The Industrial Institute for Economic and Social Research, Stockholm

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Policy Making in a Disorderly World Economy

Editors: Gunnar Eliasson, Mark Sharefkin and Bengt-Christer Ysander

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Energy and Economic Structure
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FOREWORD

A major research effort of IUI in recent years has been directed towards tracing and analyzing the causes and implications of the so-called energy crisis of the 1970s. The project – called Energy and Economic Structure – has been financed by the Energy Research Commission. It was carried out in collaboration with the Stockholm School of Economics. B-C Ysander has been coordinating the project at the IUI and K-G Mäler has been responsible for the Stockholm School part.

Much of this project work has been concerned with energy market projections and with estimation and simulation of impacts of energy price changes in the economy. Detailed documentation of that work has been and will be published by IUI.

The focus of interest in the present collection of papers is not on energy problems as such but on the general lessons of the 1970s for macroeconomic dynamics and policy. The papers have been presented in various combinations at IUI seminars over a couple of years. They have been revised, updated and edited to address the stability and macroeconomic policy problems of the 1980s. We have chosen to publish them in this form in our conference series.

The papers report empirical evidence, simulation results and policy suggestions. They should be useful in the ongoing reconsideration and reconstruction of macroeconomic theory. In particular, we believe that this book represents a novel way of looking at the increased levels of uncertainty, instabilities and stagflation that have characterized the disorderly economies of the 1970s.

Stockholm, January 1983

Gunnar Eliasson

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PART I

INTRODUCTION

STABILITY AND MACROECONOMIC POLICY:

The Lesson of the 1970s

by Gunnar Eliasson, Mark Sharefkin and Bengt-Christer Ysander

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INTRODUCTION

In the 70s the world economy shifted from orderly growth to disorderly stagflation. That shift forced the economic profession to abandon the orthodox Keynesian macroeconomics of the postwar years. By the 80s, the profession was divided between alternative and often extreme macrotheories and their implied policy prescriptions.

But out of disillusionment and controversy, a new consensus view of macro policy is gradually emerging. The traditional Keynesian emphasis on demand management now tends to be counterbalanced by a revived interest in supply behavior, in price- and wage- setting, and in the processes by which real markets and firms adjust to changing relative prices. Inflation is no longer discussed simply in terms of aggregate excess demand or excess liquidity. Traditional fiscal and monetary policy tools are increasingly viewed as complementary to policies directed towards the functioning of markets and the expectations of price- and wage-setting firms. Intensified research into market search behavior and price-signal transmission and dispersion is a vital part of attempts to furnish the microeconomic underpinnings of a new macro theory.

That better macro theory should help us explain what went wrong in the 70s, and should also help us design policies for the 80s. We can even hope for a deeper understanding of the meaning of and the conditions for economic stability in industrial economies and in the world economy as a whole.

The papers brought together in this volume aim at providing material for this on-going reconstruction of macroeconomic theory, and a point of departure for a better understanding of the 70s. Three different kinds of papers are included. The first presents and summarizes empirical evidence on the price and quantity disturbances that plagued the advanced economies in the 70s. The second set of papers analyzes the results of simulations of dynamic adjustment to supply-price shocks in three different kinds of macro models. The final set is concerned with the policy and decision problems confronting national policy bodies, business firms, and private individuals in the disorderly macro environment of the 70s and 80s.

The next section of this introduction presents some "snapshot" pictures of developments during the 70s. We then move to an overview of the evidence, and to the formulation of some tentative explanations of what happened. After examining the methods and results of the different papers in more detail, we conclude the introduction with some preliminary conclusions about the macro stability problems we are facing and the macro policies we might adopt.

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WHAT HAPPENED AFTER 1973?

Even a brief glance at the macroeconomic record of the 70s forces some disturbing questions upon us. Why did output growth among western industrialized countries fall by 2 to 3 times as much as can reasonably be explained by the direct effects of the terms-of-trade induced demand contraction caused by the oil-price hike in 1973/74? Why did growth rates then stay at about half pre-shock growth rates? How could inflation run much higher than can be explained by the direct-cost effect of higher oil prices, and why did it remain high for so long?

Why did growth rates among countries diverge so much after 1973? Why, for example, did Swedish industry, which earlier grew at the OECD average rate, fall into last place along with the industrial sector of the U.K. (Figure 1)?

Most economic postmortems of the 70s have prominently featured the oil price hike illustrated in Figure 2, and the automatic transmission of this "cost increase" to all countries in the form of inflation. But the diagram also shows at least two other things. Real oil prices had been declining since the end of the war, well before the shock. With the shock they recaptured the ground lost in earlier years. Then they began a new decline which lasted until the second oil price shock of 1979. Moreover, the aggregate price level in the industrial world had been on an increasing trend for many years before 1973. That period also saw steady growth rates and a downward trend in excess capacity. In fact, many observers during that time claimed that the business cycle was a thing of the past.

After 1973 came a protracted inflationary period characterized by a wide dispersion of relative prices lasting several years (see the papers by Josefsson & Örtengren and by Faxén in this volume). It became increasingly harder to predict future prices from current and past prices. The same was true of exchange rates once the Bretton Woods agreement had broken down (Figure 4). There was a marked deterioration of the information content of price signals within and across countries.

Policy-makers in different countries responded very differently. In Sweden attempts were made to bridge the world recession of 1975 by stimulating domestic demand along traditional Keynesian lines. At the time this policy was praised by the OECD organization. West Germany chose the opposite policy and was severely criticized abroad (Figures 5). World trade decreased dramatically (Figure 3).

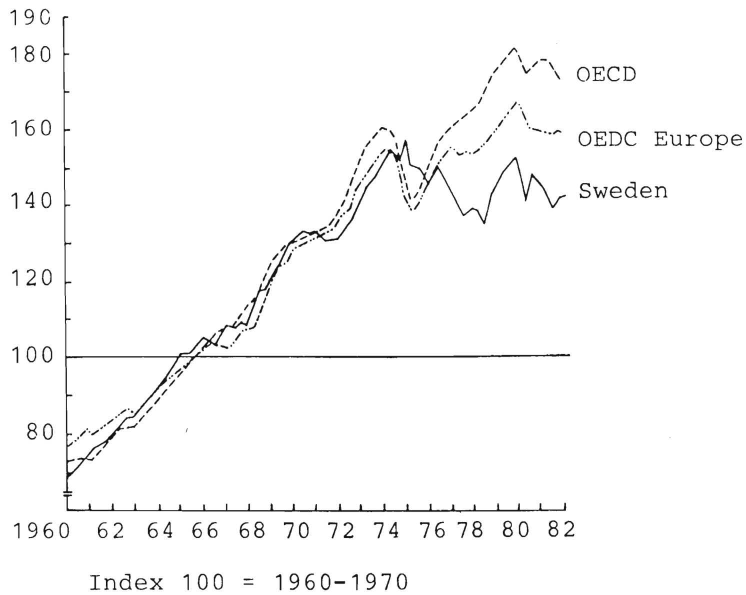
Thus there were substantial policy and performance differences between OECD countries in the 70s. In Sweden, an extreme factor-price ("wage-cost") explosion followed the oil price hike, and the Swedish export shares were drastically curtailed. The Germans, on the other hand, allowed their exchange rate to rise substantially, and German domestic inflation was stopped dead relative to that of the rest of OECD (Figures 5E, F and G).

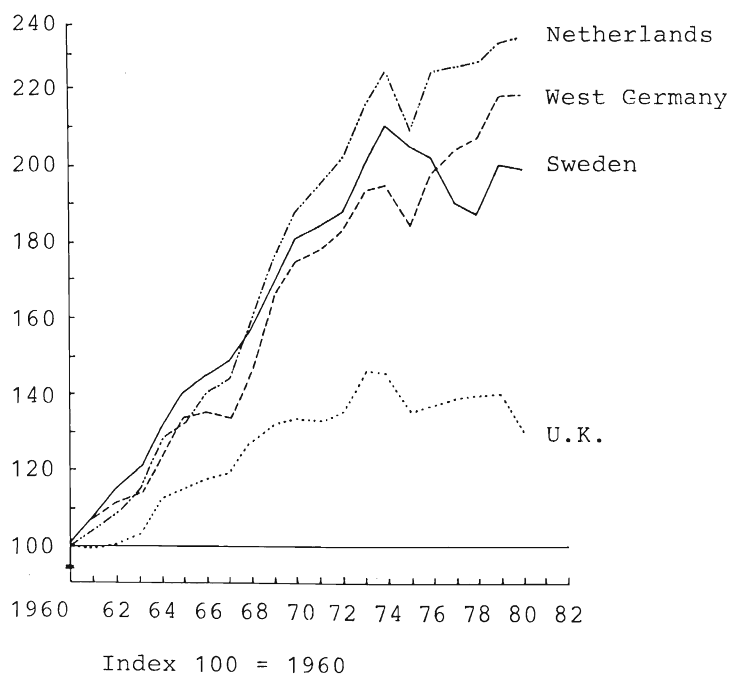
The picture becomes even more puzzling when we include Austria. That country expanded both private and public consumption relatively more than Sweden and West Germany. It controlled domestic inflation about as well as West Germany through appreciations of the currency. Austria scored best in terms of long-term GNP and industrial output growth rates among these countries (Figures 5).

But the real puzzle comes when we look at investment in manufacturing (Figure 5D). Sweden had the "best" investment performance and by far the worst output performance. Sweden also performed better than the other countries in keeping capacity utilization rates high during the initial years of the oil crisis. A comparison between Swedish and Dutch manufacturing after 1973 (cf Fries' paper) raises some new questions. Swedish industry invested more, and maintained higher employment than Dutch manufacturing. But Dutch manufacturing outpaced Swedish manufacturing in growth performance by a wide margin (Figure 1).

This anecdotal evidence brings us back, with renewed interest, to the questions we started with. To understand the 70s we must go back and examine what happened with the various determinants of economic stability during the 50s and 60s.

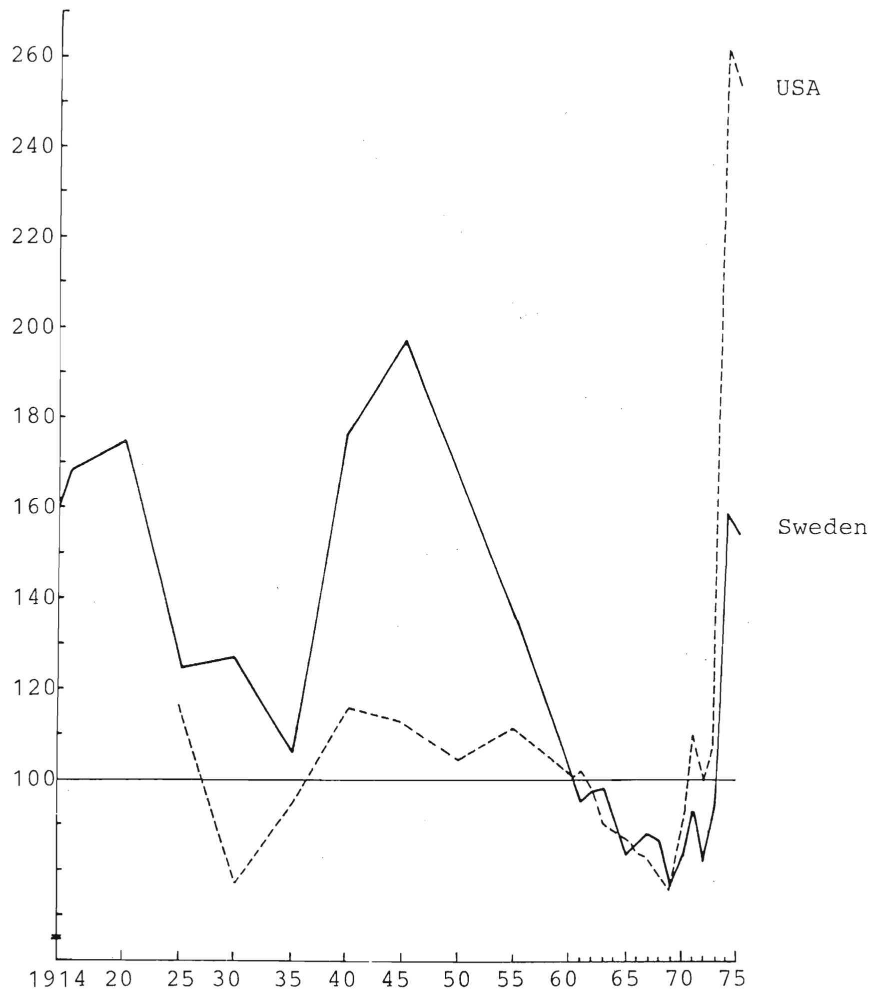
Figure 1 Industrial output in various countries 1960-80





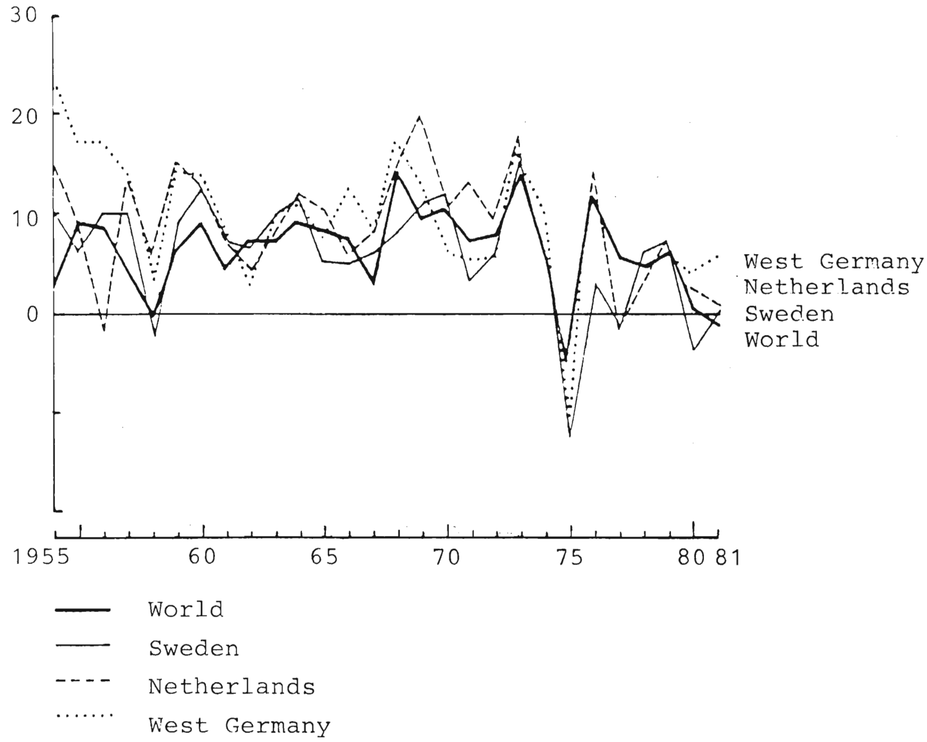
Sources: OECD and national sources.

Figure 2 The real price of heavy oil, 1913–80, defined by consumer price index, Sweden and USA



Source: Carlsson, Bo, Relative Energy Prices and Their Impact on Energy Consumption. Industrial Structure and Choice of Technology: An International Comparison. Repri from Ds I 1977:17, 1978, 87 pp.

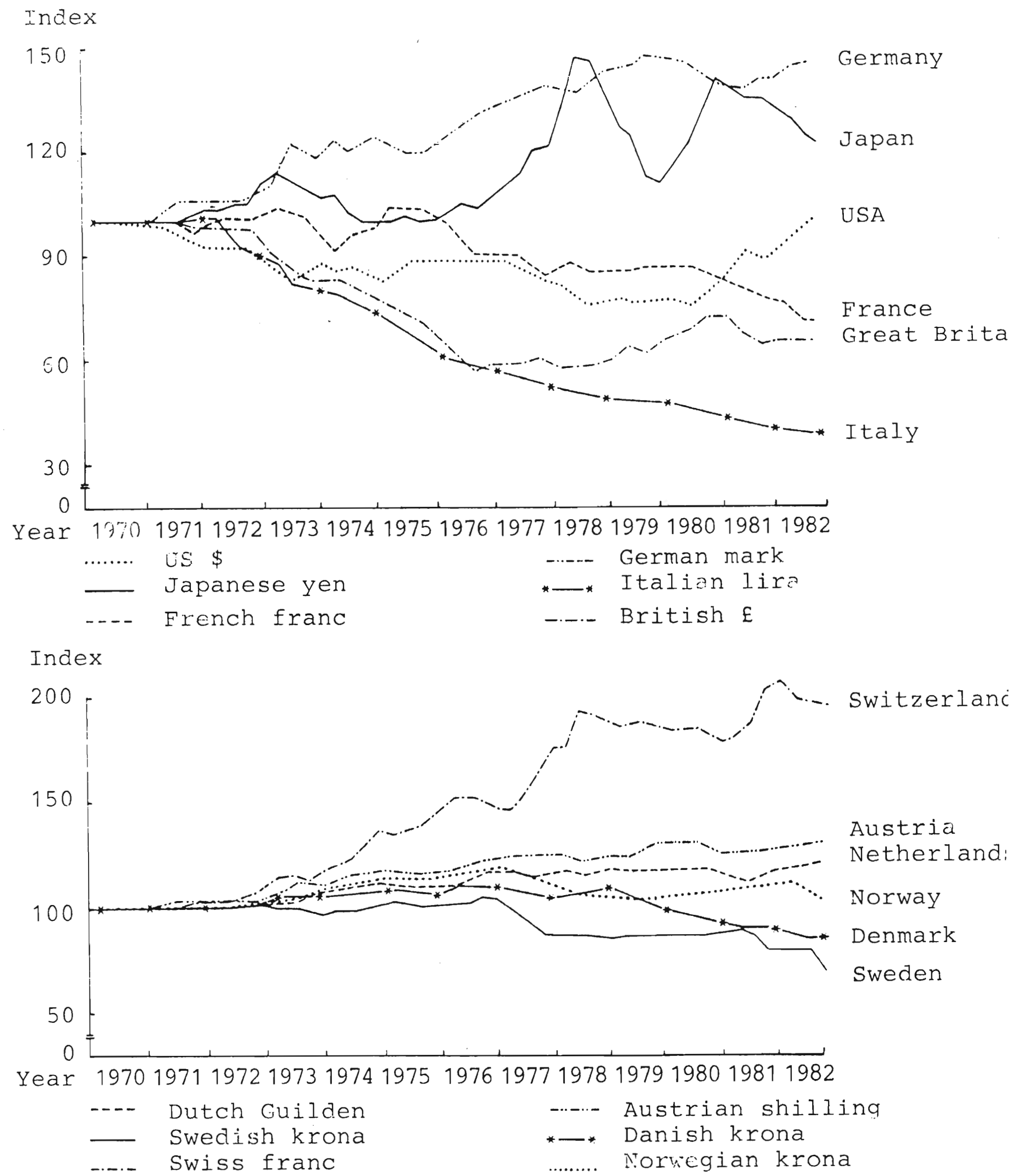
Figure 3 **World trade 1955-81**
Annual percentage volume changes



Source: IMF and estimates by Eva Christina Horwitz, IUI.

Figure 4 Effective exchange rates in various OECD countries 1970–82

Index 100 = 1970



Source: Lars Oxelheim, Foreign Exchange Risk Management in Swedish Corporations, Working Paper, Stockholm, 1982.

Figure 5 **Country comparisons, Austria, Sweden, West-Germany and all OECD, 1972-80**

Index 100 = corresponding value for OECD

Figure 5A **GDP development**

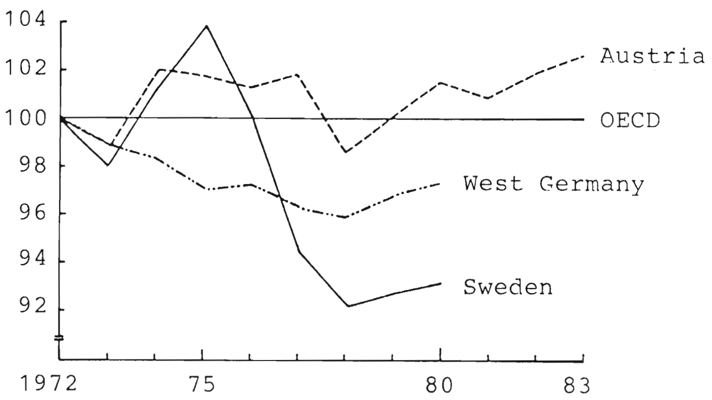


Figure 5B **Public consumption**

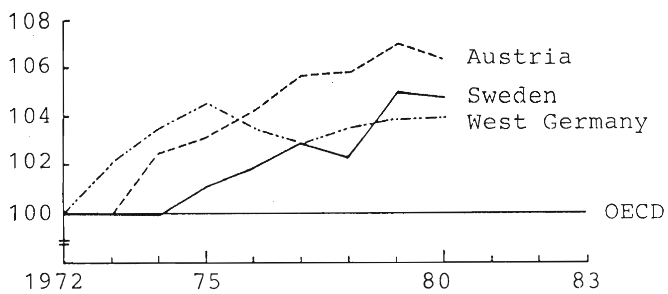


Figure 5C **Private consumption**

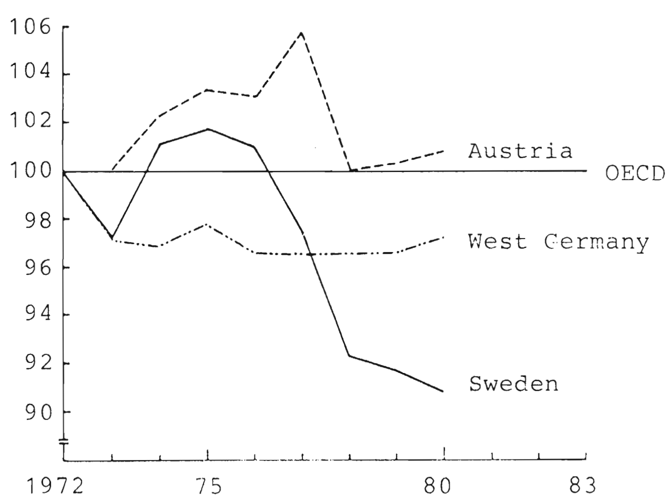


Figure 5D Manufacturing investment

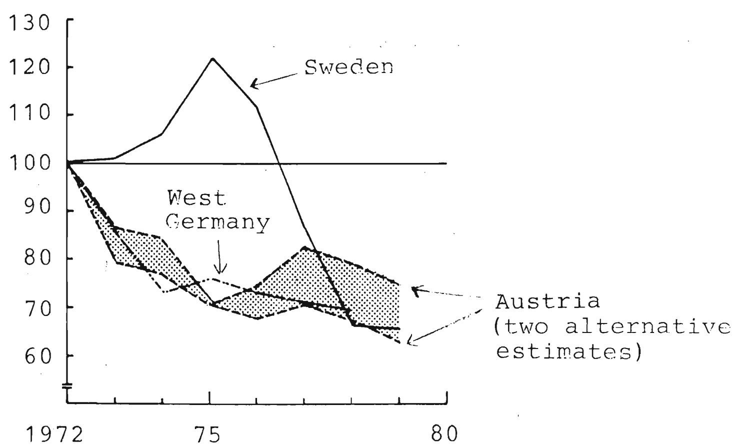


Figure 5E Exports

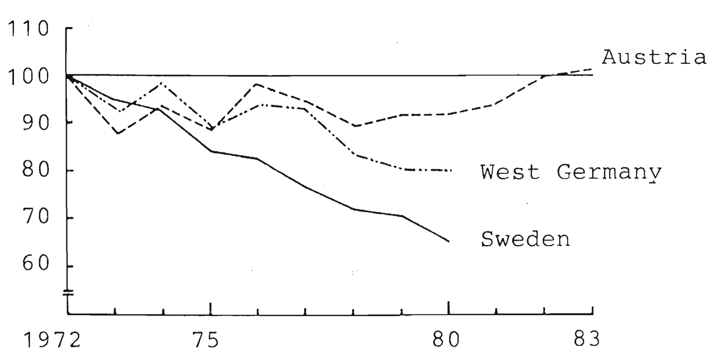


Figure 5F $ Export prices

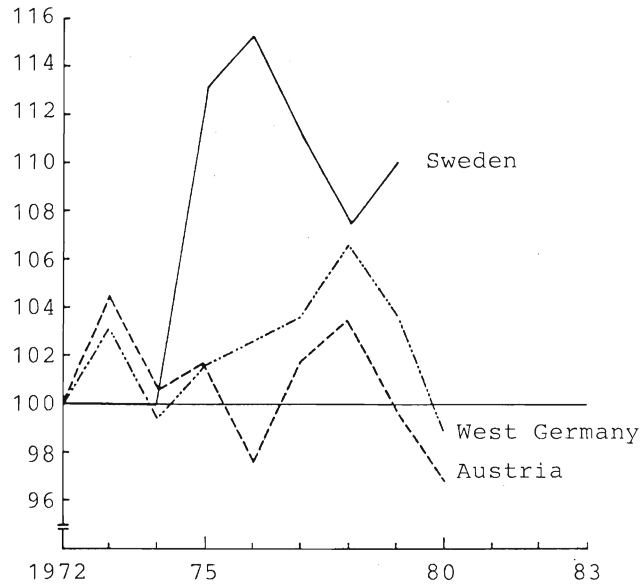
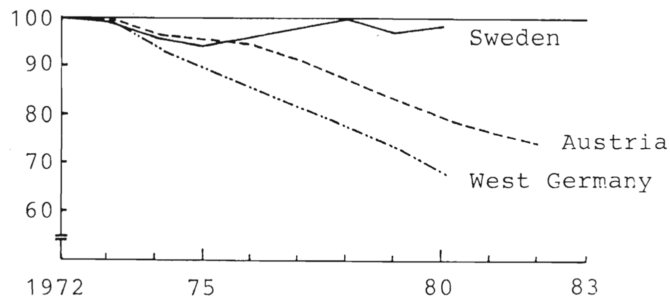


Figure 5G Consumer prices



Sources: OECD and nations sources.

