes. The impact was so dramatic that significant structural changes occurred within a few years after the first commercial use of the new technology. Some authors attribute the high unemployment figures recorded in the last few years — which were quite atypical of the postwar period — to these innovations.

In the mid-1970s an international group of experts of the OECD began to study these questions. Under a mandate of the Directorate of Science, Technology and Information the interrelations between information technology, microelectronics, productivity and employment were analysed. The increase in unemployment in some of the major OECD countries was among the reasons why the project was given top priority.

Even though Austria reported high growth rates and only moderate unemployment figures as compared with the OECD average, the problem was recognised at an early time and the Federal Ministry of Science and Research included it in its research programme as a new and separate item of central importance.

FIGURE 1

Structure of the model



The Austrian Academy of Sciences and the Austrian Institute of Economic Research were given the task of assessing the major economic and social implications of technological progress in the field of microelectronics in Austria and thus to prepare an analytical basis for the definition of appropriate economic, social, educational and research strategies and measures.[1] To what extent the study, which was published in 1981, met these most ambitious objectives depends largely on individual expectations. Still, it certainly was a first step on the road towards a new and urgently needed line of research.

The structure of the model

Figure 1 shows the structure of the model underlying the study. Basically it is an integrated multi-sector macromodel focusing on modelling the application and spreading of the new technologies and their effects, particularly in the labour market.

The approach centres on an input-output model of the Austrian economy, which is broken down into 26 sectors of production. This Leontief model[2] allows for a consistent assignment of flows of demand to the individual production sectors and at the same time considers the dependence of the individual industries on mutual supplies. If the final demand is given, this method can be used to determine the sectoral production figures by means of a matrix (of the Leontief-inverses). By multiplying these production figures by the corresponding labour coefficients we obtain the manpower demand and, if the pattern of distribution by sex and qualification is known, the corresponding employment figures.

Basically, input-output models rely on a matrix of constant coefficients, or in other words, a constant technological structure. For the problem in hand, the assumption of constant coefficients and the *ad hoc* extrapolation of past trends on which economic studies are based proved to be of little value. In order to be able to allow fully for changes due to technological progress some qualitative assumptions concerning possible developments had to be made.

The authors of the microelectronics study distinguised:

- changes in labour productivity reflected in changes of labour coefficients;
- changes in the pattern of previous processing steps resulting in a variation of the input-output coefficients; and
- changes in final demand.

The next step was to quantify this specific information and introduce it into the model. At the same time the production requirements (i.e., intermediate and primary inputs) of the new technologies had to be defined and the degree of penetration and its development in the individual sectors had to be determined.

For this purpose a survey of 265 Austrian enterprises was undertaken in order to determine, in quantitative terms, the degree of utilisation of microelectronic equipment and in particular to trace its development in the production process, the products themselves and in the sevice functions. While details of these highly interesting results cannot be discussed here, mention should be made of one fact which does not come as a surprise to Austrians: as compared with other Western industrial nations the use of microelectronics in the production process in relatively limited. The reason given in the study, viz. that Austria is lagging behind in electrical engineering production, is, however, not fully satisfactory. Rather, this situation appears to be largely due to sociological and structural factors such as, in particular, the relatively large share of small and medium-sized enterprises and the disproportionately large role of nationalised industry.

The authors thus based their approach on the assumption that there were no links between technological progress and structural factors. It is only on this assumption that the aggregation problem as well as the possible emergence of new and the disappearance of old enterprises with traditional products can be disregarded. Since, however, technological progress manifests itself first and foremost in such structural changes — the US semiconductor industry may serve as a case in point — such an approach fails to consider a vast area of shifts induced by technological progress.

Calculation variants

As has been pointed out, traditional methods are not fully adequate to attain the objectives sought. As, in the past, new technologies were either nonexistent or were being used on a very small scale only, so that no empirical data were available, new speculative methods had to be used. Accordingly, the approach chosen by the authors of the microelectronics study was to develop a series of scenarios, to assign certain parameters for selected variables within the individual scenarios, and finally to analyse the results thus obtained. 1976 was chosen as the base year for the calculations relating to 1985 and 1990. A standard model with two variants and five scenarios was used.

In the standard model the developments of productivity in the various branches was extrapolated exponentially from the changes experienced between 1976 and 1980. Investments were assumed to give rise to a 3 per cent growth of gross domestic product and working hours were assumed to remain constant in variant 1 and to be in line with the trend of previous years in variant 2.

Scenario 1 assumes that microelectronics gains ground rapidly and that working hours remain constant. In scenario 2 the assumption is that the spread of microelectronics is slow, while working hours are reduced. Scenario 3 assumes shorter working hours and the production of microelectronic equipment in Austria. Scenario 4 is based on the assumptions of scenario 2 and, in addition, a lowering of the retirement age of night workers and persons doing particularly heavy work. Scenario 5 assumes a massive penetration of microelectronics into all sectors.

As it would lead too far to give the detailed results obtained for the standard variants and the different scenarios, this paper concentrates on a few highlights. The chief results are shown in Table 1.

The results obtained for the standard variant assuming constant working hours (40-hour week) was an average annual economic growth of 3.2 per cent, and 2.8 per cent in the case of a reduction of working hours per week in line with the trend. In the former case, however, the unemployment figure amounted to 203,000 as against, in the second case, only 118,000 or less than 60 per cent of the unemployment figure expected in variant 1. The differences were seen to be even more marked for the year 1990. The first variant projected an unemployment figure of 220,000 as against no more than 29,000 in the second case.