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WHY DID IT HAPPEN?

The Origins of Inflation

With hindsight, we can trace the origins of the stability problems that became manifest in the 70s back to policies and developments of the preceding decades. The western economies that were hit by the supply shocks of the 70s were already inflation-prone from years of expansive demand policies exerting pressures on increasingly rigid supply structures. An accelerating inflationary drift was observed as early as the end of the 60s.

Stable and high economic growth rates in the 50s and 60s, unprecedented in recorded western economic history, led governments and electorates to view the future with confidence. Those governments were also led to neglect the adjustment problems associated with supply inflexibilities. Economists, politicians and the public at large tended to believe that cyclical variations in growth would shortly be compensated by government policies capable of returning the economy to stable and high long-term trend growth rates. Though unfavorable trends in world trade were already evident in the 60s, western industrial countries were, in their consumption behavior, discounting continuing high rates of economic growth.

That ill-founded optimism and sense of security not only led governments to institute long-term spending and redistributional schemes based on fast economic expansion, but also raised the aspirations of labor in regard to job security and steady wage increases, and made business less risk-conscious and willing to accept smaller safety-margins.

Investment levels in industrialized countries had long been propped up by low interest rate policies. Those policies sustained low rate-of-return capital vintages, which were very sensitive to competitive change in world markets, and particularly sensitive to increases in capital cost.

Concurrently, increasing specialization in trade and production, supported by a regime of fixed exchange rates, contributed to rapid increases in world output, but at the cost of increased structural inflexibility.

Expansive monetary and fiscal policies, aimed at maintaining full employment, also served to reinforce the trend towards increased rates of capacity utilization, increased wage shares in value added, and gradually declining rates of return in industries. Business risk-buffers (profit margins, financial gearing ratios etc) tended to be adjusted downwards in response to a perceived greater predictability in markets. Wage-increase expectations were at the same time conditioned on past, relatively high productivity growth rates.

Rigid supply structures, and market behavior characterized by monopolistic competition, meant that price disturbances, once initiated tended to bounce back and forth "within the system", sometimes in a cumulative fashion ("overshooting"; see Genberg's and Eliasson's papers). With wage- and price-setting becoming increasingly institutionalized in terms of wage norms, mark-ups and other rules-of-thumb, price flexibility and price competition were downgraded. Creeping inflation went largely unnoticed.

The Price Shocks

The supply shocks of the early 70s had all the more impact because they occurred in a world that had come to think of itself as shock-proof, as successfully and permanently riding a stable and high trend growth rate. Increasing supply inflexibility combined with constant inflationary demand pressure help explain why the oil price shock of 1973 so destabilized the industrial economies.

By chance, that oil price hike occurred almost simultaneously with other major supply disturbances. Food and other raw material prices increased substantially just before the oil price hike. Environmental controls and costs were beginning to be imposed in the wealthier industrial nations, notably on energy-producing facilities. Low interest-rate policies were generally being abandoned in industrialized countries towards the end of the 60s, principally because of the growth of an efficient, international credit market. The organized actions of labor were beginning to work in a supply-contracting direction, and the Bretton Woods system had collapsed in the early 70s. The industrial competence of the nonindustrial world was rapidly improving, and those countries were making competitive inroads in the markets for unsophisticated basic and engineering industries.

Those trends enhanced world-market competition, and squeezed profitability among firms in the industrial world from both the demand and the cost sides. Investment was discouraged, and a supply problem grew.

But the oil price shock was large in comparison with the other supply disturbances. It sent an immediate expectational wave of severe quantity cut-backs through the world economy. The resulting large relative price change between oil and other products and services (Figure 2), and the strong dispersion of relative prices persisted for several years.

Those primary disturbances led to two secondary imbalances. The first, in the international market-pricing system, amounted to a degradation of the information content of market signals. And the second was a further deterioration in the competitive situation of some basic industries already under secular competitive pressure from the new industrial countries. Increased relative energy prices hit the world tanker market immediately, and soon afterwards affected such other major users of energy as the automobile industry. Shipyards and large automobile manufacturers – the main users of standard steel – were affected soon thereafter, sending a third wave of effects through all stages of the steel industry, and reaching as far down into the production chain as high-cost iron mining. Some countries had relatively more of these so-called basic industries, and thus bore a disproportionate share of the structural adjustment burden.

But the question remains: why did the initial round of disturbances and reactions become cumulative? The explanation is to be sought in the rules and attitudes of actors in the markets that had developed during the preceding 20 years of prosperity and steady growth. In a global economy characterized by segmented monopolistic competition, all actors responded in a destabilizing way. Governments honored existing welfare commitments out of dwindling output growth. Households, facing inflation, tried to maintain the real value of their savings, or moved planned consumption forward in time. Firms were in an inflationary mood, since there seemed to be ample leeway for price increases without negative quantity effects. Rates of return that had been declining for years could temporarily be restored to higher, historical levels. Most signals – profits, for example – were, in an inflationary world, seriously biased measures and bad predictors. Money illusion was widespread; high profits and rapid inflation sparked a wage-compensation round that was easily accomodated by employers.

This initial inflationary wave had two immediate types of consequences. Price levels rose far beyond what a general mark-up for oil prices would suggest. That threw established relative prices out of line, preparing the way for future, inflationary adjustments. The second set of effects came in the form of cumulative quantity contractions.

Down We Go - Market Reactions

What was the nature of those quantity responses?

Within each national economy, initial quantity cut-backs driven by higher prices were seen shortly after the supply shocks. Producers then realized that factor prices, notably wages, had risen too far, and began idling unprofitable capacity. Unemployment rose; uncertainty increased, and producers increased their prices further to protect margins and cover perceived risks. The initial, significant price disturbance was now causing significant changes in both relative prices and quantities. A new round of the same chain of events was then initiated. Some producers, particularly in markets for staple basic products, were subjected to increased competition from the new industrialized countries, and first experienced an inflationary profit boom. They reacted perversely, by increasing investment and adjusting supply upwards, creating an oversupply in world markets.

The consequences of misinformation are well exemplified by the Swedish experience. Basic industries in Sweden registered a profit windfall immediately after the 1973 oil price hike. Those profit perceptions arose in part from biased information (price-inflated profits), and in part from biased expectation mechanisms (rules of thumb). These generated excessive optimism regarding future profits, leading to extraordinary wage increases throughout the labor market. A marked investment boom followed in the basic industries that later turned into crisis industries; the upwards drift of wages and salaries spread through the entire economy, and led to factor prices distorted relative to world prices. Swedish industry went into a nose dive (Figure 1) from which it has not yet recovered.

At the same time, the profitability and debt situation in the business sectors of most industrialized countries deteriorated. This reduced both incentives and financial backing for further risktaking and long-term financial commitments: a few successful firms were the exceptions to this rule. At the same time inflation, in conjunction with an income tax written in nominal terms, created new opportunities for short-term financial operations, making investment in manufacturing even less attractive.

All this led to demands for political remedies. Those demands often took the form of patchy, legislative reforms, adding further to increased uncertainty in the market. In most countries governments initially tried to stem the rise in unemployment. In the process, large deficits on foreign and domestic accounts were created, but demand was expanded in such a fashion that structural adjustment was impeded. Inflation then followed, and in order to avoid additional unemployment, additional demand was injected. Rising interest rates and flexible exchange rates were other important elements of the new, risky environment to which firms, households and governments had to adapt.

Rapid and increasing inflation had destabilized relative prices in the global economy and degraded the information value of price signals, thus increasing the general level of uncertainty in the world economy. Wage rates, rates of return and the interest rate were frequently seriously distorted, both within the individual industrial countries and in world trade. Those misalignments led to further erratic adjustments in exchange rates, making profit calculation and investment decisions even more difficult and hazardous.

A natural reaction to increased risk and uncertainty is to try to "play safe" by reducing long-term commitments and making faster and smaller adjustments. The sector in which long-run commitments are most typical is manufacturing. The contracting or crumbling markets of the late 70s, and the inefficiency of the fiscal remedies attempted, can be interpreted and understood from this commonsense point of view.

Market responses in individual countries were subsequently multiplied throughout the industrial world. Those economies are strongly interwoven by a network of trade, and inflation and other immediate effects were rapidly transmitted and reinforced. But even more important was the way macropolicies adopted by individual-country national authorities were augmented by international repercussions.

Wrong Go, Wrong Stop - the Policy Reactions

As illustrated above (Figures 5), policy responses throughout the industrialized world varied widely. The immediate post-1973 reaction was often protection of the domestic economy from mounting foreign deficits by demand restraint. That reaction was widespread, and world trade was severely contracted (Figure 3). When those depressive tendencies became apparent, most governments tried to protect employment by subsidizing crisis industries, honoring welfare commitments by generating public deficits and borrowing, and protecting domestic consumption levels by borrowing abroad. Even with accomodating monetary expansion, in many countries those responses pushed interest rates upward, further restraining investment.

As noted above, one important feature of most industrialized countries at the time of the first oil price hike was a reduced supply elasticity. With relative factor prices – especially after-tax wages and salaries – insulated from the supply shocks, and with obstacles to the withdrawal of resources from depressed industries, a mismatch of supply and demand structures developed.

Overcapacity could have rapidly disappeared through shutdowns. But policy authorities stepped in to support ailing or dying industries, preventing capacity from being scrapped and labor from searching new jobs, and supporting previously-negotiated relative wage and salary structures. Since basic industries, including shipyards and automobile manufacturing, had been high-wage industries, this meant that an existing relative wage structure providing no incentives for labor to move out of the crisis industries was made permanent by central policy decisions.

Next came growing public deficits and extensive foreign borrowing. It took some time for the authorities to realize the extent of the deficit problem, and to accept a share of the responsibility for creating a strong inflationary potential in the world economy and undermining the traditional self-regulatory mechanisms of supply.

Budget deficits and foreign indebtedness gradually became self-reinforcing through interest payments, particularly when interest rates were adjusted upwards, both in real terms and to compensate for inflation. High interest rates and unpredictable prices further reduced investment incentives, and lowered activity levels, thereby increasing claims on compensatory public expenditures, and leading to a vicious spiral of unemployment and inflation.

In some countries, notably the U.K. and the USA, the fight against inflation was given first priority. But because of installed rigidities in supply and in price- and wage-setting procedures, that deflationary policy called forth massive unemployment and required extremely high interest levels. World trade then contracted, increasing the employment problems of all the trading partners, and seemingly leading the OECD countries into long-term stagnation. A one-sided emphasis on demand management had thus misled governments into exaggerated and ill-timed go-stop policies. Finding a way out of the present stagnation will require a coordinated but cautious global demand expansion, complemented and preceded by a more decisive change in the industrial structure of western nations. This requires fighting inflation where it starts – in the wage- and price-setting decisions of firms and labor unions – and accepting an adjusted factor-price structure. But we question whether such a consensus global policy can be agreed upon, and whether we know enough to implement such a policy even if a consensus is reached.

WHAT DO WE KNOW?

During the 1970s, the unprecedented boom enjoyed by the Western economies in the postwar years ended; for most of those economies, the 1970s were years of slow growth and high unemployment. We have been discussing what went wrong. On one point there is considerable agreement: the supply-side shocks of the 1970s, particularly the oil- and food-price shocks, were significant. And policy responses to those shocks, conditioned by long experience with demand-side disturbances during the postwar boom years, may have been counterproductive and destabilizing. The question arises: how much of the economic shambles of the 70s is the result of the demand policies of the preceding decade, how much of the shocks of the early 70s, and how much of policy reactions to those shocks by national authorities?

Can we answer that question? Do we really understand how industrial economies behave when subjected to external disturbances like those of the 1970s? Can we say that we have learned from those experiences, so that we can manage our economies better next time? The authors of this introduction would answer these questions in the negative. And the papers collected in the present volume are evidence that we have a long way to go before economists understand dynamic economics and before we can recommend policies to improve the performance of economies in the state of disarray that has marked the industrial economies since 1973. The papers by Sharefkin and Faxén suggest that we have an even longer way to go to an understanding of the policy issues.

The papers presented in this volume range over the approaches suggested by received theory, in places suggest where received theory is inadequate, and finally suggest what may be better. They are clearly preliminary and exploratory, and rather lead to new and more specific questions.

Price Shocks: Mining the Data Evidence

In trying to assemble the data evidence to be used in hedging against prospective future shocks, just what data evidence is relevant? Because data on the Western economies have grown explosively over the past fourty years, there is a natural tendency to confine the inquest to those years, and even to the period of the supply shocks of the 1970s.

That, we think, would be a mistake. It is true that recent data are generally better data. But institutional and structural changes have occurred and been recorded in the Western economies for more than fifty or so years. This record embodies information on past adjustments to shocks, and can tell us about the state of the economy during the decade preceding the 1973 shock. The shock appears to be a long-run phenomenon, if we include both its origin and the adjustment period. The last great periods of price upheaval in the international economy, the periods of commodity price shocks during and immediately following the two world wars of this century and the Korean war, can teach us something. In their paper, Josefsson and Örtengren examine that record for the Swedish economy.

Even for that time of far less institutional price rigidity, the progress of a major price shock through the real economy is anything but rapid and smooth. The evidence suggests that we should be wary of theories, or models, that predict (or assume) adjustments to price shocks that are rapid and relatively costless in terms of the real economy. Josefsson and Örtengren find that relative prices dispersed greatly after 1972. It took some 7 years for them to stabilize again, just in time for the new oil price hike of 1979. Contrary to experience from "war shocks" and the Korean cycle in 1950/51, relative prices of manufactured goods returned roughly to where they were before the "oil price shock".

Perhaps more typical of modern analytical methods are the papers of Horwitz and Genberg. Both aim at extracting, from the relatively recent record, information critical to an understanding of how external price shocks affect the domestic economy. The results of both papers reinforce the general impression that the uncertainties surrounding those responses are enormous.

The paper by Horwitz examines the problem of estimating price elasticities of the goods imported, and exported, by a small open economy. The relevance of those estimates to, say, macropolicy makers making plans in the face of possible external price shocks is apparent. In the extreme case of unit price-elastic export and import demand functions, there is no problem: price shocks leave the values of imports and exports unchanged, and macroeconomic variables unchanged. In the very different extreme of large import-demand price elasticities, a sudden increase in the price of the imported commodity may result in excess demand on domestic resources. And in the related case of extreme export-demand price elasticity, that import-price shock may lead to domestic unemployment.

So much for the rather obvious point that those price elasticities carry important information for macropolicy makers. But how much do we actually know about those elasticities? The answer is clearly "too little", as demonstrated by the specification-sensitivity of the results reviewed in Horwitz' paper. It is not unusual for there to be a difference of a factor of 2 in estimates of import or export price elasticities, depending upon the inclusion or exclusion of restrictions imposed upon the estimating equation. The latter often involve variables which are proxies for incompletely-understood effects.

Nevertheless, those large bounds carry important information for macropolicy makers. They indicate the range of consequences – in terms of domestic inflation and employment – that should be associated with the risk of an external price shock. If those policy makers act like good statistical decision theorists, they will express their beliefs about future shocks and their effects as probabilities. Then they will associate with any given shock, and any given set of elasticities, a macroeconomic "consequence". Among other things, Horwitz' paper tells us that the marginal probability distribution on price elasticities must, on the data evidence, be relatively flat. In other words, the possibility of high elasticities, and large shock effects, cannot be excluded. That means that expected losses from shocks, and the value of policies aimed at insuring against or mitigating the effects of shocks, may be large.

The model underlying Horwitz' paper is an adaption of the standard neoclassical Walrasian model, and of course embraces the corresponding informational assumptions: information is costless and perfect. Over the last decade, economists have increasingly moved away from those assumptions, and toward a recognition of the importance of information costs and informational imperfections.

Genberg's paper is in this spirit. His results confirm those of Josefsson and Örtengren in that he observes a relatively long transmission period for external price impulses, and a transmission time that depends on the size of the external price shock. His results also confirm the existence of "overshooting": prices move away from their long-run "equilibrium" position for some time before they converge. That property of a dynamic economic system is demonstrated in simulation experiments in Eliasson's paper, and the quantity responses of the economy appear to be both large and long-lived.

Genberg first develops an apparatus for distinguishing, and then estimating, the effects of anticipated domestic inflation, on the one hand, and external inflation, on the other, on the domestic price level. The point of the exercise and its importance for policy vis-à-vis shocks is apparent. If external price shocks – in contrast to domestically-generated price rises – are unanticipated, then forecasts of the impact of price shocks must be based upon estimated inflation equations which distinguish between anticipated and unanticipated inflation (cf Faxén's paper).

The point is unarguable, and the econometric results are intriguing. Nevertheless, it is important to remember that Genberg's method is what electrical engineers call a "black box" method: a price-related equation is estimated from time series, with relatively little fuss about the variables and mechanisms excluded from that equation. There are "inputs", anticipated and unanticipated price shocks, and there is an "output", the change in the domestic price level. The "real world" of price and quantity changes in the real economy lies within the "black box".

Since the method is an attempt to confirm simulation results from the micro-to-macro model (see Eliasson's paper), one might use that model to explain the long lags. The main explanation seems to lie in the time needed to transmit price increases by way of economic agents through a multitude of markets. In the process mistakes are made, especially if initial price shocks are large. Disturbances are transmitted through the economy and may be magnified for some time. Both prices and quantities may overshoot and move away from their long-term positions for a considerable time before they begin to converge.

These simulation experiments also demonstrate (1) that the character of the price transmission can significantly affect the allocation of resources in the economy, and hence economic growth, and (2) that policy-making on the part of national authorities can affect the properties of the price transmission mechanisms. One lesson from Fries' country comparison (the Netherlands, Sweden, the United Kingdom and West Germany) is that the four countries differed considerably in their real economic responses after 1973. The more governments interfered with resource allocation mechanisms, slowing down the adjustment process, the lower were realized rates of post-shock economic growth.

Learning From Shocks with Models

To go beyond "black box" statistical methods, we must impose prior information on the data evidence, information summarizing what we think we know about how economic agents act, and how the market and other institutions resolve conflicting demands for scarce resources. The papers by Sarma and Ysander, and part of Eliasson's paper tell us how to learn from the shocks of the 1970s. Each, in its own way, tells us how to use what we learn to deal with prospective future shocks. Each of those papers either constructs, or suggests construction of, a model or models relevant for those purposes. The conceptual device – the glasses – we put on to interpret what we observe in the economy tell different stories, and especially about what policy makers should do.

Agreement on measures for ex post evaluation of a policy aimed at preventing, or mitigating, the impacts of prospective shocks is quite general: we all want relatively stable growth and reasonable price-level stability. But the policy debates of the 1970s, and the postmortems of the 1980s, revealed sharp disagreement about "how to get there". Those disagreements often took the form of public disputation over the conflicting predictions and implications of various models of the economy and the energy subeconomy. But where models really differ is in their preconceptions. Those essential differences are often hard to bring to the surface.

The papers by Sarma, Ysander and Eliasson provide a setting for that important exercise. We suggest that they be read with the following questions in mind. What does this model assume about the ways firms and governments act during a price shock? What does this model assume about the way the price mechanism links firms and the government? And how plausible are those assumptions?

The reader must conduct his or her own foray through this material. But the trip can be made more tempting if we hint at the richness of the questions raised by these papers. Begin with the Sarma paper. There, the Wharton Econometric Associates (or WEFA) and LINK models are joined to forecast the impact on the international economy of an oil price shock. Very roughly, the individual national economies are represented by econometrically-estimated macroeconomic models. Since macroeconomic disturbances in any one national economy propagate into all others through the international trade and the international monetary system, those interdependencies must be represented.

A look at the model runs suggest that the propagation of a price shock through the macroeconomy is relatively rapid and not very traumatic for the real economy. Inflationary consequences are constrained by implicit mark-up pricing and no overshooting assumptions. In fact, the quantity effects appear so minor that it seems natural to ask why. The 50 percent oil price hike in 1979 yields a world steady-state GNP effect of less than 0.5 percent. The OECD area has lost 1 percent of its GDP (relative to the base, reference case) by 1985, and no more. Are there no dynamic allocation effects, no price destabilization, no price overshooting among and between countries? That question naturally leads us to another: how are consumer and firm responses to price shocks and market mechanisms represented in conventional macroeconomic models?

The short answer is that such events are excluded from models of this kind by assumption. What serves instead is a set of equations describing how individual industries, or sectors, make price and output decisions. Those industry or sector equations typically include the quantity effects that are the hallmark of macroeconomic models. Industries and sectors respond to cost increases by mark-up pricing increases. Those mark-ups are usually constant percentage mark-ups independent of the magnitude of the cost increase. Quantity effects arise from the impact of aggregate pricelevel inflation on demand.

For that reason, large price shocks affect the WEFA-LINK model much as small shocks do, only proportionately more. After the shock, with a return to normal rates of inflation, the real economy rapidly returns to normal. Large shocks do not call into question the way in which firms make price and quantity decisions, and neither do they force changes in the way in which government stabilization policy is conducted.

Is all this plausible? The answer probably depends upon the magnitude of the shock. Surely there are disturbances large enough to force changes in both firm and government behavior, though it is far from clear how to model such changes. The papers by Ysander and Eliasson both represent attempts in this direction. One way to look at Ysander's paper is as analyzing and evaluating government post-shock behavior. The essential insight is simple but important: government medium-term macroeconomic policy rules can be sources of poor long-term responses to shocks; rules for public sector employment and wage-setting can be particularly important. Note how different this is from the view of the economic agent called "the government" that is implicit in conventional macroeconomics. There, the government controls the fiscal and monetary policy instruments and runs stabilization policy. Its objectives are short-term, and success in short-term policy is assumed to guarantee success in medium-term policy.

Ysander departs from standard theory by taking explicit account both of the various possible political restrictions on public policy and of the different kinds of inertia or adjustment lags connected with capital structure, wage- and price-setting procedures etc. A rather detailed modelling of energy supply and use also makes possible a more direct tracing of the transmission of energy price hikes through the economy. In his model, existing medium-term stabilization policy can be a source of poor adaptation to shock-related structural imbalances.

Similarly, Eliasson's paper departs from standard macroeconomic theory in its description of the firm. The paper examines the effects of an oil price shock in a model setting in which there are real firms. Perhaps the contrast with the representation of the firm in conventional macroeconomic models makes the point best. In conventional macroeconomic models like the WEFA model, firms respond to cost shocks of whatever magnitude by mark-up price increases. But in the micro-to-macro model, firms are represented as organizations with real-world rules for transmitting price and cost change into employment, output and pricing decisions. Those decisions are in general not the same as, and are hopefully more realistic than, mark-up pricing rules.

Finally, note how the model chosen can condition the policy responses identified as feasible. Conventional macroeconomic models focus our attention on fiscal and monetary policy. Ysander's model directs us to government medium-term policy; Eliasson's model points us to those choices which can increase the adaptability of individual firms to post-shock conditions.

After the Shock: Stability and Reality

Whatever the model, it must be judged by its descriptive realism and by the extent to which it allows us to identify good policies. In some significant ways, the 1970s changed economists' preceptions of then-existing economic models. In particular, the feeling that neoclassical equilibrium concepts are seriously inadequate gained ground. The reasons are of course relevant to the issue central to the papers in this volume: what can be done about prospective shocks to the economy? Do we know more now about how to handle the next shock than we did in 1973 or 1979?

The sources of dissatisfaction with equilibrium economics are many and we must be selective here. One is at least as old as modern macroeconomics itself: the observation that there are long periods in which prices do not clear markets. At the onset, macroeconomic theory incorporated that assumption by fiat, simply declaring that certain prices were rigid "for institutional reasons". There have been subsequent attempts to rationalize that declaration, typically by establishing conditions under which rational economic agents – labor unions and firms – will choose rigid, long-term contract prices.

That seems to us to be a halfway measure, and one which overlooks an important and necessary source of "price rigidity", the large nonprice allocation systems we call "firms" and the public sector. In an influential paper, Coase (1937) argued that the extent of the firm is determined by the boundary at which the advantages of price and nonprice allocation mechanisms are equalized. Firms are, in effect, large decision systems with operating rules formulated in both quantity and price terms: while ultimately responsive to the price system, those rules need not be immediately responsive to even abrupt changes in "external" prices.

That separation allows the advantages of both allocation mechanisms, quantity and price, to be exploited. But it seems likely that exploitation of both kinds of allocation schemes requires relatively stable prices. In this perspective, one source of persistent disequilibrium is the slow internal response of the nonprice allocation systems, and especially the public sector, to extraordinary rapid changes in external prices.

In such an economy, shocks can "overwhelm" the system, in effect requiring that existing institutions perish. New institutions with internal allocation systems better matched to the external environment must take their places before there can be a return to steady growth and reasonable employment levels.

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A MORE SHOCK-PROOF ECONOMY?

Our Current Predicament: Some Perspectives

As we read and reread our own account of the transition – from the steady growth of the 60s to the disarray of the 80s – central to this book, we find it almost impossible to point to a single, dominant strand. Instead there are many. There is the broad problem of the *relationship* between the *micro and macro* levels of analysis, between stability at the macro level and flexibility at the micro level. We say relationship rather than micro foundations of macro, the standard formulation, because we believe that the determinancy runs both ways.

There is the *game-theoretic* problem: if all countries can agree to a demand expansion compatible with the correct long-run adjustment of supply, then we may be able to bring ourselves out of the current world recession. But if such an agreement cannot be reached then we all will hang together, perhaps indefinitely.

There is the theme, and the problem, of the gradual *disruption* and corruption *of the price system,* by governments and national authorities carrying out policies leading to inflation. The price system becomes increasingly noisy, firms find it increasingly difficult to distinguish signals from noise, and the decentralizing functions of the price system are lost gradually.

There is the theme, dating at least to Schumpeter, of the dynamic *welfare benefits of the business cycle.* The cycle, Schumpeter held, inspired winners and eliminated losers. Smoothing the cycle helps some in the short run but at the price of imposing costs on all of us, in the long run.

There is the theme of the conflict, or *tradeoff, between short-term stabilization and redistributional policies,* on the one hand, and long-term stability and flexibility requirements, on the other. Many of the policy measures that have evolved in the industrial countries since the depression of the thirties aim at moderating the rigors of the business cycle. Most of those measures are necessarily redistributional, but many also have the effect of insulating major segments of our economies from the discipline of the price system. For that reason those measures contribute to increasing inflexibility, and greater instability. Flexibility is virtually synonymous with responsiveness to price signals indicating the need to reallocate resources. And stability at the macro level requires flexibility at the micro level: if resources cannot move relatively easily between firms and sectors, then the ensuing disequilibria, and high levels of unemployment in particular, will give rise to political pressures for the further distortion of the price system.

Finally, there is the theme of *increasing international competition,* particularly from the newly-industrialized countries. Many of the crisis industries in the advanced industrial nations are crisis industries because new competitors, armed with the latest technologies and unencumbered by outdated labor practices, have entered the field.

So much for a listing of our current problems. Any one of those perspectives can be, and has been, the point of departure for scholarly disputation and policy debate. In fact the choice of a particular perspective is perhaps the most important step towards analysis and subsequent advocacy, because it amounts to a choice of a way to look at what is important in the world. From there it is a short distance to defining a research agenda and only a slightly longer distance to policy recommendations. We want to emphasize caution here. No one of these perspectives alone explains the debacle of the 70s; they are all important and interdependent. And thus far we have no satisfactory method for integrating these perspectives: that is why we have a problem of understanding.

Our own view is eclectic, and partly conditioned by our views of what is possible. Thus increasing international competition is a fact of life, but from at least one point of view a humdrum fact: were the world economy working smoothly, and were the individual economies of the advanced countries functioning as they should, rising productivity in the newly industrialized countries could contribute to increasing the welfare of all countries. The real problem presented by the newly industrialized countries is the problem of understanding why the adaptation of the advanced industrial economies to those new competitors has, this time, been so sluggish and inadequate.

Similarly, we do not believe that the cooperative games perspective should be placed high on the research agenda. This is not to say that the perspective is either uninteresting or unimportant. To the contrary, the international monetary system, and the stabilization problem among the advanced industrial economies more broadly defined, are helpfully viewed as games that can be cooperative, but that can also degenerate into noncooperative, arrangements. In the relatively open economies that all the advanced countries have now become it is obvious, for example, that demand expansion in one country will fail if all other countries are deflating. To paraphrase a famous expression, Keynesianism in one country is impossible.

Then why don't we award this perspective pride of place on the research agenda? Because world models based on incorrect national macromodels may be misleading. We can of course try to model the world economy as a set of coupled macroeconomies, using standard models for each of the countries. But we believe that many of the features critical to an understanding of our current predicament are excluded from those models. For that reason we will have little confidence in the individual country models, and even less confidence in a world model built on those national models.

This exclusion leaves us with the following research agenda for the macroeconomics of the 80s and 90s. Three broad areas are defined: decision rules in large organizations, the relationship between micro and macro levels, and the general area of what might be called catching up with Schumpeter.

Decision Rules in Firms

In the 1965 blackout of the Northeast U.S. power grid, failure of a relatively small component of one power system led to failure of the power grid for the entire northeastern United States. In retrospect, it is easy to see what happened. A large, interconnected system is simply too complex to allow complete enumeration of all possible failure sequences: only the most likely sequences can be studied. The operating rules of each of the subsystems comprising the power grid are then designed to handle those "most likely" failure sequences: because operating rules must be simple and rapidly applicable, they cannot cover all possibilities. Inevitably, there will be some combination of component failures which, given the subsystem failures, will trigger system failure. Again, the analogy with severe economic disruptions more or less suggests itself. The subsystems are the firms, the households and the government, the major economic agents. The operating rules are those agents' normal practice operating rules, derived from years of experience in "normal" economic environments. Unusual, disruptive events, like oil price shocks, combined with the responses they trigger via agents' operating rules, can lead to severe disruptions of the economic system. And the state of the system at the time of the shock will condition the nature of its response.

Models built along these new lines may have surprising properties. Underlying the relatively simple dynamic structure of the traditional models of price and quantity adjustment that economists work with are rather strong assumptions about what market agents – individuals and firms – know, and about how they act on what they know.

Typically, those actions are dictated by some optimizing model of individual or firm action. Many years ago, debates raged in the economics profession about the validity of such optimizing models, and about the relevance of alternative behavioral models, notably so-called satisficing models. Those debates generally ran in terms of statics, but the issue seems more important, and its outcome more critical, in a dynamic setting. There, the time lag within which firms must respond to significant changes in their operating environments is too short to permit the full accomodation implied by optimization models: in fact they use rules of thumb that have been "learned" by past experience. And it is not only in the private sector that we find decision rules that are only loosely related to optimizing principles in place: in the public sector such rules are typical, rather than exceptional.

But serious disruptions are ultimately overcome. The Northeast grid was restored to service, and firms, under pressure, abandon old rules and search for better ones. In a sense "the dynamic system" has simply been redefined at a higher level: it is now determined by all agents' choices of operating rules. But that second level of choice is crucial. It is the essential difference between physical systems, which follow invariable laws, and economies composed of agents who change the rules of the game while they play. That second level of choice must be adequately modeled – in a way reflecting the real information and decision procedures of the major agents – if there is to be any hope of understanding major disruptions in the economy.

Beyond calling attention to this analogy as a general source of inspiration, we call attention to some implications. The most important has to do with method. To come straight to the point, we believe that future work on macroeconomics will have to make far greater use of simulation methods. The radical decreases in the cost of computation over the past few years make this recommendation feasible. Once we recognize that the economy is populated by major actors employing their own decision rules, the necessity of simulation methods is almost a foregone conclusion. Only highly-simplified full-optimization rules will allow easy, analytical assertions about system stability properties. Realistic sets of decision rules permit no such easy generalization from the micro-to-macro levels: simulation is necessary for serious analysis.

Micro and Macro Stability

It might be helpful, in facing up to our current predicament, if the economics profession recognized how limited, and how accidental, its current perspective on questions of stability is. The profession has learned much of what it knows about such questions by borrowing from physical science. This is not surprising: the oldest principle of learning is that something is easy to learn if you can assimilate it to one of your "own" models. The Walrasian general equilibrium model, from which we derive most of our notions of economics, was borrowed from Newton and Laplace: it is, down to the assumption that information is costless, the model of classical physics. And since there can be instabilities in classical physics, attempts have been made to borrow those as descriptions of the instabilities observed in economic systems.

This is illustrated by the physical phenomenon of turbulence, which occurs under certain conditions in all fluid flows through, or around, solid boundaries. For certain ranges of the system parameters – especially the fluid-solid relative velocity – the flow pattern is smooth, or "laminar", and changes only gradually with small changes in the parameters. The flow pattern might be said to be "resilient" to those parameter changes at those parameter values.

But there is one, or there are several, discrete critical parameter values above which the flow pattern becomes anything but smooth: in this transition to turbulence, the flow appears to be unstable and chaotic, perhaps even "stochastic", despite the essential determinism of the basic equations defining the system. According to the modern theories of the onset of turbulence, such "stochastic" appearance is generated not by any "inherently" random mechanism, but by extreme sensitivity of the flow pattern to initial conditions. In that region, the flow pattern is no longer "resilient" to changes in the parameters. Since molecular fluctuations (if nothing else) always guarantee fluctuations in the initial conditions, the observed flow pattern will seem random or chaotic. But by analyzing the equations, we can determine where in the parameter space the "onset of turbulence" may occur: in this way we can try to design our systems to avoid, or mitigate, the problems associated with turbulence.

The temptation to apply such models to social phenomena is strong. Occasionally we do observe severe disruptions of "business as usual", such as large firm bankruptcies or severe depressions. Since we tend to think of the economy in normal operation as a kind of self-equilibrating dynamic system, disruptive events appear analogous to the "onset of turbulence". Our theories of economies operating in their "normal range" might at the same time define regions, in the space of the parameters defining the economic system, where severe disruptions are likely.

But we are skeptical about this analogy. The instabilities of classical physics arise from the interaction between the local and the global. And the components of the system are not agents with objectives of their own. Thus we believe there will be diminishing returns to continuing efforts to learn about the causes of economic disarray from this particular natural-science analogy. But there may be a better set of natural-science models to draw upon for a rigorous notion of the relationship between macro stability and micro flexibility. Look at firm entry and exit into industries, and at technical and organizational changes in existing firms, as kinds of diffusion processes. Diffusion is a generic name for physical processes which, though based upon the random motion of many individual particles, nevertheless exhibit some coherence in the aggregate. Those physical diffusion processes are typically driven by the thermal kinetic energies of the individual molecules or particules. To make the analogy explicit: individual firms are the diffusing particles, their position coordinates are indexed by technologies and operating practices, and the processes are driven by profit incentives. The latter will vary over the business cycle, and thus so will the rates at which firms search over, and move between, "positions" – physical plant and operating practices. An industry is a cluster of diffusing firms, following and surrounding an "average firm" orbit. But in an industry of limited diversity, all firms cluster in a thin pencil about the orbit. In the former case macro shocks – shifts in the demand orbit – can be relatively easily tracked by the industry, because the initial spread of firms leaves some close to where the new orbit will lie. But in the latter case, a macro shock – a sudden shift in the orbit – will find almost all firms far away from the new, postshock, correct average-firm orbit. In the latter case, swings in industry output will be greater than in the former: thus the connection between micro diversity, or flexibility, and macro stability.

Within this kind of model we may be able to add a new, dynamic dimension to our understanding of industry structure, conduct, and performance. Most theories of industrial organization are essentially static: the model sketched above adds another, essentially macro and dynamic dimension to performance – the industry's contribution to macro stability. And in this kind of framework we may be able to sharpen our own notions of the tradeoff between a moderated business cycle and the longer-term welfare penalty from weakened incentives to dynamic efficiency.

Catching up with Schumpeter

Prosperity makes odd bedfellows, and no two have been odder than the Keynesian and Walrasian traditions that have dominated the thinking of the economics profession in the post-Second World War period. Paul Samuelson, in his famous text, came close to declaring the marriage permanent when he coined the phrase "the grand neoclassical synthesis". That phrase meant that Keynesian fiscal and monetary policies could keep the economy operating at or near full employment, in which operating range Walrasian general equilibrium theory became the correct theory of price formation and income distribution.

Much of the analytical effort of the economics profession rested upon that synthesis. And the general conviction that the macroeconomic problem had been solved diverted both analytical attention and professional energy away from another, and we believe deeper, vision of modern capitalism. We are referring to Schumpeter, today considered hopelessly outdated by many of those economists who have taken the trouble to read him at all. This, to say the least, is unfortunate. If Schumpeter has not received the analytical wrapping that has been given Walras, it is because formalization is intrinsically harder, and because the profession hasn't tried very hard.

It should, and soon. For many of the insights that we can draw upon in seeking ways of understanding, and in seeking policies for improving upon, our current predicaments are Schumpeter's. This is most clearly true of the dynamic welfare analysis of the business cycle. Having tried to eliminate the cycle, we may have both increased its amplitude and sacrificed its contribution to maintaining the flexibility and resilience of the agents populating the economic landscape. The formulation of a rigorous framework in which to think about the tradeoff between short- and long-term stability seems to us to merit serious attention.

Part of that effort will necessarily involve an attempt at understanding the cost, in efficiency losses, of policies which degrade and disguise the informational content of price signals. Firms, in making their investment and output decisions, lean heavily on those signals. And since all signals are composed of both information and noise, firms must be able to discriminate between the two when making decisions.

But such discrimination becomes harder as more and more noise is superimposed on the underlying information. And we are convinced that so-called general inflation, often described by economists as a simple rate of increase in the general price level, has this effect. That is because inflationary shocks are transmitted through different sectors at different speeds, so that it is very difficult to know what is inflationary noise and what is signal. Incidentally there is a discipline devoted to just this problem: control engineers try to build decision rules for controlling systems by first separating information from noise, and then acting upon the extracted information.

These suggestions represent an ambitious program for economic research in the coming decades. But they cannot be avoided if we are to do better during the next twenty years than we have done over the past twenty years. In fact, since what is acceptable as doctrine so conditions what is thinkable as policy, we would go further: without such a program, we are unlikely to do better. We invite readers of this very preliminary volume to share in that effort.

PART II

EMPIRICAL STUDIES

CRISES, INFLATION AND RELATIVE PRICES INVESTIGATIONS INTO PRICE STRUCTURE STABILITY IN SWEDISH INDUSTRY 1913-80

by Märtha Josefsson and Johan Örtengren

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I INTRODUCTION

Like most industrialized countries, Sweden experienced a shift upwards in the rate of inflation during the seventies. Since 1972, the average annual increase in the general price level has exceeded 8 percent. This is not only the highest rate of inflation since the Korean boom in 1951, but also the longest peacetime inflationary period in Sweden since the industrialization process started.

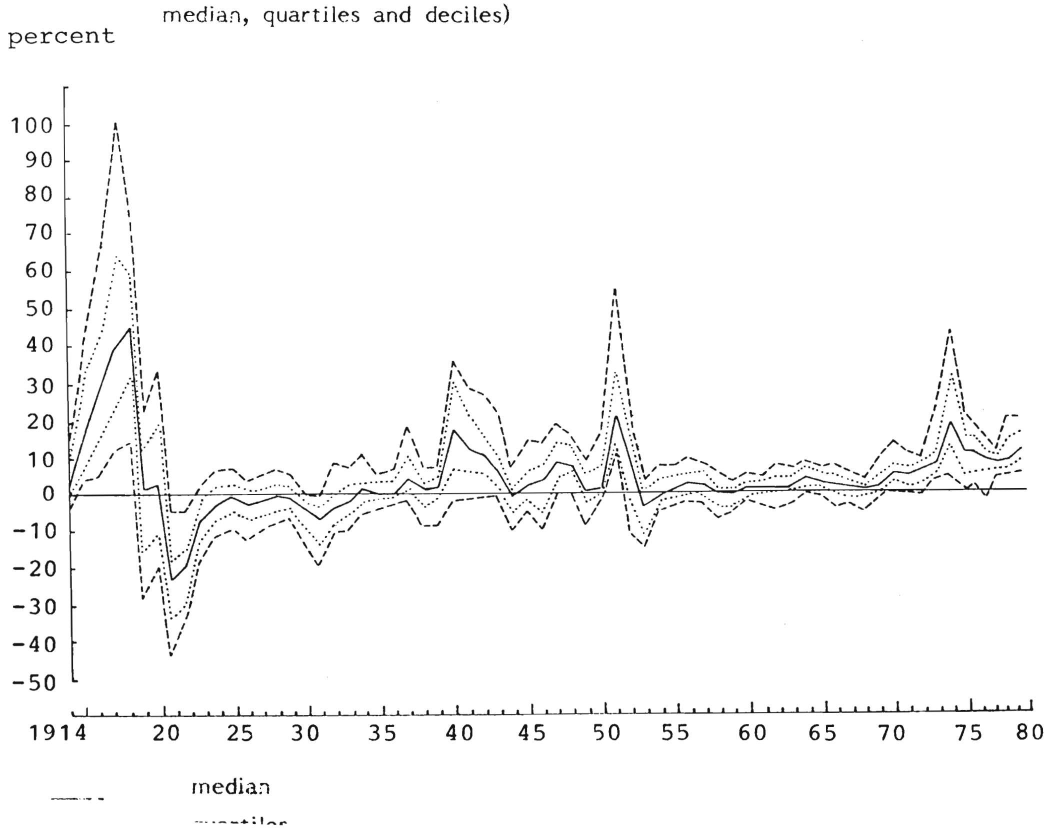
Aggregate price indices are, however, only rudimentary representations of what has happened to prices in the Swedish economy. Behind the figure on inflation there is a broad spectrum of diverging price movements. Between 1970 and 1980 industry prices on average increased 151 per cent in Sweden.[1] In some industries prices went up considerably more, for example in the oil industry (+ 406 percent), the cement industry (+ 244 percent), the glass industry (+ 226 percent), the sawmills (+ 229 percent) or the candy industry (+ 214 percent). On the other hand prices in the mining industry only rose 86 percent, in the steel industry 122 percent, in the shipyards 101 percent, in the dairy industry 89 percent and in the milling industry 68 percent.

The 70s are of course not unique in this respect. On the contrary the whole period treated in this paper is characterized by strongly diverging price movements in different industries. A picture of this diversity is given in Figure 1, which shows the median, quartiles and deciles in yearly price changes in 42 industries. Thus a point on the bottom curve delimits those four industries that experienced the lowest rate of change in prices that year.

Figure 1 illustrates that the aggregate inflation figure conceals large differences among industries. It also points to the role of prices in the industrial transformation process. In a market economy, the fundamental task of the price system is to communicate information to those who participate in the market process, producers as well as customers. They need the information in order

Figure 1 **Prices in Swedish industry 1913–77**

(Annual percentage change in prices in 42 industries: median, quartiles and deciles)



to decide what to produce and how, as well as what to buy. The efficiency with which a working price system performs this task and coordinates the fragmentary knowledge possessed by the participants in the market process makes it indispensable in a working market economy. (See, for example Hayek, 1949.)

The price signals relevant for resource allocation, are, however, not the nominal prices but the changes in relative prices. This paper focuses on relative prices as the most important part of the information system in a market economy. Changes in relative prices indicate a need to reallocate resources in one way or another. A short-run temporary change indicates a need to reallocate resources over time, but within the given production framework. If, however, a change in relative prices reflects or is interpreted as reflecting long-run changes in the supply and/or demand conditions we have what might be called a transformation pressure, i.e. a need for long-run adjustments.[2]

Interpretations and expectations are keywords in this context since they form the basis for decisions taken by the economic agents. Temporary changes in relative prices may be wrongly interpreted as reflecting a transformation pressure, and thus may lead to errors investment. This was for instance the case in the Swedish shipyards during the first half of the 70s. Difficulties to discriminate distinguishing between price signals may also have contributed to the widespread uncertainty characterizing the business world at the beginning of the 80s.

The reshuffling of factor and product prices that has been the result of the two oil price hikes of the 1970s provides a good example of transformation pressure with repercussions throughout the economy. One reaction among economic agents has been to reallocate resources towards energy saving. In the U.S., for example, there has been a shift in demand from large domestic cars to smaller imported cars that use less gasoline.