According to scenario 1 the rapid increase in the use of microelectronics at constant working hours will result in the deterioration of

TABLE 1

Impact of Mechanisation on the Austrian Economy

		1990 Projections				
	1976	Standard Version		Scenario		
	actual	1	2	1	2	3
Gross Domestic Product (10^9 Schillings)	738	1.180	1.113	1.190	1.114	1.149
Average Work Week (hours)	42.1	39.6	35.2	39.2	35.3	35.3
Employment (1000 persons)	3.222	3.221	3.413	3.056	3.277	3.366
Unemployment (1000 persons)	55	220	29	386	165	76

the balance of current transactions; however, irrespective of whether working hours remain constant or are reduced the labour market will deteriorate significantly.

Similarly, the developments envisaged in scenario 2 will result in a deterioration of the balance of current transactions on account of imports of new technologies. If part of the microelectronic equipment is produced domestically (scenario 3), the current account drain will be reduced and the balance of current transactions in this specific case will be nearly in equilibrium.

By virtue of the early retirement scheme assumed in scenario 4 unemployment will be just under 160,000, or in other words, the unemployment rate will be significantly higher than 5 per cent. Scenario 5, on the other hand, would result in 645,000 unemployed persons, a politically disastrous figure in the present circumstances.

Assessment of the method and evaluation of the results

At a first glance some results may appear surprising or even implausible. The method may seem to be too abstract and an unrealistic oversimplification.

This may be true for certain parts of the model, as has been discussed in detail in a paper by Lamel and Richter.[3] Nevertheless, the study in question means a new departure from the well-trodden paths of traditional econometrics by taking into account the multidimensionality of the problems involved and extending beyond the purely economic evaluations underlying most traditional analyses.

Seen in this light the study merits wholehearted approval. Indeed, Leontief himself commended the study in an extensive contribition in *Scientific American:* "The Austrian study thus constitutes the best model currently available on which to base forecasts for the United States for the year 1990."[4] The author of the present article considers it hardly feasible to apply the model directly to the American economy. Irrespective of the fundamental merits of the method some criticism of certain aspects of the model and the results derived from them appear to be justified, particularly as regards their political implementation.

In the first place, criticism attaches to the assumption of a direct and exclusive cause-and-effect relationship between the introduction of microelectronics and the loss of jobs. This one-sided approach may prompt politicians not fully familiar with such models and the assumptions on which they are based to draw premature political conclusions, and past developments have gone to show that this danger is a real one. In this context it ought to be noted that the study under consideration does not sufficiently underline the interrelations between the introduction of a new technology, the development of costs and prices and demand patterns, and that spurts in demand triggered by increases in purchasing power are all but neglected.

For methodological reasons the model also largely disregards technology-induced structural shifts in the production sector of the economy. According to analyses by Bell[5], the trend towards a service society is a phenomenon not exclusively due to demand but in large part also to production. On account of the considerable differences in the development of productivity, neglect of these shifts may distort projections of the aggregated demand for labour.

In addition to these methodological shortcomings some other assumptions must be considered unrealistic, such as the constancy of the package of goods of private consumption on the one hand and the linking of the development of foreign trade and domestic production on the other. While these aspects may be marginal from a methodological point of view, they are anything but marginal in their repercussions on the results obtained. Alternative calculations would yield necessary additional information in particular in the two cases mentioned above.

POLITICAL IMPLEMENTATION

Austria currently witnesses more or less vehement discussions of the necessity and consequences of a technology-induced shortening of working hours. Shorter working hours are mainly — and almost exclusively — advocated by the chairman of Austria's largest individual union — that of private employees, and the Minister for Social Affairs, while opposing views are held by some of the unions and all representatives of business. In these discussions, which reached their climax so far at the Federal Congress of the Austrian Federation of Trade Unions in October 1983, positions ranged from the call for the fastest possible introduction of the 35-hour week without a reduction of earnings, (i.e., at constant monthly wages) to the demand that the status quo with regard to working hours per week should be maintained as far as possible (by the Federal Economic Chamber) and variations of working hours between individual industries (by some of the unions).

The former position is based on the argument that the high unemployment figures cannot be tolerated on moral grounds and at the same time place an undue burden on the budget, which will be difficult to control even in the absence of such additional strain. The argument advanced by the opponents is that a reduction of working hours as an isolated step would place an extremely heavy burden on business and reduce the competitiveness of Austrian undertakings, which might cancel out the intended influences on the Austrian labour market.

A recent study by the Institute for Advanced Studies stressed the interconnections between working hours, competitiveness and the balance of current transactions.[6] The authors concluded that the Austrian economy might successfully cope with the gradual transition to the 35-hour week provided that wage and incomes policies succeed in walking the tightrope between the maintenance of domestic purchasing power and the preservation of international competitiveness even under conditions of shorter working hours. The IAS study, which clearly demonstrated the repercussions of shorter working hours on economic policy and, in particular incomes policy, found little echo in the general public. At least this factor should be borne in mind in all discussions of the problem of shorter working hours.

NOTES AND REFERENCES

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