The rest of this paper is organized as follows.

First, we start with a brief discussion of the factors determining the development of relative prices in the market process.

Second, we study the short-run stability of industrial prices in Sweden, especially the relationship between annual relative price dispersion and inflation.

Third, a more long-run perspective is taken with focus on transformation pressure. The relationship between long-run relative price movements and the inflation rate is examined.

Fourth, we study the development and stability of industry prices in the Swedish industry during periods of "abnormal" imbalances -- during the two world wars and their aftermaths, the great depression of the 30s, and the stagflationary crises of the 70s.

II RELATIVE PRICES IN THE MARKET PROCESS - AN INTRODUCTORY DISCUSSION

A characteristic feature of economic development is the movement from one set of disequilibria to another. Under certain assumptions and conditions we can construct "virtual" equilibria at any point in time. We may perhaps also assume that these equilibria indicate the direction in which the economy would be heading, given no change in other market conditions.

Although never attained in reality, such hypothetical equilibria are a useful conceptual tool. We therefore start by assuming that the economy is in a state of long-run equilibrium. All economic agents are omniscient and have full knowledge of tastes, technical possibilities, etc. All expectations and actions are consistent with ruling prices and quantities that are associated with the equilibrium.

Regarding prices, this means that in each product market the prices of the products correspond to their cost of production, including the cost of capital. This can be expressed as

$$P_i = c_i$$

where $i = 1,2,....,n$

The cost of production of product i can be expressed as

$$c_i = \sum_{j=1}^{m} v_{ij} P_j$$

where

$i = 1,2,....,n$

v_{ij} = requirement of factor j in the production of product i

P_j = price of factor j

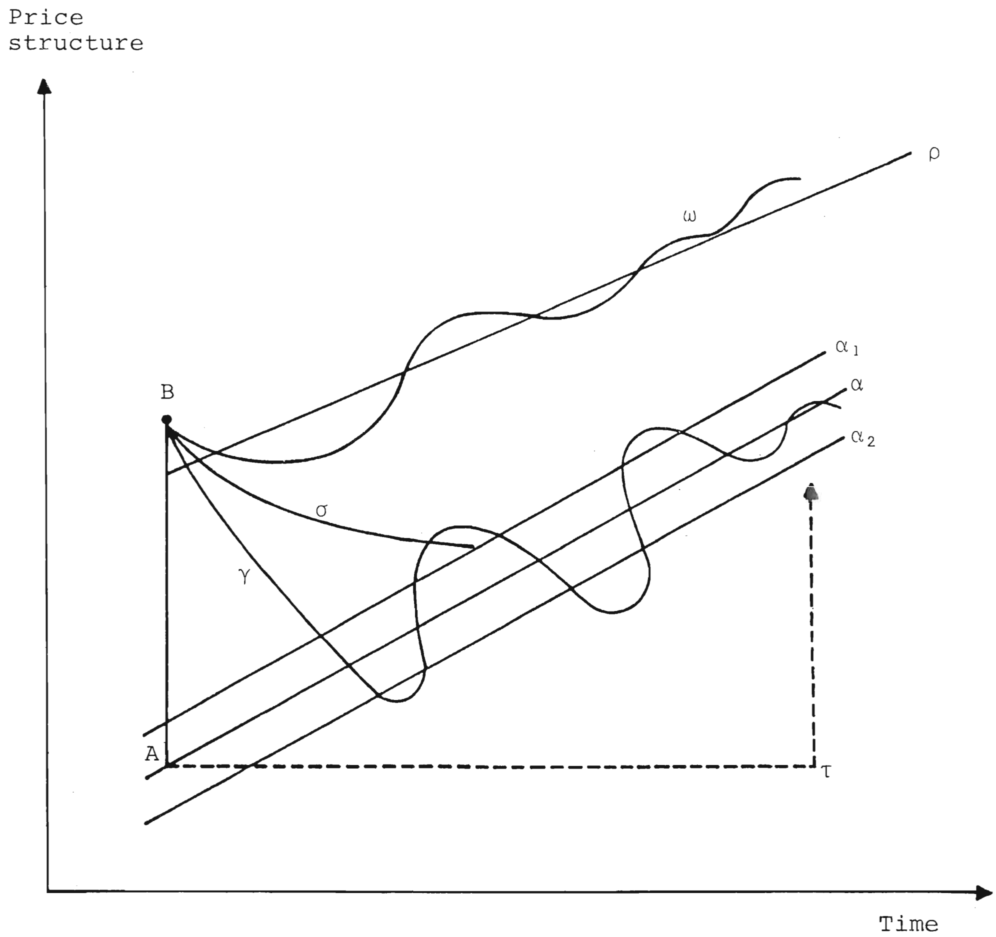
Since factor prices in a competitive in equilibrium are the same for all producers, the structure of relative costs, and hence the structure of relative prices, will be determined by the factor mix employed in production.

In Figure 2 initial equilibrium prices are represented by the point A. If technological change is introduced as an exogenous dynamic element in this static world, equilibrium prices will change over time. Those changes will reflect the impact of the new technologies on production costs. If the change in the underlying conditions immediately becomes known to everybody, and adjustment is instantaneous, relative prices will move along an equilibrium price path. In Figure 2 this path is labelled by α.

An economy in equilibrium, consisting of omniscient units which react but do not act, which immediately and painlessly adjust to changing supply-side conditions, is a poor representation of economic reality. This is particularly true for the industrial transformation process, and for the role played by prices in the market process.

The economy is never in equilibrium. Furthermore, an equilibrium concept at the macro-level makes no sense once endogenous structural change has been introduced in the model. In a market system, knowledge is imperfect and incomplete. Plans are continually being frustrated and revised in accordance with the participants' interpretation of market signals, among which prices are the most important. The adjustment to changing conditions is not an uninteresting intervening stage but as important as the change itself. "A system - any system, economic or other - that at <u>every</u> given point of time fully utilizes its possibilities to the best advantage may yet, in the long run, be inferior to a system that does so at <u>no</u> given point of time, because the latter's failure to do so may be a condition for the level or speed of long-run performance." (Schumpeter, 1942, p. 83.)

Figure 2 Relative price structure in a dynamic perspective



This means that there will be an incessant flow of disturbances in the price system, reflecting agents' alterations of plans in the light of the outcome of yesterday's plans. Changes in the underlying conditions will also bring about disturbances. Still, even if we have no major disturbances we might still say that the price structure will oscillate around the equilibrium path α, within rather narrow limits. In Figure 2 those limits are represented by $\alpha 1$ and $\alpha 2$.

Major disturbances do, however, occur and move the price structure far from any equilibrium. In figure 2 this is represented by the point B, a disequilibrium state characterized by widespread ignorance. The path which the price structure follows from B towards a new set of equilibrium prices, either on the old equilibrium path α or on a new one, is a path along which agents are learning by interpreting market signals. That means that the way in which price signals are transmitted to the market participants, and the extent to which those are allowed to guide the allocative decisions in the economy, are essential ingredients of the market process. The degree of rigidity in different markets will determine how long and sluggish the adjustment process will be, and what the costs of adjustment will be.

Given a structure of relative prices represented by A and a major disturbance which moves it to B, how will the adjustment process be reflected in relative prices? If the underlying equilibrium solution, represented by the underlying cost structure, has not changed we should expect a gradual return towards α. How rapid will the process be, and what will it look like? Which path will be followed? In Figure 2, path α represents repeated "overshooting" during the adjustment process. In terms of price structure, it is a case characterized by large short-run fluctuations around a stable trend. It can also be expressed as short-run instability and relative long-run stability. A different case is represented by the path σ along which the adjustment towards the original equilibrium path is gradual and smooth. In this case, relative price changes will be small in the short-run but larger in the longer run.

These cases are of course abstractions from a more comprehensive representation of what happens to prices in, for instance, a shock of the 1973 kind. One important question discussed extensively in Eliasson's and Sharefkin's papers in this volume is whether we have reason to believe that the economy will ever return to the old equilibrium path. The disturbance itself leads to feedback effects on the supply and demand sides. Demand patterns are altered and technical change is induced. The underlying long-term cost structure can develop very differently, depending on which path the price adjustment process takes. In this state, which can persist for years, ignorance prevails, market uncertainty is high and the agents in the market respond with mistakes and with increased caution. (See below Genberg's paper and the simulation experiments in Eliasson's paper.) The more sluggish the adjustment process, the greater the feedback effects and the more market agents will interpret the temporary disturbance as a long-term phenomenon -- and make long-run adjustments to the new signals. In Figure 2 this case is illustrated by the new equilibrium path ρ and the movement of ω towards it. We can illustrate this case by referring to the Swedish cost explosion in 1975. It did not reflect any change in the underlying long-run market conditions: to the contrary, it ran against to them. It was an effect of the overheated Swedish economy in the middle of the 70s. In this state of unpredictability, Sweden's basic industries embarked on excessive investment spending programmes based on misinterpreted price and profit signals.

That rise in wages threw the structure of relative factor prices far off its original track. Given the rigidity of the Swedish labor market, with centralized negotiations and very strong unions, the imbalance in the factor market was not corrected by market forces. But Swedish export industries, being price takers in competitive world markets, had to adjust to the new cost situation with strategies like substituting machines for labor and investing abroad rather an in Sweden. Thus a new structure of factor prices represented by the track ρ in Figure 2, was established.

The economic debate in Sweden has in the meantime been focused on whether Sweden has returned to the unit labor costs the country enjoyed prior to the crisis; the criterion was some sort of purchasing power parity. The recent devaluation of the Swedish krona (October 1982) seems to have ended this discussion but cannot be interpreted as a return to the precrisis cost situation. In fact, it amounts to a new shock to the price structure.

In Figure 2, τ represents a price structure gradually moving away from its "equilibrium path". As a consequence of price-controls, for instance, a price structure is no longer consistent with the underlying cost structure may persist for some time. Industry subsidies can have the same effect. If controls or subsidies are abolished or break down, we expect pries to adjust and move towards an "equilibrium" set of prices.[3] This means that what we experience as a shock to the price system might in fact be an adjustment. Something like that happened with the exchange rates when the Bretton-Woods system was abolished.

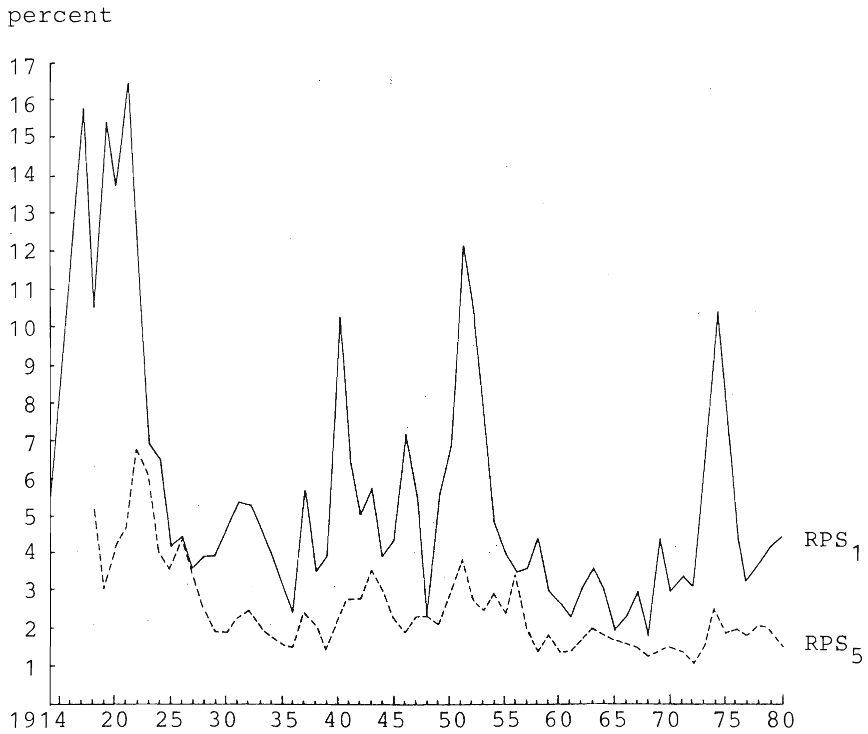
III SHORT-RUN PRICE STRUCTURE STABILITY

The first thing to establish is whether the structure of relative prices has been "stable" and if not, its movement. Figure 3 shows relative price-change dispersion annually and over five-year periods.

It is clear from that figure that the price structure has been far from stable. Furthermore, the instability has varied considerably. Periods of turbulent relative-price movement can be distinguished. To a large extent, those periods have coincided with great upheavals in the international economic order, such as the two world wars, which radically changed the demand and supply situation.

World War I and the following deflationary crisis in Swedish industry was characterized by extremely unstable relative prices. After the end of the war and the adjustment to peace-time conditions that followed, relative prices were comparatively stable until the end of the 30s. The great depression of the early 30s seems to have had only minor effects on relative prices in Sweden. This is well in line with other findings that the crisis of the 30s had a much smaller impact on long-run resource allocation in Sweden than the crisis of the beginning of the 20s. (See B. Carlsson et al., 1979). World War II and its aftermath represented a new period with considerable shifts in the structure of relative prices. Those developments culminated in the Korean War boom of 1951. Stabilization of the price structure followed up to the oil crises of the 70s, which show up as a new bump in the curves.

Figure 3 Relative price change dispersion in Swedish industry 1913-77, annual (RPS_1) and over five-year periods (RPS_5)[1] (percent)



[1] The measures are explained in Appendix 1.

IV INFLATION AND RELATIVE PRICES - THE SHORT RUN

Inflation degrades and distorts the informational content of price signals. During a rapid and imperfectly anticipated inflation, it becomes difficult for economic agents to distinguish between nominal price changes and relative price changes. Nevertheless, many economists have argued that we have no reason, a priori, to expect that changes in the aggregate price level should affect relative prices, or vice versa. In an Arrow-Debreu world, the aggregate price level is just a multiplier of equilibrium relative prices. (See Patinkin, 1965, p. 131, and Vining & Elwertowski (1976)). On the other hand, many macroeconomic policymakers have blamed the inflation of the 70s on rising oil prices.

But empirical findings suggest that changes in the general price level are in fact correlated with changes in the structure of relative prices. The direction of the causality is, however, far from clear. The issue was raised by Mills as early as 1927, and the hypothesis was tested by Graham in 1930. To our knowledge the question was not raised again until the middle of the 60s, when Gleiser (1965) found a strong correlation between the rate of inflation and relative price dispersion. During the 70s similar conclusions were reached, by Parks (1978) and Vining & Elwertowski (1976).

It is easy to construct theoretical arguments for the hypothesis that movements in the general price level affect relative prices. Different markets react with different speed to an inflationary pressure. An economy consists of a many interdepending markets with differing price dynamics. In some of those markets, prices are adjusted daily or even more frequently. In others, prices are set infrequently and administratively. The latter is typical of markets where prices are set in long-term contracts or adjusted only by negotiation. (See for instance J.M. Clark, 1961.) The variety of price-setting procedures in an economy means that we should expect at least a temporary shift in relative prices even in the face of inflationary pressures.

Furthermore, demand patterns should shift in periods of rapid inflation. To protect themselves from rising prices, economic agents try to maintain real wealth. Thus they increase their demands for durable goods and raw materials, and decrease their demand for other products. Thus demands for different goods will have different elasticities with respect to the rate of inflation.

Moreover, in inflationary periods it becomes more difficult to identify changes in relative prices, and to discriminate between relative-price and nominal-price changes. Consumers and producers become less sensitive to nominal price signals, and their supply and demand curves become less elastic. A given change in demand or supply leads to a larger spread in relative prices.

Finally, a rise in the general price level, whatever its origin, generates compensating wage claims. Depending on the relative bargaining power of labor unions and employers, cost increases will differ across industries, changing relative prices.

Thus far we have assumed that the direction of causality runs from inflation to relative price changes. But we might also assume the opposite direction of causality: from shifts in relative prices to increases in the general price level. Different markets react with different speeds to inflationary pressure, but they also react asymmetrically to upward and downward pressures on prices. Very few markets in an economy, if any, are of the "exchange" type, where prices move freely up and down to a market-clearing price. To the contrary, almost all prices are "administered" in the sense of being quoted or negotiated. Such prices are more or less sticky in the short term.

A prime example of such a market in Sweden is of course the labor market. Centrally-negotiated increases and wage drift allow for some flexibility upwards, but it has been virtually impossible to lower a wage. In such a market a random series of pressures on wages results in a "ratchet action" increasing the level of prices. (Clark, 1961.)

The labor market is an extreme case, but the combination of flexibility upwards and rigidity downwards is characteristic of most markets. Moreover, the degree of administration in price formation seems to have increased. Structural change within manufacturing supports this trend, as product differentiation and product sophistication increase in importance. In the Swedish engineering industry, for example, the price of the product has become less important as a competitive factor. (Carlsson et al., 1981.) Increasing Government interference in the formation of prices by means of controls and subsidies contribute to the same tendency.

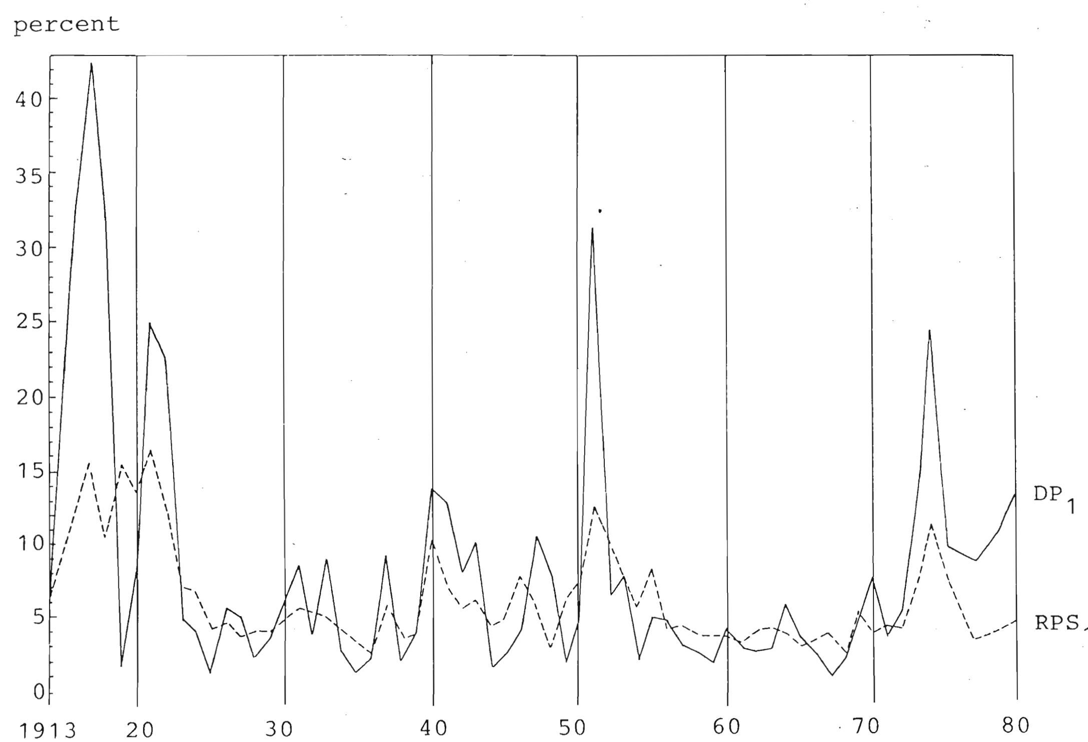
Thus the combination of disequibrium, structural imbalance and price rigidity downwards means that prices tend to rise on markets with excess demand, but that prices on markets with excess supply will not fall correspondingly. The result will be an increase in the aggregate price level.

A related observation is that more rapid inflation tends to be associated with greater variation in the rate of inflation. This hypothesis has been tested by Foster (1978) and Logue-Willett (1976), by cross-section analysis on a sample of countries. Their findings support the hypothesis. When their methods are applied to Swedish industry data, the hypothesis cannot be rejected. The coefficient of correlation between absolute changes in the general price level (DP1) and fluctuations in the rate of inflation (VP_1) is 0.44.

There are some important implications for the behavior of relative prices. Expectations regarding future inflation rates will differ widely among economic agents. Since prices depend, in part, on those expectations, an increase in the dispersion of relative prices is likely.

The relationship between changes in the general price level and changes in relative prices for Swedish industry is illustrated in Figure 4. It shows annual changes in price dispersion (RPS_1) and the annual absolute change in industry prices. No qualitative distinction is drawn between inflation and deflation.

Figure 4 Annual change in prices for industrial products, absolute value (DP_1), and annual relative prices change dispersion (RPS_1) 1913-80[1] (percent)



[1] Measures are defined in Appendix 1.

The impression one gets from the figure is that the two variables are correlated. That impression is supported by the results reported in Table 1. The simple correlation coefficient between the spread in relative price change (RPS_I) and the absolute change in industry prices (DP_I) is given; the coefficient is 0.72.[4] The correlation coefficient between RPS_I and fluctuations in the rate of inflation (VP_I) is even stronger: the coefficient is 0.76.

If we go one step further and estimate a linear regression where annual relative price change dispersion (RPS_I) is regressed on the absolute change in the industry price (DP_I), the variability of the rate of inflation (VP_I) and a trend factor (T), we get the result reported in Table 2.

Table 1 **Correlation between annual relative price change dispersion (RPS_1), annual change in industry prices, absolute value (DP_1) and annual change in the rate of inflation (VP_1) 1914–77**[1]

	RPS_1	DP_1	VP_1
RPS_1	1	0.72	0.76
DP_1	0.72	1	0.44
VP_1	0.76	0.44	1

[1] These measures are defined in Appendix 1.

Table 2 **Linear regression with annual relative price change dispersion (RPS_1) as dependant variable and annual change in industry prices, absolute value (DP_1), annual change in the rate of inflation (VP_1) and a trendfactor (T) as independent variables 1914–77**[1]

Dependent variable	Independent variables					
RPS_1	Constant	DP_1	VP_1	T	DW	R_2
	0.0432	0.1679	0.2355	-0.0004	1.545	0.797
	(7.87)	(6.6)	(7.60)	(-3.78)		

(Student t-values (in parenthesis), and R^2 adjusted for degrees of freedom)

[1] These measures are defined in Appendix 1.

V INFLATION AND RELATIVE PRICES - THE LONG RUN

The fundamental role of the price system is to transfer information to agents in the market process. Producers and consumers can then decide what to produce or consume, and how. The information content of price signals in this connection lies in relative prices: the price of oil relative to coal, the price of labour relative to capital, the price of engineering products relative to textile products, and so on.

We have seen that as the rate of inflation increases it tends to vary more rapidly over time. We have also seen that there is a strong tendency for relative-price change dispersion to increase. Sometimes those changes in relative prices are temporary and reflect instabilities in the price system. In that case, the original relative prices are quickly restored, and market agents need not make any long-run adjustment. If, however, the new relative price reflects long-run changes in market conditions we have what we call transformation pressure.

The speed of adjustment depends on whether we introduce adjustment costs in our scheme of thought or not. Traditionally, we assume, however, that there exists a unique equilibrium, and that the economy eventually will get there. But to understand the role of prices in a dynamic transformation process, we must abandon such abstractions. Decisions to react to a price signal by reallocating resources depend on how participants in the market process perceive the change in relative prices, i.e., as being temporary or permanent. Transformation pressure exists only if the change in relative price is perceived as reflecting a long-run shift in market conditions. If that change is transitory, expectations are frustrated as the old relative prices are reestablished. When, for instance, the Swedish steel industry interpreted the 1973 increase in relative steel prices as permanent and started to invest heavily, it made a costly error.

For the actions triggered by a price signal, the distinction between real and fictitious is unimportant; for the consequences, the distinction is of course fundamental.

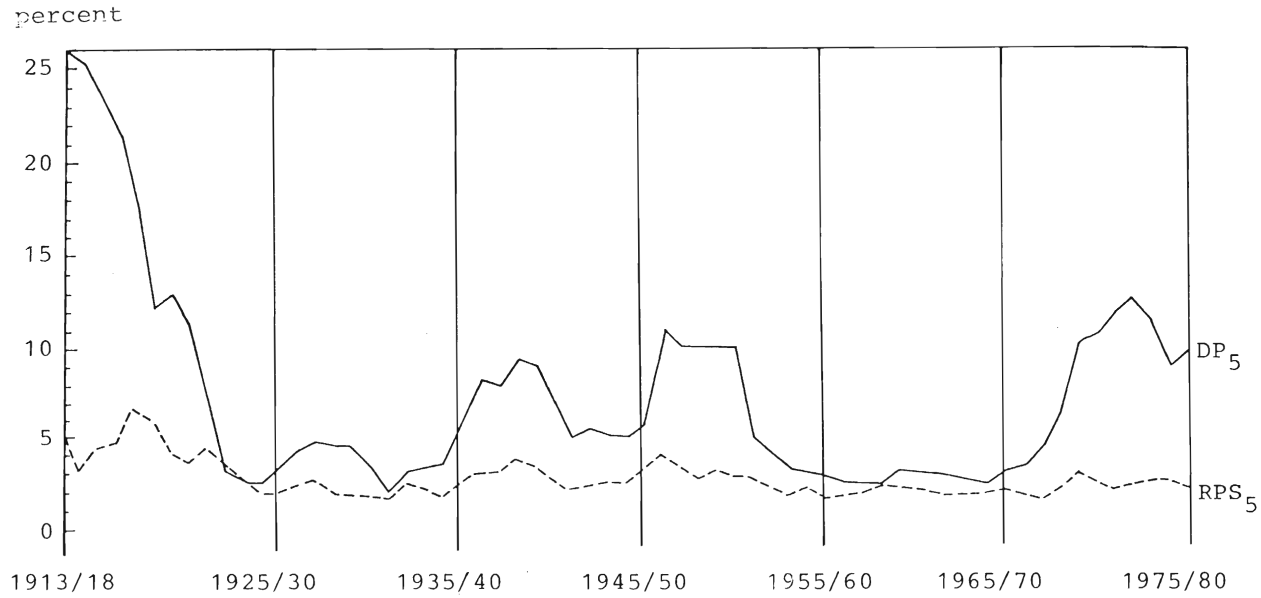
For a change in the relative prices to be interpreted as a long-run shift, the question of duration is crucial. Transformation pressure will hardly arise if an increase in the relative price of a product is wiped out within a year. On the other hand, as time passes more economic agents will make long-run adjustments to price signals. Those reactions will in turn affect the relative price. The Swedish iron-ore mining in the post-war period illustrates the point. After World War II the relative price of Swedish ore rose by about two thirds until the end of the 50s. Enormous land rents were earned by the principal Swedish iron ore company, LKAB, which had gross profit margins of about 65 per cent. During the 60s and 70s the high price resulted in new mines being opened up in other parts of the world, eroding land rents earned by LKAB and lowering the relative price of iron ore. Today the relative price of Swedish iron or mining is one-third lower than it was at the end of World War II. LKAB has become burden on its regional economy.

Thus when we ask whether transformation pressure has had time to arise or not, the choice of period has to be a compromise between these two aspects. We have calculated relative price change dispersion over five year periods (RPS_5) for the period 1913 to 1980. That measure, together with the measure of annual dispersion is shown in Figure 3. Comparison of the two curves suggests that many of the annual changes in relative prices indeed were temporary, and disappear if five-year periods are studied. Nevertheless the characteristics of the one-year curve remain. It is clear that the period up to the end of the 20s, and the decades of the 40s and 50s, were characterized by considerably more transformation pressure than the 30s and particularly the 60s up to the first oil crisis. Particularly striking is the increase in transformation pressure in the 70s.

The connection between relative price change dispersion and changes in the general price level also remains strong. In Figure 5, RPS_5 is shown -- along with the arithmetic mean of absolute changes in industry prices (DP_5). The two variables are analogous to the price variables presented on an annual basis above. As can be seen in Table 3, the coefficient of correlation between inflation and relative price change dispersion is 0.68 on a five-year basis.

The hypothesis that a high rate of inflation is associated with greater variability in the rate inflation is also supported. The coefficient of correlation between those variables on a five-year basis is 0.90, considerably higher than the corresponding calculation computed from annual data. We also find a strong correlation between the spread in relative price changes and variability in the rate of inflation. As can be seen from Table 4, we obtain a better estimate of the linear relationship between relative price changes and inflation variability than between price changes and the changes in the general price level. If both variables are considered, variability takes over completely as an explanatory variable. This is of course due to the strong correlation between the two independent variables.

Figure 5 Change in industry prices, absolute value (DP_5) and relative price change dispersion over five-year periods (RPS_5), 1913-80[1]
(percent per year)



[1] These measures are defined in Appendix 1.

Table 3 Correlation between relative price change dispersion (RPS_5), change in industry prices (DP_5) and variability in the rate of inflation (VP_5) 1913-77. All variables on a five-year basis[1]

	RPS_5	DP_5	VP_5
RPS_5	1	0.68	0.80
DP_5	0.68	1	0.90
VP_5	0.80	0.90	1

[1] These measures are presented in Appendix 1.

Table 4 Linear regressions with relative price change dispersion (RPS_5) as dependent variable and change in industry prices, absolute value (DP_5), variability in the rate of inflation (VP_5) and a trendfactor (T) as independent variables 1913-77. All variables on a five-year basis[1]

Dependent variables	Constant	Independent variables				
		DP_5	VP_5	T	DW	R^2
RPS_5	0.255 (8.475)	0.1038 (5.356)	-0,003	0.895 (-4.417)	0.5839	
RPS_5	0.0220 (8.491)		0.0360 (7.984)	0.0002 (-3.906)	1.247	0.705
RPS_5	0.0224 (8.602)	-0.0389 (-1.1806)	0.0453 (4.987)	-0.0003 (-3.921)	1.308	0.707

(Student t-values in parenthesis, R^2 adjusted for degrees of freedom.)

[1] These measures are presented in Appendix 1.

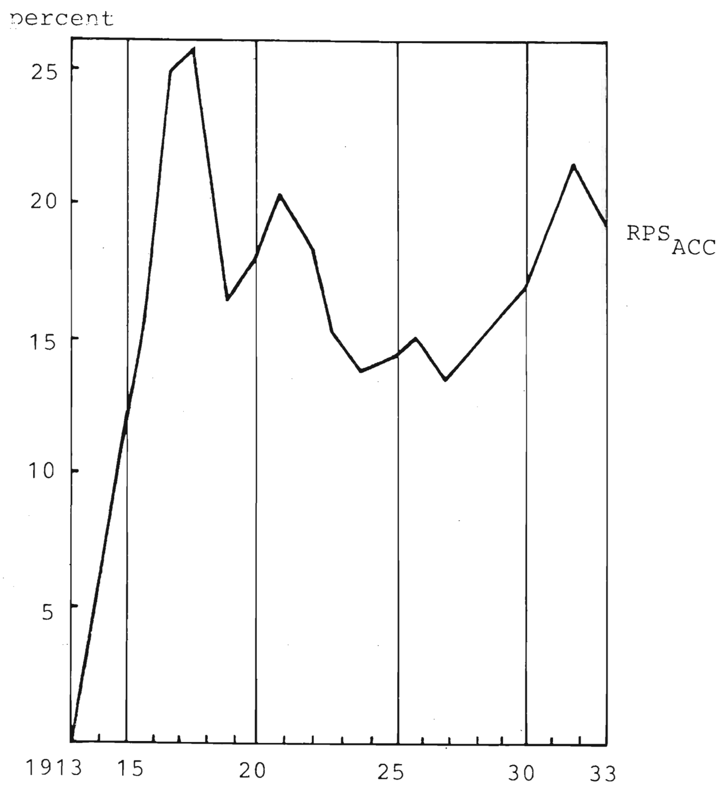
VI CRISES AND RELATIVE PRICES

We have seen above that some periods in the history of Swedish industry have been characterized by substantially larger changes in relative prices. Those periods are the two world wars, including their preludes and aftermaths, the Korean boom in 1951 and the stagflationary crisis of the 70s. The Swedish economy was characterized by extreme imbalances during these periods. The discussion above has indicated that they were not just temporary. They had considerable structural content, meaning that price signals pointed to the need for long-run structural adjustment. We have called those periods "crises", and we view them as shocks that moved relative prices far from equilibrium. How, then, did prices adjust after these shocks? What, for instance, was the time profile of aggregate relative price changes? Can we identify repetitive patterns?

To explore these questions we want to study how prices developed during and after the crisis in comparison with the price structure prior to the crisis. We have chosen 1913, 1920, 1939, 1949, and 1972 as base years: those are the prices with which we wish to compare price changes. Starting from these years we have accumulated data on relative price changes 20 years into the future. The behaviour of this measure RPS_{ACC} is illustrated in Figure 6. That figure shows how the structure of industry prices evolved during 1913-33, compared to the price structure of 1913. Price dispersion increased up to 1918, when relative price changes in industry averaged 26 per cent. Subsequently, relative prices moved towards the structure of 1913. That movement was interrupted in 1920-21 and resumed again in 1922. The relative prices of 1913 were, however, not reestablished. If this had been the case, RPS_{ACC} would have been 0 that year. Instead, movement towards pre-war relative prices ceased in 1927 at a relative price change of some 15 percent on average compared with 1913.

The behaviour of the price structure during the six crises episodes is shown in Figures 7A-F. The measure depicted indicates

Figure 6 **Accumulated relative price change dispersion (RPS_{ACC}) 1913-33**[1]
(percent per year)



[1] The measures are presented in Appendix 1.

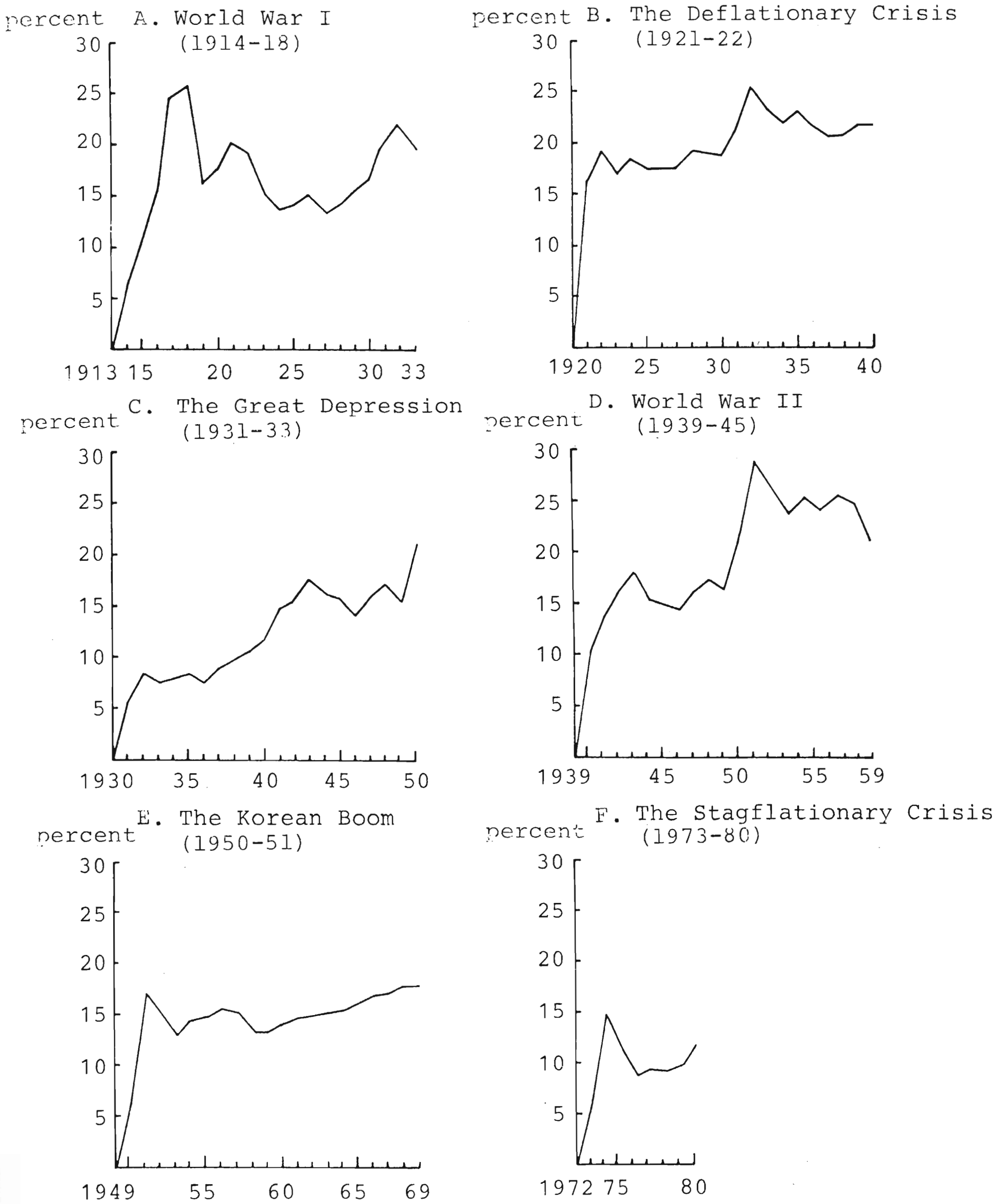
whether relative price changes have been temporary or persistent. Did the structure of relative prices return rapidly to the preshock structure? Did diverging price movements also reflect long-run shifts in market conditions and thus signal transformation pressure in the Swedish economy? If price shocks were temporary the curve of cumulative relative price change should move rapidly toward zero or toward a long-run trend of relative price change. There are some conceptual problems in interpreting Figure 7 since, regardless of external shocks, productivity changes generate continuous changes in relative prices.

The curve with 1913 as base year shows the effect of World War I on relative price development. (Figure 7A.) The outbreak of the war led to considerable relative-price shifts. Accumulated relative price change increased up to 1918. That period was also characterized by very high rates of inflation, on average 25 percent per year. Those price movements reflected the abnormal situation the Swedish economy experienced in the shadow of the war on the continent.

It is obvious that these very large changes in relative prices reflected long-run shifts in the composition of demand, contingent on continuation of the war. As seen in Figure 7A, an average relative price change in Swedish industry from 1913 to 1918 was 26 %. Sweden adapted to a war economy, or rather to an economy in a state of alert, through an inflationary, and increasingly speculative, boom.

On the other hand, much of the price signaling reflected the extraordinary demand and supply conditions of World War I. The fact that Swedish industry made long-run adjustments to those conditions meant that once the war was over, a painful readjustment to peace-time conditions would be necessary. Major sectors of Swedish industry had almost no chance of surviving that readjustment. A movement in relative prices towards the structure of 1913 was initiated in 1919 and the rate of inflation decreased

Figure 7 **Accumulated relative price change dispersion (RPS_{ACC})[1] 1913-33, 1920-40, 1930-50, 1939-59, 1949-69 and 1972-80**
(percent per year)



[1] The measures are presented in Appendix 1.

markedly. Extensive inventory accumulation delayed the readjustment crisis. At the end of 1920, however, prices started to fall. The openly-declared intention of the Swedish government to return to the prewar gold-standard reinforced that fall in prices. The postwar deflation culminated in 1921, when the average price of industrial goods fell by 25 percent, and by another 22 percent in 1922.

Thus far, that was the most severe crisis Swedish industry had experienced. Regarding relative prices, we can see from the 1913 curve that some movement towards the price structure of the base year occurred. That movement continued in 1922-24, when the general price level had stabilized. Nevertheless, if we summarize the accumulated changes in relative prices, World War I and its aftermath saw far greater changes, and even long-run changes, than any other period during the 20th century.

If we examine the curve from 1920 onwards, we get a somewhat different impression of what has been called the Deflationary crisis. (Figure 7B.) The large relative-price changes of 1921-22 were of a long-run character. Between 1922 and 1930, relative prices changed very little from their 1920 values.

The production and employment effects of the Great Depression of the 30s on the Swedish economy were considerable, but they were short-lived. The depression did not really reach Sweden until 1931, and the trough bottom of the slump came in 1933. After that, a vigorous upswing started and peaked in 1937, when industrial production was up 50 per cent over the previous boom. Sweden's foreign trade increased more than 20 per cent from peak to peak in a time when world trade was stagnant. The successful, but more or less accidental, devaluation of 1931 played an important part in the performance of the Swedish industry in the 30s.

The behavior of industrial prices and transformation pressure in the crisis of the 30s differed radically from the corresponding behavior patterns during other crises. The deflationary tendency of the 20s persisted through the crisis and up into the middle of the 30s. That decade saw the origins of the inflationary period that has run through the whole post-war era. It is no coincidence that this historical reversal of trends began within a few years of the reorientation of economic policy under the Social Democrats, who carne into power 1932.

Relative prices remained remarkably stable in comparison with the great dispersion in relative price changes that has characterized the other crises (Figure 7C.)

The beginnings of the next wave of inflation coincide with the outbreak of World War II in 1939. We have chosen this as the base year for our next curve. (Figure 7D.) As was the case during World War I, Swedish industry had to adapt to a "war economy". But that transition was much smother this time, in part because of better policy decisions but also in part because conditions were different. Swedish industry could depend on a much larger domestic market, and was to a larger extent oriented towards that market. And Swedish industry had seen more than 15 years of financial consolidation, albeit from a weak position. World War I was preceded by hectic growth with a considerable element of speculation; Sweden had a much more stable and mature industrial sector in 1939.

Nevertheless, the smooth adjustment of Swedish industry to large changes in relative prices was remarkable. Given wartime conditions, most price signals must have been perceived as structural and expected to persist. Thus strong transformation pressure was created. This is indicated by the 1939 curve, which suggests that price dispersion was significantly and cumulative, during the first half of the war. A relatively high rate of inflation was also characteristic of that period. By 1944 prices had stabilized, and three years of gradual movement of prices towards those of of the 1939 occurred.

At the end of World War II, Swedish economic policy was mobilized for structural crisis like that of the 20s. The expected crisis never materialized, and what happened was entirely different from what had been expected. The Swedish economy obviously adjusted very easily to post-war conditions. Relative prices showed no tendency to return to prewar levels in contrast to what happened after World War I. To the contrary, the 1939 curve of cumulative changes in relative prices indicates a movement still further away from the price structure of 1939 (Figure 7D.) Furthermore, those price movements were, on the whole, extremely favorable, reflecting the unique competitive position of Swedish industry, after the war. One indicator is the development of Sweden's terms of trade, which increased some 50 percent in the first five years after the war.

That development peaked in the inflationary Korean Boom of 1951 (Figure 7E.) It was also characterized by rapidly shifting relative prices. Calling the Korean boom a "crisis" may seem somewhat surprising. Price signals this time, however, had a strong structural content as can be seen from the curve of cumulative price changes starting from 1950. Those changes created reallocation pressures with far-reaching long-run consequences for the development of Swedish industry. We can identify a tendency for the price structure of 1950 to be reestablished. It is small, however, and most of the relative price changes represented long-run shifts.

From the middle of the 50s, there were almost 20 years of gradual accumulated change in the price structure relative to the structure in 1950. The curve strongly suggests an economy not subject to major external shocks. Relative prices tend to oscillate around an "equilibrium" path, as dictated by underlying productivity changes. But an increase in the rate of change can be spotted from the middle of the 60s.

In 1973 inflation gathered speed once more, and relative price changes increased as the Stagflationary Crisis deepened. This shows up very clearly in Figure 7F; in that figure 1972 is taken as the base year. Those price trends were further reinforced in 1974. As the rate of inflation decreased in 1975, there was a marked return of relative prices towards the structure of 1972. In this respect the first oil crisis -- or rather the boom for raw materials, of which the oil price rise was an important part -- saw more over-shooting than the earlier crises. Moreover, the price movements of 1973-74 saw smaller long-run shifts in relative prices (except for the relative price of oil) than any of the earlier crises, apart from the depression of the 30s. That does not mean that the crisis of 1973-74 did not signal increasing transformation pressure. On the contrary there was a marked increase in such pressure in the 70s compared with the 60s, but it seems to have been smaller than in the other six crisis episodes. Particularly noteworthy was the difference between price movements in the first and second oil crises. Whereas the first oil crisis was part of a more general materials boom, the second oil crisis was a "true" oil crisis: the relative price of oil increased rapidly, while other prices lagged.

Considering the problems facing large sectors of Swedish industry, this behavior was puzzling. Perhaps sectors had lost their ability to make the necessary long-run reallocation even in the face of a moderate increase in transformation pressure, for want of financial resources or managerial skills or because of rigidities in the wider economy. Or perhaps those sectors were forbidden, by the government, to adjust, for reasons of regional and labor-market policy considerations. The existence of "lame duck industries" from which private capital has withdrawn and the state has moved in with huge subsidies give some support to this observation. Probably, however, we must link the increase in transformation pressure with the wage cost explosion in the Swedish economy in the middle of the 70 s. That abnormal increase in wage costs created financial problems for much of Swedish industry, problems that were mistaken for structural problems.

VII RESULTS AND CONCLUDING REMARKS

The fundamental role of prices in a market economy is that of guiding resource-allocation decisions. The relevant prices in this context are relative prices, represented in this paper by producer prices for 42 individual industries in relation to a price index for all manufacturing and mining.[5]

Changes in relative prices, regardless of the underlying causes, create transformation pressure, i.e. pressure to reallocate resources. In a functioning market economy, the agents participating in the market process must respond. An increase in demand for the output of some particular industry pushes up the relative price of its products, and draws additional resources into that industry. A drop in demand, on the other hand, creates an incentive to withdraw resources. Changing relative prices, originating in changes on the supply side work in the same manner.

If relative price changes in the economy are aggregated, we can define an indicator of the economy-wide tranformation pressure. In such a measure (defined more precisely in Appendix 1), relative price changes should enter with their numerical values since both upward and downward changes signal transformation pressure.

Disequilibria in which positive and negative quasi-rents are being earned are the usual state of affairs in a modern economy. Thus there are always profits to be made, and the person who first perceives such opportunities is the entrepreneur. Indeed those disequilibria represent a driving force in the transformation process, and hence in economic development. They may be the result of new products, new processes, new markets and new institutions. This is the Schumpeterian process of creative destruction, which alters the economy from within. The disequilibria may, however, be the result of external shocks to the economic systems, such as the two world wars or the oil crisis of the 70s.

Whatever their causes, disequilibria result in diverging relative price movements. How participants in the market process interpret and react to such movements will be decisive for the speed and direction of economic development.

The first thing we established in this paper was that the structure of industrial prices in Sweden has been far from stable during the peirod analysed. And the size of that instability has varied considerably, as shown in Figure 3. Thus the transformation pressures in Swedish industry have varied over time. We can distinguish periods characterized by large relative-price shifts. To a considerable extent those periods coincide with upheavals in the international economic order, such as the two world wars, including their prologues and aftermaths. The associated changes in demand and supply conditions clearly did not reflect technological change.

A related question is whether these results reflect purely short-run relative-price instabilities, which would disappear over the longer term. We have chosen to examine this issue by looking at five-year periods. The results are also shown in Figure 3. The differences between the annual and the five-year relative price change dispersion show that relative prices were signaling short-run changes. Nevertheless, the two curves are qualitatively similar.

In the context of industrial tranformation and the signalling function of prices, temporary relative price changes are not uninteresting phenomena. If the amplitude of short-run price signals grows it becomes increasingly difficult for participants in the market process to discriminate between long- and short-run signals. Allocative decisions then must be made in a situation of greatly increased uncertainty, and errors in investment are likely.

Since economic agents must rely on nominal price signals, unanticipated inflation in effect increases the noise to signal ratio and reduces the information content of the price structure. Moreover, if prices are sticky downwards, increasing relative prices for some industry's output will increase the rate of inflation. The hypothesis that there exists a correlation between short-run fluctuations in the general price level and annual relative price dispersion has been tested on a cross-section of countries. For those countries, it cannot be rejected. Our data for Sweden give similar results, both on an annual basis and on a five-year basis.

Since 1913 Swedish industry has been exposed to several shocks or "crises", as a result of drastically changed market conditions. The outbreak of World War I initiated an inflationary boom in the Swedish economy, which grew increasingly overheated and speculative. The return to peacetime market conditions took place in a deflationary crisis with mass unemployment and the financial collapse of major sectors of Swedish industry. The crisis of 1921-22 was much more severe than the great depression of the 30s. Above all transformaton pressure -- the need to make long-run adjustments -- was much smaller in the latter crisis.

World War II drastically changed market conditions for Swedish industry. This time the increse in transformation pressure was much more successfully handled by industry. Similarly, the problems encountered after World War I were not repeated. On the contrary, the competitive strength of Swedish industry can be summarized by the 50 percent increase in terms-of-trade that took place 1945-51. This development culminated in the inflationary boom of the Korean war in 1951. The international economic environment then stabilized, and the Swedish economy was not subjected to new external shocks until the oil crises of the 70s.

In all these crises the ability of Swedish industry to adjust to radically new market conditions was tested. A world crisis in this context does not necessarily mean worsened market conditions. On the contrary, the years following World War II greatly improved the competitive position of Swedish industry. Nevertheless, transformation pressures forced Swedish industry make long-run adjustments, with consequences for the transformation of Swedish industry all through the post-war period.

The development of industrial prices in all but one of these crises was characterized by an initial phase of rapid change in the general price level and by turbulent relative-price movement. High inflation rates characterized the beginning of the two World Wars, the Korean boom and the oil crises. The deflationary crisis, on the other hand, almost halved the price level within two years. In this general picture the crisis of the 30s stands out as a noteworthy exception, since it was not accompanied by any major change in industrial prices. This is in line with other findings that the crisis of the 30s differed from the others in important aspects.

Price movements during the initial phase of most of the crises included considerable overshooting. But after a few years there was a tendency for relative prices to return to their original values. Once again, the crisis of the 30s is an exception, since it saw neither inflation/deflation of any significance, nor substantial relative price change dispersion, and consequently no overshooting. The deflationary crisis of the 20s was moreover characterized by a larger one-time shift in relative prices.

The tendency for a precrisis price structure to be restored should, however, not be exaggerated. In almost all the episodes, there remained a marked shift in relative prices, meaning that relative price movements had reflected long-run changes in market conditions. It is not possible to talk of any of the crises as bubbles, or temporary shocks to the price structure, without long-run consequencies.

The findings in this paper show that relative price movements in stagflationary crisis of the 70s to some extent resemble those of the other crisis episodes. The initial phase, of inflation and strongly diverging price movements, is there. The tendency to re-establish the original structure of relative prices seems to have been more pronounced, meaning that relative price dispersion was essentially short-run nature. The stagflationary crisis thus has meant less transformation pressure on Swedish industry, i.e. smaller long-run shifts in relative prices. But this time Sweden has coped with the crisis much less successfully than with previous crises in terms of growth, external balance and price stability. The ability to adjust and the flexibility of the economy have been inadequate. Could it be that all our sophisticated economic policy measures aiming at stabilization and fine tuning of the economy cost us the ability to handle price shocks? Have we so constrained the working of markets that they no longer can perform their tasks satisfactorily?

APPENDIX I

P - Price index

The analysis is based on data showing how prices have developed in 42 industries 1913-80. These price series have been aggregated into a producer price index for industrial goods. The index formula used is a Divisia-index formula.

$$P_t = P_{t-1} \cdot \sum_{j=1}^{42} (\sigma_{j_{t-1}} \cdot \frac{P_{j_t}}{P_{j_{t-1}}}).$$

where

P = price index total manufacturing and mining industries

P_j = price index, branch j

σ_j = share of production value of manufacturing and mining industry for branch j.

RPS_x - Relative price change dispersion

$$RPS_{x_t} = \frac{1}{x} \sum_{j=1}^{42} \sigma_{j_{t-x}} \left| \left(\frac{P_{j_t}}{P_{j_{t-x}}}\right) / \left(\frac{\bar{P}_t}{\bar{P}_{t-x}}\right) -1 \right|$$

where

x = The length of period (here 1 and 5 years)

$\sigma_{j_{t-x}}$ = The share of branch j in the total production value of manufacturing and mining industry in year t-x

P_j = Price index for branch j

$\bar{P}$ = Price index for industrial products

RPS_{ACC} – Accumulated relative price change dispersion

$RPS_{ACC_{t-(t+x)}}$ = Accumulated relative price change dispersion between the base year t and year t+x

$$RPS_{ACC_{t-(t+x)}} = \sum_{j=1}^{42} \sigma_{j_t} \left| \left(\frac{P_{j_{t+x}}}{P_{j_t}}\right) / \left(\frac{\bar{P}_{t+x}}{\bar{P}_t}\right) - 1 \right|$$

where

x = 1, 2, 3,....20.

DP – Change in the prices of industrial products, absolute value

1. DP_{1_t} = Annual percentage change in the price index for industrial products, numerical value

$$DP_{1_t} = \left| \dot{p}_t \right|$$

$\dot{p}$ = Annual change in industry prices, percent

2. DP_{5_t} = Average change over 5-year periods in the price index for industrial products, absolute value

$$DP_{5_t} = \frac{1}{5} \sum_{i=t-x}^{t} \left| \dot{p}_i \right|$$

VP - **Variability in the rate of change in the price index for industrial products**

1. VP_1 = Annual variability in the prices of industrial products

$$VP_{1_t} = \left| \dot{p}_t - \dot{p}_{t-1} \right|$$

2. VP_5 = The variability in the prices of industrial products over 5-year periods

$$VP_{5_t} = \sum_{i=t-5}^{t} \left| \dot{p}_i - \sum_{i=t-5}^{t} \dot{p}_i/5 \right|$$

APPENDIX II
The Data

The picture of Swedish industrial transformation we have presented is based on statistical material compiled for this paper and for an earlier paper on relative prices and structural change (Josefsson-Örtengren, 1980). At this level of disaggregation, no comparable data exists for Swedish industrial development from 1913 to 1980. Below we list the sources of our data on prices, production volume and sales value.

In our compilation of data we have aimed at an internally consistent set of indices. Another principle has been to use official figures, when available. These two principles have sometime been in conflict with one another. In those cases we have given priority to the second, i.e. that official figures should be used. The most important deviation from this rule concerns the price index for Total Manufacturing 1953-63, where our implicit deflator has been chosen. The reason is that the official index for wholesale prices deviates considerably from our implicit index. We have in this case given priority to the need for consistency.

The 42 branches (see below) have been classified according to the Swedish standard classsification of economic activities (SNI), which is identical with the ISIC 1968 up to and including the four digit level. In addition it has a fifth and a sixth digit level of national classification.

That system for classification has been used in the Swedish industrial statistics since 1968. Before 1968, establishments in industry were classified according to a national nomenclature. In its outlines it dated back to 1913, with some alterations. For comparability over time, our time-series have been linked. The most important such linkages are for 1939, 1945, 1951, 1953, 1963 and 1967.

1 Sales value

Sales value in current prices has been taken from the Swedish industrial statistics 1913-80. Sales value has been chosen, instead of value added, since no data on the latter variable is available before 1953. That is the year in which it was introduced into Swedish industrial statistics.

2 Production Volume

We have used three sources.

a 1913-40: The basic statistical material compiled at the IUI in 1950, when the Institute revised the production volume series of the Federation of Swedish Industries (see Ruist, 1950).

b 1940-49: The production-volume figures calculated by the Board of Commerce and published in the journal Kommersiella Meddelanden.

c 1949-80: Different production volume figures from the Swedish Central Board of Statistics.

For total Mining and Manufacturing the production volume has been calculated as the weighted average of the production volumes in the individual branches. A standard Divisia-formula has been used.

3 Prices

In most cases, when official price indices have been available, they have been used. But where no official price index exists, which is the rule before 1950, we have calculated prices as the implicit deflator between the sales value in current and constant prices, calculated as given above.

This means that our price indices should be treated with some caution. Besides the usual problems of price index calculations, they have the problems of historical time series.

Branch		SNI-class	Type of price index[1]
1	Mining, quarrying	2	Calculated from the foreign trade statistics
2	Meat production	3111	1949-1980: Wholesale prices
3	Dairies	3112	1949-1980: Wholesale prices
4	Fish, fruit or vegetables tinned or frozen	3113-3114	1963-1980: Producer prices
5	Margarine production	31151	1963-1980: Producer prices
6	Milling industry	3116	1949-1980: Wholesale prices
7	Bakeries	3117	1949-1980: Wholesale prices
8	Sugar industry	3118	1963-1980: Producer prices
9	Confectionary	3119	1963-1980: Producer prices
10	Beverages (liquor excl)	3133	1963-1980: Producer prices
11	Other food industry		1963-1980: Producer prices
12	Spinning, weaving etc	3211	1963-1980: Producer prices
13	Knitwear industry	3213	1949-1980: Wholesale prices
14	Wearing apparel	322	1949-1980: Wholesale prices
15	Tanneries	3231	1949-1980: Wholesale prices
16	Furs and leather industry	3232-33	
17	Footwear	324	
18	Other textile industry		
19	Sawn wood	33111	1963-1980: Producer prices
20	Other wood products		1963-1980: Producer prices
21	Pulp industry	34111	1949-1980: Wholesale prices
22	Paper industry	34112	1949-1980: Wholesale prices
23	Other pulp and paper		
24	Printing, publishing	342	1963-1980: Producer prices
25	Fertilizers	3512	1949-1980: Wholesale prices
26	Paints	3521	1949-1980: Wholesale prices
27	Soap and detergents	3253	1949-1980: Wholesale prices
28	Petroleum refineries	353	1949-1980: Wholesale prices
29	Matches	352901	2)
30	Other chemicals		
31	Rubber products	355	1949-1980: Wholesale prices
32	Pottery, china etc.	3610	1963-1980: Producer prices
33	Glass and products	3620	1963-1980: Producer prices
34	Bricks and tiles	3691	1963-1980: Producer prices
35	Cement	36921	
36	Other stone and clay		
37	Iron and steel	37	1949-1980: Wholesale prices
38	Metal products	381	1963-1980: Producer prices
39	Machinery n.e.c.	382	1963-1980: roducer prices
40	Electrical machinery	383	1963-1980: Producer prices
41	Transport equipment	3842-49	1963-1980: Producer prices
42	Shipbuilding, repair	3841	Producer prices
43	Mining and Manufacturing	2+3	1913-1963: Implicit deflator 1964-1980: Producer prices

[1] When no index type is specified, an implicit deflator has been used.

[2] No data available after 1971 for reasons of confidentiality.

Table 1 Sales value in Swedish mining and manufacturing 1913-80

Million SEK

The branches are numbered according to the list presented above (page 97).

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1913	79	22	110	4	26	115	31	107	11	39	166	153	16	28	37
1914	59	27	110	7	27	127	37	101	11	40	174	149	16	32	39
1915	76	53	122	16	44	156	46	116	15	45	195	177	18	47	75
1916	101	101	143	16	36	178	56	119	17	49	256	236	25	53	82
1917	125	96	133	11	3	129	62	110	23	56	221	262	30	79	72
1918	135	72	96	19	8	146	82	105	40	40	255	206	29	102	116
1919	101	74	145	16	45	274	101	173	49	58	415	378	36	119	103
1920	95	86	205	13	46	281	113	261	48	91	474	503	63	163	120
1921	84	84	187	12	33	206	102	347	35	88	464	219	28	94	50
1922	73	67	153	11	29	160	87	341	28	65	364	272	38	94	49
1923	66	71	161	12	36	163	82	197	30	66	325	287	37	104	56
1924	85	73	178	14	44	182	87	188	31	74	333	289	39	111	56
1925	108	74	182	14	60	190	91	144	29	82	353	259	36	114	53
1926	110	91	193	14	61	177	98	144	30	84	365	263	43	123	51
1927	123	101	211	14	52	182	106	103	32	86	332	264	50	132	57
1928	56	105	222	15	61	186	110	132	33	86	346	274	57	145	61
1929	144	113	243	19	63	172	112	147	34	93	354	270	58	157	50
1930	141	115	216	18	56	151	113	103	33	100	354	265	63	172	49
1931	87	96	199	18	45	137	111	103	32	95	343	217	54	161	45
1932	46	89	176	17	42	138	105	98	32	95	354	241	59	154	37
1933	55	95	189	17	40	128	98	132	31	85	343	246	63	156	37
1934	86	112	246	20	42	131	106	154	35	84	353	306	76	196	43
1935	116	164	247	24	44	143	114	149	39	90	381	307	76	217	46
1936	159	193	267	24	48	151	123	155	41	93	396	329	83	243	48
1937	246	215	313	28	52	163	133	161	45	103	423	353	91	271	59
1938	287	259	358	33	50	164	142	188	50	111	452	317	92	286	49
1939	268	307	411	37	49	174	153	174	57	120	518	362	109	330	63
1940	247	409	448	41	40	212	178	216	66	121	603	476	130	370	101
1941	238	474	473	60	43	208	160	213	76	120	694	473	153	384	94
1942	259	353	452	68	90	167	153	248	91	115	822	522	163	393	95
1943	301	460	742	77	81	198	180	252	94	134	831	548	162	459	79
1944	240	579	811	65	85	198	184	261	112	137	920	585	160	499	93
1945	148	568	908	80	106	220	330	299	115	148	855	630	167	551	101
1946	211	618	970	86	63	225	209	290	124	156	1081	683	189	653	117
1947	264	706	1080	106	78	245	404	295	134	183	946	778	228	829	133
1948	383	717	1094	127	130	268	476	301	175	196	1060	933	274	1023	138
1949	440	853	1220	122	175	282	466	333	163	209	1167	1027	265	1050	145
1950	532	932	1312	115	186	287	435	377	168	208	1272	1086	256	1079	139
1951	727	1190	1430	132	256	337	490	424	153	222	1516	1359	306	1316	196
1952	1140	1385	1532	183	297	413	558	426	166	258	436	1032	253	1191	143
1953	1182	1359	1564	208	290	412	563	476	171	282	1784	1132	300	1338	165
1954	1007	1443	1546	222	305	427	601	485	188	285	1809	1056	282	1293	144
1955	1149	1678	1638	262	319	420	642	435	194	319	1909	1024	279	1339	142
1956	1360	1822	1773	302	339	412	673	526	205	310	2014	1032	297	1380	140
1957	1486	1867	1885	293	329	423	715	484	217	303	2068	1088	317	1403	154
1958	1355	1959	1798	318	304	421	746	390	225	318	2367	1031	300	1358	135
1959	1291	2264	1904	366	312	444	773	403	246	350	2468	1089	309	1373	150
1960	1480	2387	1981	420	325	456	811	457	241	348	2515	1191	356	1491	136
1961	1616	2625	2073	437	320	466	876	381	262	370	2592	1217	365	1636	136
1962	1667	2926	2218	505	325	501	960	374	279	294	2820	1248	395	1709	147
1963	1422	3323	2280	572	320	518	1023	513	319	330	2979	1303	443	1814	162
1964	1629	3733	2434	640	340	533	1106	462	353	356	2299	1370	474	1928	158
1965	1788	3924	2622	731	354	558	1151	380	374	392	2461	1419	457	1975	151
1966	1720	4325	2659	839	382	578	1218	425	378	456	2667	1289	469	1958	160
1967	1566	4521	2683	886	383	596	1263	426	394	470	2773	1310	484	2007	160
1968	1645	4686	2815	989	277	589	1297	455	406	554	2886	1262	497	1950	155
1969	1732	5420	2860	1065	288	633	1368	396	435	591	2665	1281	574	1986	172
1970	1887	5748	2925	1264	343	667	1481	449	452	604	2987	1285	610	2021	153
1971	2111	5728	3212	1232	365	694	1561	530	502	762	3045	1242	618	1893	151
1972	2097	6271	3805	1327	348	739	1673	540	559	843	3305	1299	705	1945	187
1973	2357	6554	3983	1511	348	754	1719	685	609	957	3729	1493	734	2079	200
1974	3001	6980	4175	1857	0	752	1836	1051	789	1032	5027	1775	845	2276	209
1975	3310	7366	4632	2017	0	873	2067	939	865	1230	5249	1588	851	2406	220
1976	3408	8402	4866	2348	0	887	2312	1059	972	1429	6483	1848	875	2444	270
1977	2799	9327	5054	2661	0	970	2411	1181	1189	1478	7480	1800	821	2216	275
1978	2445	9987	5805	2852	0	1024	2613	1178	1261	1523	8240	1821	821	1913	301
1979	3221	10823	6304	3061	0	1065	2828	1330	1393	1694	8752	1911	939	2057	357
1980	3834	12077	7180	3299	0	1201	3204	1413	1609	1759	9487	2046	970	2188	306

0	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1913	5	49	13	218	38	101	72	24	50	14	3	27	0	19	28
1914	5	57	13	198	39	102	69	24	55	12	3	28	0	20	31
1915	6	107	11	235	43	114	86	28	58	14	4	38	0	34	50
1916	8	118	19	349	57	209	151	51	67	21	8	59	0	45	76
1917	10	130	22	369	80	212	192	55	92	21	12	62	0	46	106
1918	13	158	27	375	113	220	243	67	140	23	16	68	0	46	133
1919	15	136	38	528	111	232	196	65	169	45	11	109	0	52	94
1920	19	234	32	699	128	486	376	116	198	57	11	102	0	63	99
1921	9	121	18	211	75	181	154	49	168	25	6	54	0	38	53
1922	10	104	22	283	62	180	149	44	145	16	6	52	0	34	50
1923	10	118	22	356	73	198	170	52	147	16	7	62	0	37	54
1924	10	109	25	339	79	225	184	59	144	16	8	73	0	34	58
1925	9	106	28	310	83	243	200	63	151	19	7	81	0	33	70
1926	9	101	29	310	93	285	212	73	160	19	9	80	0	36	68
1927	10	104	32	342	96	293	207	74	166	17	10	80	0	37	68
1928	11	108	29	367	104	240	198	68	174	19	10	80	0	39	65
1929	11	100	29	351	114	330	231	86	182	19	12	80	0	41	77
1930	11	110	31	309	125	294	203	79	187	20	13	68	0	39	82
1931	10	98	22	226	122	219	190	71	181	15	13	61	0	32	76
1932	9	79	22	177	105	181	181	62	173	11	13	57	0	21	76
1933	9	79	25	199	91	231	172	63	173	13	14	72	0	16	79
1934	11	80	35	281	118	271	187	73	183	13	16	77	0	15	93
1935	13	87	39	241	153	281	200	78	199	14	20	90	0	17	112
1936	15	90	45	263	179	318	216	89	214	12	21	99	0	17	111
1937	18	103	52	362	207	436	271	110	236	14	25	114	0	16	130
1938	19	107	47	292	229	395	231	103	255	16	26	112	0	16	138
1939	24	122	55	315	260	350	262	109	268	16	33	139	0	20	166
1940	35	176	61	293	219	301	223	104	257	21	31	127	0	16	191
1941	41	152	95	285	247	238	222	69	284	16	39	110	0	9	281
1942	43	164	124	346	324	385	316	102	333	14	52	156	0	7	342
1943	43	127	156	388	367	308	319	95	375	31	66	207	0	7	393
1944	49	165	188	354	413	271	340	96	410	33	74	243	0	8	423
1945	63	187	200	454	519	417	414	127	443	38	78	268	0	12	418
1946	86	198	215	544	664	658	568	163	498	42	100	246	0	17	401
1947	116	226	221	619	710	925	692	192	534	33	120	287	0	24	446
1948	117	264	228	655	723	1133	809	226	589	42	126	382	0	27	514
1949	89	268	219	742	703	866	710	188	642	49	116	138	75	31	777
1950	88	262	219	864	775	1189	847	215	693	56	130	157	152	39	867
1951	108	343	290	1339	1015	2559	1738	464	855	60	155	182	214	56	1112
1952	104	270	237	1263	914	1742	1246	409	873	74	147	181	222	56	1140
1953	100	310	224	1318	933	1345	1059	354	904	73	151	191	214	46	1180
1954	93	307	257	1563	1073	1649	1272	459	998	88	160	195	249	45	1237
1955	99	306	261	1636	1146	1837	1428	533	1090	96	174	196	269	44	1292
1956	107	308	266	1470	1152	1990	1535	561	1171	102	193	212	317	49	1470
1957	112	327	296	1486	1239	2020	1626	601	1239	113	203	220	399	47	1599
1958	119	309	307	1457	1280	1791	1601	625	1307	93	213	233	349	43	1677
1959	129	311	350	1271	1376	1774	1704	666	1376	104	242	263	396	43	1853
1960	131	316	366	1616	1528	2092	1938	772	1510	110	261	285	424	46	2021
1961	142	306	432	1728	1704	2219	2063	823	1642	116	284	300	383	46	2130
1962	154	321	477	1747	1845	1954	2167	864	1790	125	303	322	378	46	2261
1963	179	346	545	1836	2124	2129	2411	937	1964	123	331	344	414	40	2411
1964	190	360	600	2181	2479	2628	2671	1056	2208	140	390	369	431	40	2756
1965	176	340	600	2517	2864	2832	2822	1209	2515	163	424	403	474	42	3213
1966	167	297	579	2427	2991	2613	2892	1212	2703	160	436	392	493	48	3465
1967	165	294	643	2439	3222	2683	3090	1265	2875	168	481	409	734	41	3791
1968	164	294	698	2562	3546	2618	3249	1399	3075	392	506	455	1084	42	3941
1969	188	296	798	2849	3967	2923	3686	1521	3404	377	538	472	1138	52	4450
1970	173	296	854	3312	4390	3694	4274	1674	3771	362	556	467	1363	62	4981
1971	161	267	835	3603	4401	3701	4357	1748	3836	398	589	490	1649	63	5246
1972	170	290	883	3795	5045	3544	4837	1811	4131	404	651	502	1542	0	6037
1973	163	333	1056	5289	6167	4172	6435	2189	4533	428	744	542	1871	0	7210
1974	189	368	1276	6980	8470	6602	10069	3003	5394	669	986	604	4029	0	10846
1975	198	400	1296	6190	8089	7428	9389	2995	6336	756	1033	696	4575	0	10887
1976	186	482	1475	7233	9166	6793	10128	3256	7246	753	1062	745	7089	0	12621
1977	182	506	1560	7815	10121	5415	10569	3406	8069	758	1070	782	8207	0	12840
1978	193	469	1510	8066	11183	5589	12162	3626	9016	834	1113	839	8900	0	14569
1979	214	511	1799	9392	12760	7322	14824	4189	10258	849	1326	960	13020	0	18140
1980	225	553	1608	11249	13712	8106	16889	5244	11504	1032	1541	1047	19331	0	22023

0	31	32	33	34	35	36	37	38	39	40	41	42	43
1913	11	7	11	22	11	32	210	84	164	35	0	20	2213
1914	11	7	11	20	8	30	179	80	172	36	0	26	2192
1915	15	10	15	22	10	26	254	121	200	47	0	27	2776
1916	20	8	19	28	12	31	409	196	315	72	0	45	3862
1917	12	10	22	45	17	41	706	277	437	110	0	61	4563
1918	19	14	29	66	23	64	782	321	488	131	0	99	5126
1919	41	17	36	60	24	76	477	270	480	146	0	134	5650
1920	46	20	44	58	28	86	480	310	501	140	0	165	7061
1921	22	13	14	31	19	43	141	127	336	103	0	104	4147
1922	26	13	17	26	19	35	138	120	217	60	0	75	3732
1923	28	14	21	40	16	43	139	144	240	61	0	53	3815
1924	33	12	19	41	16	50	211	165	275	75	0	53	4099
1925	40	11	20	42	18	54	213	170	299	91	0	59	4210
.1926	38	11	20	42	20	51	201	176	342	111	0	65	4411
1927	36	10	21	39	20	62	208	178	348	121	0	73	4495
1928	47	11	21	42	19	63	230	199	422	145	0	91	4692
1929	53	11	21	45	21	69	277	220	472	147	0	103	5134
1930	36	11	22	45	22	74	232	204	467	157	0	110	4901
1931	41	10	20	39	18	53	203	180	409	138	0	107	4297
1932	41	9	18	30	15	48	209	164	343	117	0	76	3919
1933	40	10	17	27	12	40	255	172	331	117	0	57	4028
1934	46	11	21	39	16	49	359	229	464	141	0	81	4899
1935	47	15	24	46	20	59	386	275	588	169	0	95	5424
1936	53	16	26	50	23	67	416	311	641	198	0	104	5945
1937	61	17	30	57	24	75	557	403	798	243	0	139	7155
1938	54	18	29	58	30	84	539	377	906	269	0	164	7351
1939	63	20	32	62	37	94	580	449	990	304	0	179	8082
1940	88	18	26	36	33	81	758	483	1016	316	0	200	8768
1941	83	25	31	47	28	99	782	514	1127	349	0	248	9281
1942	76	32	45	67	34	147	868	596	1333	399	0	256	10552
1943	82	37	49	82	41	186	969	658	1502	428	0	298	11812
1944	91	39	45	87	48	196	934	642	1609	477	0	339	12505
1945	124	45	53	94	54	237	912	637	1313	378	0	285	12992
1946	158	51	71	97	64	249	1015	891	1966	616	0	406	15660
1947	171	55	75	104	67	261	1121	995	2269	675	0	490	17840
1948	197	69	83	112	67	256	1297	1139	2515	850	0	570	20286
1949	199	69	84	114	83	234	1455	1207	2650	949	0	636	21210
1950	241	70	86	121	93	250	1529	1282	1956	1040	639	691	22937
1951	371	95	101	143	127	315	2084	1748	2469	1341	906	829	31071
1952	325	106	95	162	147	370	2573	1825	2893	1579	1009	1035	30411
1953	317	93	94	154	149	397	2328	1552	2766	1344	1041	1091	30956
1954	370	104	104	153	149	442	2390	1727	2937	1425	1256	1163	32955
1955	419	115	116	166	150	469	3047	1986	3247	1531	1321	1221	35941
1956	433	112	121	168	160	505	3477	2149	3613	1732	1448	1425	38830
1957	467	114	123	167	172	576	3618	2243	4047	1843	1487	1830	41244
1958	470	116	127	158	168	606	3251	2459	4219	1871	1648	1879	41401
1959	523	120	137	170	184	713	3741	2511	4093	2022	2568	1760	44139
1960	588	137	155	181	175	793	4516	2957	4662	2311	2869	1756	49112
1961	636	143	163	196	188	897	4863	3306	5331	2547	3130	1806	52893
1962	626	152	178	221	196	996	4659	3472	5843	2937	3536	2076	56011
1963	640	167	211	234	207	1141	4768	3651	6210	3124	3942	1861	59610
1964	736	186	253	255	232	1384	5876	4278	6782	3424	4476	2037	66234
1965	811	198	289	253	242	1574	6867	4877	7747	3924	5076	2244	73433
1966	821	206	316	231	238	1705	7158	5259	8307	4304	5488	2369	76799
1967	837	222	355	215	258	1883	6947	5231	8592	4351	5632	2532	79277
1968	943	220	382	212	261	1941	7564	5496	8979	4627	6058	2530	83702
1969	1042	232	418	214	268	2062	8914	6248	9732	5105	7210	2705	92275
1970	1192	252	444	227	301	2232	10691	7393	11358	5911	8458	3108	104673
1971	1245	267	448	230	349	2251	9963	7786	12139	6691	9635	3545	109538
1972	1208	282	485	227	348	2367	9962	8126	12748	7266	10826	4184	117312
1973	1332	320	543	265	372	2533	12422	9450	14498	8138	12500	5011	136229
1974	1722	376	625	321	439	2874	16989	11912	18608	10664	15783	6068	177471
1975	1735	454	651	351	485	3167	16490	13622	21551	12487	18675	7304	190854
1976	1716	483	773	360	538	3518	16129	14528	23016	13612	21057	7758	209326
1977	1817	474	948	361	542	3638	15425	15014	23961	14200	21348	7386	216076
1978	1881	486	1045	356	501	3915	17899	15654	25578	14658	24228	6746	232800
1979	2134	555	1166	392	576	4624	23937	17848	29312	17062	30189	6740	275834
1980	2398	558	1285	459	634	5063	26292	20762	31639	19064	30399	6553	309743

Table 2 Procuction volume in Swedish mining and manufacturing 1913-80

Index 1968 = 100

The branches are numbered according to the list presented above (page 97).

0	1	2	3	4	5	6	7	8	9	10	11	12
1913	19.8	3.9	23.9	2.0	19.7	88.2	14.4	46.3	8.6	44.6	20.1	43.7
1914	17.4	4.6	23.9	3.0	20.2	87.2	15.4	45.6	9.1	46.0	19.3	42.2
1915	18.2	6.1	20.4	5.2	27.2	81.4	15.9	50.0	11.0	45.5	19.9	46.4
1916	18.5	8.9	21.6	3.7	18.0	95.0	17.4	48.5	9.9	47.3	18.5	47.7
1917	16.4	8.3	16.2	1.6	.4	60.1	15.7	44.1	6.5	40.1	9.8	34.7
1918	17.4	4.0	8.5	1.6	1.3	58.2	13.9	37.5	7.4	15.5	10.5	16.1
1919	13.1	4.3	10.4	2.3	12.3	78.5	15.1	42.6	10.8	26.4	16.4	28.5
1920	12.1	5.9	16.6	2.6	12.7	73.7	16.2	49.3	11.8	39.6	20.0	35.1
1921	17.2	7.3	20.8	2.9	10.5	74.6	16.4	52.2	12.2	39.1	22.4	26.4
1922	16.4	7.3	21.9	3.2	14.0	83.4	17.2	61.0	12.0	34.6	21.5	37.4
1923	14.7	9.0	23.1	3.5	18.9	93.0	17.7	44.1	14.1	38.2	16.1	42.5
1924	17.2	9.8	25.0	4.2	23.7	97.9	19.5	52.2	16.0	37.8	20.0	43.1
1925	21.4	8.5	25.8	4.3	30.7	95.0	20.5	48.5	15.2	41.4	20.7	39.0
1926	22.3	10.3	30.4	4.8	33.3	92.1	22.6	62.5	16.0	43.2	25.8	42.6
1927	25.5	12.5	33.1	4.5	34.2	91.1	24.4	41.9	16.9	44.2	19.5	44.3
1928	12.3	12.5	33.1	5.2	40.3	96.9	25.4	53.7	17.9	43.7	23.5	46.0
1929	30.3	12.5	38.5	6.0	43.8	96.9	25.7	73.5	19.0	45.5	31.4	45.2
1930	29.2	13.8	42.0	6.1	42.5	96.9	26.9	61.0	20.9	50.1	32.9	47.1
1931	19.8	15.3	42.3	6.6	40.3	92.1	27.7	73.5	21.9	48.3	35.7	41.7
1932	11.8	14.7	41.6	6.8	40.3	97.9	27.2	65.4	21.9	47.8	35.1	48.7
1933	12.6	15.2	42.7	6.9	40.8	91.1	26.7	82.3	21.7	39.6	32.7	49.4
1934	19.0	17.8	48.1	7.5	43.8	91.1	29.3	100.0	24.7	37.8	31.4	61.5
1935	26.8	20.8	48.9	8.2	46.5	97.9	31.0	93.4	28.1	40.5	31.6	61.1
1936	35.7	23.6	52.3	8.4	47.8	98.9	33.9	99.2	29.9	41.9	31 2	66.7
1937	45.0	25.7	55.8	9.9	50.9	100.8	36.4	100.0	32.7	45.5	34.7	68.5
1938	43.7	29.8	60.8	11.1	52.6	99.8	39.0	113.9	36.5	48.3	37.0	63.8
1939	43.2	34.0	64.7	13.0	52.2	104.7	41.6	102.2	41.1	52.3	22.7	70.8
1940	37.3	37.3	62.0	15.1	32.4	115.3	43.9	119.1	39.4	46.4	30.9	71.3
1941	35.1	34.4	56.6	17.3	28.3	112.4	48.9	103.2	40.5	38.8	25.4	65.5
1942	36.2	23.9	49.8	10.1	33.4	88.7	53.5	104.1	41.6	36.3	34.1	67.2
1943	39.4	29.3	56.6	11.3	32.0	104.5	55.4	91.9	37.4	40.0	25.7	69.0
1944	30.3	37.6	64.9	9.8	36.2	105.5	60.1	97.5	46.1	39.6	30.5	71.8
1945	20.4	36.3	71.7	12.5	39.4	118.3	68.1	101.3	49.2	41.6	31.6	78.8
1946	27.1	41.9	77.6	13.8	26.9	111.4	73.1	95.6	51.2	44.4	36.1	81.0
1947	31.1	46.1	76.1	16.3	32.4	109.4	74.4	98.5	49.2	48.9	38.9	82.7
1948	42.4	41.1	74.2	16.9	45.9	106.5	80.0	89.1	55.4	48.4	48.7	91.7
1949	44.0	46.1	83.4	17.8	60.7	106.5	80.3	94.7	52.0	50.1	53.3	96.4
1950	44.0	48.1	87.5	17.4	64.5	107.2	73.9	105.6	50.6	50.1	51.8	99.2
1951	47.2	53.4	84.9	20.4	67.6	109.5	73.6	101.1	35.2	49.7	48.7	99.9
1952	51.2	52.8	84.4	20.3	71.3	108.7	74.4	83.9	42.4	53.1	49.2	80.2
1953	52.3	51.4	84.6	26.3	66.4	99.1	73.9	110.7	43.1	56.4	55.8	89.6
1954	48.5	54.7	83.1	27.2	70.6	106.1	77.4	104.7	43.9	56.7	52.0	89.5
1955	55.0	59.1	83.0	32.1	74.0	106.0	81.2	103.6	44.2	63.2	52.7	88.2
1956	60.1	57.4	81.0	37.2	82.4	105.5	81.7	114.7	48.1	61.6	57.1	89.9
1957	64.6	59.8	86.9	36.0	90.9	106.8	84.8	105.6	50.4	61.2	59.4	94.0
1958	59.0	61.8	83.5	38.5	83.3	107.8	83.9	89.2	50.4	59.0	60.0	88.9
1959	60.1	70.2	86.2	44.0	85.7	111.9	85.4	93.3	58.0	62.7	63.2	97.5
1960	67.0	72.4	88.6	51.2	88.8	107.7	88.7	105.4	61.3	62.7	67.1	102.5
1961	74.3	77.2	89.9	53.9	88.0	106.5	92.8	91.5	68.8	64.3	69.6	102.0
1962	74.0	84.0	92.1	62.2	88.3	108.5	94.4	81.3	74.5	63.7	72.5	104.1
1963	75.6	85.7	91.1	68.1	86.0	103.6	94.5	85.7	76.9	69.7	75.9	107.2
1964	83.1	89.8	93.1	72.0	92.6	102.8	95.0	94.0	81.3	72.7	80.0	110.6
1965	87.9	90.6	95.7	80.2	95.3	102.8	95.5	79.8	86.4	75.5	84.0	111.7
1966	88.2	93.9	98.6	90.4	98.5	102.2	99.2	85.7	88.9	82.7	89.9	100.0
1967	91.7	97.9	98.6	95.1	97.9	101.5	99.7	89.8	91.7	86.9	93.8	101.8
1968	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1969	103.0	102.0	99.0	106.0	101.0	100.0	105.0	83.0	101.0	115.0	106.0	108.0
1970	102.0	108.0	99.0	121.0	104.0	100.0	105.0	89.0	102.0	119.0	114.2	107.0
1971	114.0	110.0	101.0	113.0	102.0	97.0	103.0	98.0	106.0	131.0	106.4	101.0
1972	113.0	101.0	108.0	114.0	102.0	97.0	101.0	101.0	109.0	131.0	115.9	102.0
1973	125.0	102.0	106.0	117.0	107.0	97.0	100.0	100.0	111.0	135.0	122.5	106.0
1974	130.0	110.0	111.0	127.0	109.0	96.0	98.0	109.0	111.0	127.0	125.9	109.0
1975	111.0	113.0	116.0	120.0	102.0	99.0	105.0	103.0	108.0	134.0	121.3	92.0
1976	110.0	114.0	119.0	126.0	97.0	96.0	95.0	105.0	117.0	147.0	130.0	99.0
1977	93.0	114.0	119.0	126.0	92.0	94.0	93.0	108.0	120.0	143.0	124.0	91.0
1978	79.0	114.0	125.0	120.0	93.0	91.0	93.0	100.0	116.0	137.0	126.0	84.0
1979	95.0	117.0	126.0	120.0	91.0	88.0	93.0	106.0	120.0	138.0	130.0	81.0
1980	95.0	117.0	135.0	118.0	91.0	92.0	93.0	105.0	123.0	132.0	137.0	82.0

0	13	14	15	16	17	18	19	20	21	22	23	24
1913	19.8	8.6	86.2	14.0	78.9	22.2	66.3	6.4	15.6	9.6	4.5	12.1
1914	18.2	9.4	83.5	13.5	85.7	23.6	61.7	6.1	15.2	9.0	4.7	12.9
1915	18.2	12.2	92.6	15.8	105.2	25.4	63.3	5.6	16.2	10.2	4.9	12.7
1916	19.8	11.8	79.0	15.0	102.7	24.7	70.2	5.7	17.2	11.4	5.1	12.7
1917	12.0	12.2	59.9	13.7	85.7	21.0	60.2	5.9	13.5	9.4	5.5	13.1
1918	7.4	9.0	70.8	13.4	72.1	16.2	53.2	6.1	11.8	8.8	5.9	12.3
1919	12.8	8.8	78.1	14.3	59.4	19.2	61.7	5.9	12.5	7.8	5.5	13.1
1920	25.2	11.8	92.6	15.3	93.3	19.5	67.9	6.2	17.2	11.2	5.1	12.3
1921	15.9	8.8	69.0	7.6	66.2	16.0	39.3	4.6	10.1	7.0	4.3	11.1
1922	24.4	10.3	82.6	8.9	77.2	18.4	54.0	5.6	17.6	10.8	4.7	12.1
1923	26.4	12.7	100.8	12.7	97.6	21.1	66.3	6.6	17.9	12.8	5.1	13.9
1924	26.4	13.7	105.3	12.6	94.2	24.0	67.9	7.5	22.3	14.4	5.5	13.9
1925	25.2	13.7	91.7	11.4	91.6	25.9	64.0	7.8	23.0	15.4	6.3	14.8
1926	31.0	16.1	95.3	13.0	89.1	27.0	67.9	8.9	25.7	16.8	7.0	16.2
1927	35.7	18.5	103.5	14.5	94.2	27.6	72.5	9.4	28.1	17.2	7.7	17.0
1928	38.8	19.8	99.0	15.8	91.6	27.1	77.9	9.9	25.0	17.0	8.2	18.0
1929	38.8	21.5	90.8	16.1	84.9	27.6	77.1	11.0	33.8	20.0	9.0	19.5
1930	42.3	24.1	98.1	15.1	101.8	30.4	70.2	12.4	33.1	18.4	9.5	20.1
1931	38.8	23.4	98.1	16.6	92.5	28.0	60.2	12.7	30.8	19.4	9.0	20.3
1932	41.1	23.6	88.1	15.4	83.2	26.2	53.2	11.8	28.1	19.2	8.8	20.3
1933	45.4	24.9	90.8	15.8	87.4	28.2	55.5	11.2	36.2	20.0	9.3	21.1
1934	57.8	31.8	96.2	18.5	89.9	32.2	71.0	14.3	40.9	22.5	10.4	23.1
1935	56.6	36.1	103.5	22.7	98.4	34.8	66.3	17.6	43.6	24.3	11.3	25.4
1936	61.3	40.4	104.4	26.2	97.6	38.3	66.3	20.7	47.3	25.9	11.7	27.2
1937	66.7	44.7	111.7	31.4	104.4	38.1	74.1	22.9	53.1	28.3	12.2	27.7
1938	65.6	46.4	99.9	35.4	111.2	37.9	64.0	24.5	46.0	22.2	12.6	30.1
1939	74.1	52.2	127.1	42.5	125.6	41.6	66.3	27.0	48.0	27.7	15.1	31.8
1940	71.0	53.3	149.8	64.7	134.9	39.5	54.0	21.3	31.1	18.4	14.6	29.3
1941	65.3	46.7	126.0	76.0	103.2	38.5	43.3	21.5	20.6	16.7	15.6	30.1
1942	64.2	42.0	114.7	79.0	97.2	43.6	46.7	25.3	26.3	20.6	18.8	32.3
1943	65.3	46.0	91.9	71.7	72.4	55.4	49.3	26.9	20.6	18.9	19.5	34.1
1944	61.3	49.6	103.3	79.0	92.3	61.3	45.3	29.6	20.6	20.6	20.9	37.4
1945	61.3	53.3	108.5	86.0	103.2	61.6	54.0	35.9	30.2	24.3	24.0	40.7
1946	65.3	59.1	138.4	93.3	115.1	71.0	63.3	42.6	42.1	31.5	28.2	42.9
1947	72.7	64.9	150.8	106.5	123.0	67.7	58.7	42.1	45.6	33.5	28.0	43.7
1948	81.2	73.9	151.9	106.7	128.0	64.3	54.7	40.2	48.2	35.2	29.0	44.7
1949	72.7	75.0	153.9	81.7	124.0	63.8	62.0	39.0	46.0	33.0	27.0	48.0
1950	66.9	73.0	145.5	79.3	120.0	62.7	62.0	41.0	51.0	35.0	28.0	49.0
1951	72.4	78.0	127.9	83.6	115.0	65.2	62.0	39.0	54.0	38.0	33.0	50.0
1952	62.6	72.0	112.0	82.5	96.0	54.4	56.0	36.0	49.0	32.0	28.0	52.0
1953	67.0	82.0	131.4	78.2	115.0	59.9	61.0	38.0	51.0	36.0	30.0	54.0
1954	62.5	81.0	114.8	72.7	117.0	62.7	70.0	43.0	59.0	41.0	35.0	58.0
1955	65.2	83.0	116.7	76.3	113.0	63.7	72.0	45.0	63.0	44.0	39.0	59.0
1956	67.4	85.0	115.7	78.8	113.0	61.2	65.0	44.0	67.0	46.0	40.0	61.0
1957	68.9	84.0	124.2	78.0	122.0	61.1	66.0	47.0	69.0	48.0	45.0	63.0
1958	66.9	80.0	109.3	78.3	115.0	61.3	68.0	48.0	65.0	49.0	43.0	67.0
1959	72.9	84.0	106.9	84.8	118.0	64.4	60.0	52.0	70.0	54.0	49.0	71.0
1960	85.8	89.0	96.9	83.4	118.0	67.8	71.0	56.0	81.0	61.0	57.0	74.0
1961	86.6	96.0	96.8	88.5	118.0	78.6	72.0	58.0	85.0	64.0	62.0	78.0
1962	88.5	98.0	102.8	93.8	122.0	83.4	74.0	62.0	76.0	65.0	66.0	82.0
1963	99.2	102.0	113.9	104.8	129.0	91.6	77.0	69.0	83.0	73.0	73.0	87.0
1964	102.7	105.0	111.3	104.7	131.0	95.7	85.0	78.0	95.0	80.0	80.0	93.0
1965	93.9	104.0	103.4	90.6	122.0	97.8	91.0	86.0	100.0	82.0	86.0	101.0
1966	98.0	102.0	99.7	89.9	104.0	96.0	88.0	87.0	96.0	84.0	86.0	101.0
1967	99.3	106.0	96.5	88.5	103.0	100.6	93.0	92.0	101.0	91.0	92.0	98.0
1968	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1969	118.0	100.0	105.0	99.0	97.0	95.0	104.0	109.0	106.0	110.0	109.0	108.0
1970	131.0	97.0	94.0	94.0	92.0	101.4	112.0	114.0	115.0	117.0	112.0	112.0
1971	136.0	86.0	95.0	82.0	78.0	98.4	116.0	111.0	110.0	116.0	112.0	107.0
1972	144.0	84.0	103.0	80.0	80.0	102.2	121.0	120.0	114.0	125.0	109.0	109.0
1973	148.0	88.0	91.0	72.0	84.0	111.8	129.0	132.0	120.0	143.0	120.0	113.0
1974	149.0	86.0	95.0	72.0	79.0	105.6	133.0	138.0	125.0	151.0	129.0	106.0
1975	144.0	82.0	100.0	75.0	73.0	102.0	105.0	132.0	112.0	120.0	113.0	107.0
1976	133.0	73.0	106.0	63.0	78.0	104.0	105.0	134.0	105.0	133.0	118.0	109.0
1977	109.0	59.0	98.0	55.0	72.0	99.0	100.0	132.0	91.0	132.0	114.0	110.0
1978	95.0	45.0	94.0	50.0	60.0	85.0	99.0	135.0	101.0	143.0	116.0	113.0
1979	96.0	45.0	86.0	48.0	59.0	89.0	103.0	140.0	108.0	156.0	121.0	119.0
1980	91.0	45.0	75.0	45.0	57.0	78.0	100.0	131.0	100.0	154.0	131.0	119.0

0	25	26	27	28	29	30	31	32	33	34	35	36
1913	12.2	2.3	5.2	.0	338.3	1.4	3.2	21.6	12.8	102.6	9.0	8.5
1914	12.4	2.1	5.0	.0	338.3	1.2	3.3	20.8	12.1	91.2	6.4	7.3
1915	10.6	2.6	5.7	.0	424.0	1.5	3.6	20.3	14.2	83.0	7.0	6.0
1916	8.6	3.2	5.4	.0	475.4	1.7	3.5	20.9	14.0	85.4	8.0	5.7
1917	5.6	2.4	2.8	.0	436.8	1.6	1.6	20.5	12.4	87.7	6.5	5.2
1918	4.3	1.6	2.2	.0	295.5	1.4	1.5	18.6	10.0	82.1	5.2	4.5
1919	8.4	2.1	4.4	.0	334.1	1.3	3.3	16.5	11.3	75.9	5.4	4.9
1920	11.6	2.7	5.2	.0	334.1	1.5	3.7	19.7	12.9	68.5	6.6	4.6
1921	8.3	2.0	4.9	.0	209.9	1.0	2.5	14.6	5.5	46.2	5.6	3.6
1922	8.0	2.3	5.9	.0	209.9	1.3	3.1	18.7	9.4	51.8	8.4	4.1
1923	9.7	3.0	7.1	.0	274.1	1.6	3.4	21.0	11.7	82.8	9.0	5.7
1924	11.2	3.5	8.1	.0	282.7	1.7	3.8	19.2	11.6	80.5	9.4	6.5
1925	14.4	3.6	8.5	.0	312.6	2.0	4.1	18.3	12.4	86.0	10.3	7.7
1926	14.2	3.9	9.5	.0	351.2	2.2	3.8	19.4	12.6	86.0	10.8	7.2
1927	13.4	4.0	11.0	.0	381.2	2.0	4.4	18.9	13.3	83.8	11.4	8.7
1928	14.9	4.6	12.1	.0	402.6	2.0	5.3	19.8	14.6	89.7	10.8	9.4
1929	14.7	4.8	12.0	.0	428.3	2.5	5.7	20.4	13.9	98.2	13.1	10.3
1930	16.1	5.2	11.6	.0	406.9	2.7	4.0	22.8	15.8	98.2	14.1	10.7
1931	13.6	5.8	12.1	.0	338.3	2.5	5.7	21.7	15.0	85.8	11.9	8.9
1932	11.8	5.8	11.3	.0	218.4	2.5	6.3	20.2	12.6	66.6	11.5	8.0
1933	13.3	6.3	13.8	.0	167.0	2.7	7.0	20.2	14.2	59.6	9.3	7.0
1934	13.1	7.6	15.7	.0	158.5	3.1	8.7	23.1	15.8	87.8	13.4	8.4
1935	15.8	9.0	17.5	.0	175.6	3.6	8.5	27.2	18.1	103.7	17.0	10.0
1936	14.0	9.7	18.1	.0	175.6	3.9	9.7	27.9	19.6	108.8	18.3	11.5
1937	15.2	11.2	18.9	.0	171.3	4.5	10.6	30.4	22.0	119.1	20.1	12.5
1938	16.5	12.0	20.5	.0	175.6	4.7	10.1	34.5	20.8	117.9	22.8	14.3
1939	16.8	14.8	23.1	.0	218.4	5.4	12.5	34.6	22.1	124.2	27.3	15.3
1940	14.0	11.0	17.0	.0	145.6	5.2	14.1	27.3	16.4	65.3	16.1	9.7
1941	10.7	10.8	13.9	.0	78.9	5.7	11.3	31.3	17.2	71.0	14.8	9.8
1942	9.1	12.1	17.5	.0	45.6	6.3	9.4	36.3	22.7	93.8	19.0	11.8
1943	15.9	13.7	20.3	.0	33.3	6.9	9.7	41.4	22.9	111.5	21.2	13.6
1944	19.4	16.1	24.0	.0	42.1	7.9	11.9	45.2	19.9	115.8	24.4	14.4
1945	22.5	18.1	27.7	.0	80.7	7.9	15.8	51.4	21.1	121.3	27.9	17.0
1946	26.8	25.4	27.2	.0	115.8	7.8	20.5	55.7	27.6	120.1	33.5	20.4
1947	25.2	27.5	29.6	.0	154.4	8.1	21.5	56.2	28.7	119.3	35.6	21.3
1948	31.5	28.2	37.5	.0	164.9	8.8	23.3	66.1	31.3	121.4	34.2	21.1
1949	34.6	26.7	42.8	6.0	168.4	9.5	25.0	65.0	32.0	122.4	39.1	48.4
1950	39.9	29.9	48.7	11.0	198.2	11.1	28.0	64.0	33.0	121.1	44.8	51.0
1951	39.5	29.5	47.8	12.0	214.0	12.9	31.0	72.0	35.0	125.8	47.8	54.0
1952	37.9	27.3	47.0	15.0	187.7	13.3	28.0	75.0	32.0	129.2	49.6	57.5
1953	49.0	29.4	51.0	19.0	170.2	14.2	31.0	69.0	33.0	122.5	56.7	59.6
1954	50.4	32.2	52.0	22.0	166.7	16.8	38.0	75.0	35.0	123.8	60.9	63.6
1955	61.0	35.0	50.7	23.0	166.7	18.2	40.0	76.0	39.0	128.4	63.8	65.5
1956	63.4	38.3	54.4	23.0	193.0	21.2	41.0	75.0	40.0	125.0	62.5	65.5
1957	65.2	41.4	53.7	25.0	182.5	24.1	44.0	70.0	39.0	121.3	61.5	69.5
1958	73.9	44.3	56.3	25.0	178.9	25.1	49.0	73.0	39.0	110.6	62.9	65.8
1959	63.3	51.0	63.8	30.0	175.4	30.0	53.0	74.0	43.0	117.5	71.6	72.7
1960	71.3	55.4	68.1	33.0	180.7	33.8	60.0	79.0	48.0	122.8	71.6	74.3
1961	75.4	58.6	73.1	31.0	171.9	38.8	65.0	81.0	48.0	127.3	76.6	84.1
1962	77.9	62.8	75.8	32.0	168.4	44.5	64.0	83.0	50.0	133.8	78.5	84.6
1963	83.4	69.1	80.3	35.0	152.6	49.1	68.0	90.0	58.0	132.7	83.7	89.1
1964	80.9	79.2	85.0	46.0	138.6	58.8	78.0	98.0	69.0	137.1	92.8	99.8
1965	89.4	86.5	91.1	47.0	138.6	67.1	85.0	98.0	77.0	129.7	97.5	105.5
1966	98.0	85.9	87.1	48.0	143.9	76.2	86.0	98.0	82.0	111.3	95.1	102.9
1967	95.1	96.3	90.2	71.0	115.8	87.4	90.0	101.0	91.0	104.4	100.3	102.9
1968	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1969	100.0	108.0	102.0	112.0	124.7	115.8	108.0	107.0	108.0	96.0	101.3	106.0
1970	100.0	111.0	99.0	128.0	129.3	125.9	116.0	111.0	111.0	92.0	102.9	108.0
1971	108.0	118.0	104.0	128.0	117.0	126.5	119.0	107.0	104.0	84.0	100.6	104.0
1972	105.0	128.0	102.0	119.0	118.9	143.0	115.0	102.0	109.0	76.0	97.9	105.0
1973	104.0	137.0	111.0	120.0	123.7	164.2	123.0	108.0	114.0	78.0	104.0	107.0
1974	103.0	143.0	108.0	118.0	122.3	173.0	128.0	112.0	109.0	82.0	93.0	105.0
1975	97.0	134.0	110.0	137.0	118.3	158.4	118.0	113.0	102.0	75.0	86.0	101.0
1976	94.0	127.0	110.0	166.0	.0	167.0	107.0	108.0	110.0	67.0	77.0	98.0
1977	93.0	119.0	106.0	164.0	.0	160.0	102.0	98.0	114.0	61.0	71.0	90.0
1978	91.0	109.0	110.0	167.0	.0	167.0	95.0	90.0	116.0	54.0	64.0	88.0
1979	.0	113.0	112.0	181.0	.0	173.0	97.0	94.0	115.0	52.0	66.0	95.0
1980	.0	109.0	112.0	184.0	.0	183.0	91.0	84.0	115.0	53.0	67.0	95.0

0	37	38	39	40	41	42	43
1913	15.9	6.5	5.2	3.3	.0	6.4	10.9
1914	13.8	6.0	4.7	3.0	.0	6.2	10.5
1915	16.1	7.0	5.0	3.2	.0	6.6	11.3
1916	16.4	8.0	5.4	3.5	.0	8.8	11.9
1917	16.4	7.3	4.6	3.9	.0	9.7	9.9
1918	14.5	6.2	4.0	3.4	.0	10.4	8.3
1919	12.0	6.1	4.2	4.2	.0	13.0	9.1
1920	12.2	6.9	5.0	3.8	.0	10.4	10.5
1921	5.8	3.7	4.1	3.4	.0	8.2	8.3
1922	8.1	4.8	3.9	2.5	.0	6.6	9.5
1923	8.3	6.0	4.6	3.4	.0	5.2	10.5
1924	12.7	7.4	5.1	4.6	.0	5.2	11.9
1925	12.4	7.7	5.6	5.5	.0	6.2	12.1
1926	12.2	8.2	6.6	6.5	.0	7.8	13.3
1927	12.2	8.6	6.7	7.1	.0	9.2	13.9
1928	14.1	9.9	8.2	8.2	.0	11.8	14.5
1929	16.4	11.1	9.1	8.4	.0	13.7	16.4
1930	14.1	10.8	9.7	9.4	.0	15.0	16.8
1931	12.7	10.5	9.0	8.9	.0	12.9	15.8
1932	13.1	10.0	7.7	6.9	.0	8.6	14.5
1933	15.9	10.6	7.3	7.6	.0	9.4	14.9
1934	21.4	14.1	10.1	8.9	.0	11.1	18.0
1935	23.0	16.3	12.8	10.7	.0	13.4	20.2
1936	24.9	18.1	13.9	12.0	.0	14.5	22.0
1937	27.6	20.4	15.7	14.1	.0	20.5	24.6
1938	26.0	18.8	17.4	15.1	.0	22.3	24.8
1939	28.3	22.0	18.7	16.5	.0	23.1	27.1
1940	26.3	18.4	18.7	16.8	.0	24.7	24.8
1941	25.6	17.9	19.2	17.5	.0	29.9	24.2
1942	27.0	20.6	21.3	18.8	.0	29.1	25.7
1943	27.4	21.2	22.7	19.9	.0	31.6	26.9
1944	28.3	21.2	22.9	21.9	.0	33.4	28.3
1945	26.0	20.2	18.9	17.3	.0	28.0	27.9
1946	27.0	30.0	24.9	24.9	.0	35.2	33.7
1947	25.8	31.2	25.7	24.4	.0	38.0	34.7
1948	27.4	33.2	26.5	28.6	.0	41.1	37.0
1949	30.2	34.0	28.0	32.0	17.0	46.0	38.4
1950	30.0	36.0	31.0	35.0	20.0	48.0	40.0
1951	33.2	39.0	35.0	38.0	23.0	49.0	42.6
1952	34.8	38.0	35.0	41.0	27.0	52.0	41.6
1953	32.5	36.0	34.0	38.0	31.0	52.0	42.8
1954	35.7	40.0	37.0	39.0	35.0	57.0	45.7
1955	42.2	44.0	40.0	41.0	39.0	57.0	48.7
1956	45.9	45.0	42.0	44.0	43.0	57.0	50.7
1957	47.9	47.0	45.0	47.0	45.0	68.0	53.3
1958	47.2	48.0	46.0	47.0	49.0	73.0	53.9
1959	51.6	51.0	49.0	51.0	54.0	73.0	57.8
1960	59.7	59.0	55.0	57.0	60.0	74.0	63.2
1961	66.1	65.0	63.0	62.0	64.0	77.0	67.9
1962	69.8	67.0	69.0	70.0	70.0	85.0	71.7
1963	74.0	70.0	72.0	74.0	75.0	84.0	76.2
1964	84.8	82.0	78.0	79.0	83.0	91.0	83.2
1965	92.9	90.0	88.0	87.0	90.0	99.0	89.5
1966	93.3	97.0	94.0	93.0	97.0	105.0	92.7
1967	94.2	93.0	96.0	94.0	97.0	106.0	95.2
1968	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1969	109.0	109.0	107.0	109.0	108.0	109.0	107.0
1970	115.0	118.0	119.0	114.0	120.0	121.0	114.0
1971	114.0	119.0	121.0	125.0	130.0	127.0	115.0
1972	116.0	123.0	119.0	128.0	131.0	145.0	118.0
1973	126.0	131.0	128.0	134.0	141.0	152.0	127.0
1974	135.0	135.0	148.0	162.0	141.0	156.0	133.0
1975	124.0	140.0	145.0	181.0	149.0	180.0	131.0
1976	115.0	137.0	139.0	175.0	151.0	172.0	130.0
1977	105.0	131.0	134.0	170.0	143.0	144.0	123.0
1978	109.0	125.0	131.0	159.0	144.0	118.0	121.0
1979	125.0	132.0	142.0	173.0	164.0	99.0	129.0
1980	122.0	142.0	141.0	186.0	154.0	85.0	129.0

Table 3 **Prices in Swedish mining and manufacturing 1913–80**

Index 1968 = 100

The branches are numbered according to the list presented above (page 97).

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1913	25	13	16	21	35	22	16	56	26	17	18	24	23	17	28
1914	24	14	16	22	35	24	18	54	27	17	18	25	25	17	30
1915	23	20	21	29	42	32	22	56	29	19	21	27	27	19	52
1916	26	26	24	42	52	31	24	59	37	20	26	34	35	23	67
1917	35	27	29	69	188	36	30	61	75	27	44	53	70	33	78
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1947	66	63	47	42	47	78	56	50	42	67	81	69	0	37	133
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1950	68	74	50	56	53	97	59	56	49	74	81	77	85	46	189
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1958	92	91	72	86	75	112	97	107	67	91	87	79	92	57	161
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1973	138	135	135	194	127	145	124	127	131	107	125	118	135	0	109
1974	160	159	173	247	150	232	189	168	154	87	165	153	237	0	156
1975	161	187	182	212	166	266	228	197	177	179	178	175	239	0	172
1976	182	211	209	248	184	258	215	203	196	178	190	184	270	0	181
1977	197	249	223	267	207	243	221	219	220	175	203	194	296	0	197
1978	209	263	248	266	224	211	230	233	241	184	222	207	308	0	216
1979	227	281	300	308	246	264	253	257	262	199	254	218	414	0	249
1980	245	316	350	377	280	319	296	292	296	235	289	237	546	0	261

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1918	119	33	72	34	166	72	66	91	76	74	0	38	67
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1967	99	99	97	98	98	99	99	98	98	99	100	94	99
1968	100	100	100	100	100	100	100	100	100	100	100	100	100
1969	99	102	103	104	101	100	115	109	102	102	101	98	104
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1971	105	116	119	114	133	111	120	125	114	115	111	110	114
1972	104	125	129	122	136	116	118	132	120	121	119	114	119
1973	112	133	142	132	137	122	142	150	127	131	128	130	133
1974	143	149	172	165	181	141	192	196	142	158	145	154	164
1975	159	176	204	192	216	162	186	210	172	170	166	160	178
1976	168	202	234	219	267	185	193	222	192	187	183	178	193
1977	190	220	260	244	290	206	198	234	207	200	198	162	209
1978	203	243	280	263	314	230	212	258	228	216	219	180	222
1979	215	264	303	290	350	245	248	282	246	232	239	216	246
1980	266	290	352	337	385	258	287	313	272	254	260	205	279

NOTES

[1] Producer prices.

[2] The relationship between relative prices and the structural transformation of Swedish industry 1913-77 has been studied in Josefsson-Örtengren, 1980.

[3] This again rests on the assumption that the underlying long-term productivity and cost structure is not affected by the price controls.

[4] For 64 observations a correlation coefficient of 0.25 is sufficient for significance at the 5 per cent level.

[5] See Appendix 2 for a presentation of the data.

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STRUCTURAL CHANGE AND INDUSTRY PERFORMANCE IN FOUR WESTERN EUROPEAN COUNTRIES

by Harald Fries

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1 INTRODUCTION

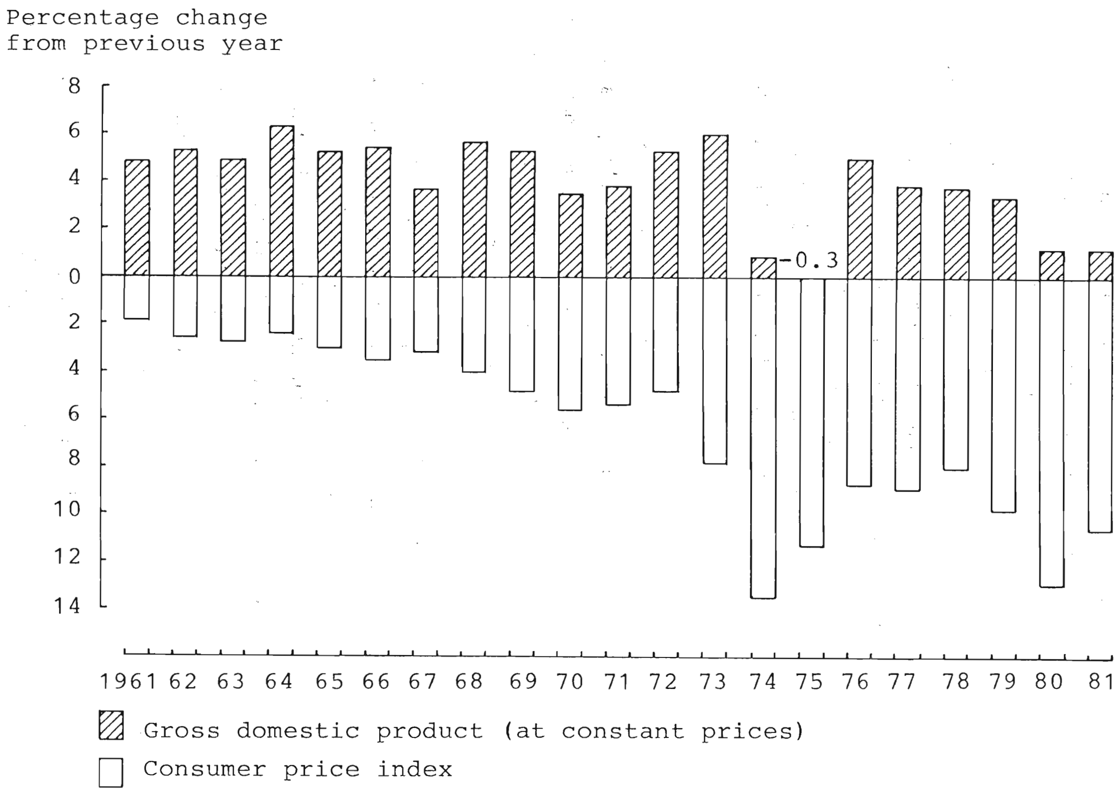
Too often the economic problems of a country are discussed in isolation from the development in other countries. By examining a group of countries, a wider perspective is given to the study of each country. In this paper, industrial development in four European countries is described and compared. This is done with special reference to the marked deterioration in economic conditions which occurred in the wake of the oil price boom in 1973/74 and which has troubled a large part of the world since. Stagflation - low economic activity accompanied by rapid inflation - has become a widespread and persistent phenomenon. This is illustrated in Figure 1.

In addition to a purely descriptive part, the study contains a discussion of the significance for structural change and long-run industry growth of such key variables as prices, profits and investments. The arguments brought forward are substantiated by empirical evidence from the four countries.

The countries studied in the paper are the Federal Republic of Germany (subsequently referred to as Germany), the Netherlands, Sweden and the United Kingdom (U.K.). This choice of countries gives a good spread of "economic size" and in policy responses to the economic problems of the 1970s. Germany is representative of a deflationary approach, whereas the U.K. and Sweden ventured a pronounced inflationary route. The Netherlands was closer to Germany in this respect.

The period covered is 1960-80 , but data for some variables are not accessible for years before 1963. The figures used for 1980 are preliminary.

Figure 1 **Growth of real GDP and consumer prices in the OECD area 1961-81**



Sources: OECD, 1982, "Historical Statistics 1960-80"
OECD, 1982, "Economic Outlook, July 1982"

The manufacturing sector is disaggregated into eight sub-sectors (industries), following the United Nations' International Standard of Industrial Classification (ISIC) of 1968. The industries analyzed are:

ISIC code		Subsequently referred to as
31	Food, beverages and tobacco	Food
32	Textiles, wearing apparel and leather	Textiles
33	Wood and wood products	Wood
34	Paper and paper products, printing and publishing	Paper and printing
35	Chemicals and chemical petroleum, coal, rubber and plastic products	Chemicals
36	Non-metallic mineral products except products of petroleum and coal	Non-metallic minerals
37	Basic metal industries	Basic metals
38	Fabricated metal products, machinery and equipment	Engineering

2 DATA CONSIDERATIONS

The data presented and analyzed in this paper are collected from a large number of statistical sources. As far as possible, international publications have been used. But to some extent it has been necessary to turn to local statistical publications. In a few instances, local statistical authorities of the countries have been consulted directly. The statistical sources used for the study are listed and numbered on p. 166. References in tables and figures to the list of statistical sources are made by giving the numbers assigned to the sources, instead of writing out their full titles.

It must be recognized that each of the eight industry categories studied here produce a wide variety of products. The industry data used in this study thus represent averages of products (and of firms) which differ in capital intensity, labor productivity, research intensity, demand elasticity and so on. The analysis of the eight industries is therefore bound to oversimplify and leave out many aspects of industrial development. For example, structural change within the sub-sectors cannot be captured. Nevertheless, the level of disaggregation adopted is the finest available which gives adequate comparability between the countries.

Even on this highly aggregated level, the data are not completely comparable between the countries. This is due, for example, to inconsistent industry classifications and variable definitions, different coverages of enterprises and, for monetary variables, the problem of different currencies. But such statistical imperfections should mainly affect across-country comparisons of levels, but not comparisons of rates of change.

The data considerations mentioned here should be kept in mind when interpreting the results in the following presentation.

3 THE MANUFACTURING SECTOR

Let us first take a broad look at the aggregate manufacturing sector in the four countries. It will serve as a framework for the subsequent industry analysis.

3.1 Manufacturing in the Total Economy

In the countries studied here, the manufacturing sector constitutes around one fourth to one third of total production and employment (see Table 1). Germany has the relatively largest manufacturing sector of the four. The employment shares are larger than the production shares in Sweden and the United Kingdom, whereas the reverse is true in Germany and the Netherlands. In all four countries, the manufacturing sector - in terms of both production and employment - diminished somewhat in the 1970s relative to the rest of the economy.

The manufacturing industry also provides the countries with foreign currency through international trade. Table 2 shows that exports of manufactured goods account for two thirds of total current account receipts in Germany and Sweden, and well over one half in the other two countries. The relatively low and falling figures for the Netherlands and the U.K. can partly be explained by sizable and rapidly growing exports of petroleum and natural gas products from these countries. The Netherlands also have a much larger share of exports of agricultural products.

3.2 Production Growth

As indicated above, the manufacturing sector in the four countries did not even keep up with the sluggish growth of the rest of the economy in the 1970s. Clear evidence of the poor industrial growth performance in the last decade is presented in Figure 2.

Table 1 **Percentage share of the manufacturing sector in GDP[a] and total employment**

Annual averages

	Production		Employment	
	1960-70	1970-80	1960-70	1970-80
Germany	40	38	35	35
Netherlands	33	28	28	24
Sweden	26	24	31	27
United Kingdom	29	26	35	31

[a] Gross domestic product at current prices.

Source: OECD, 1982, "Historical Statistics 1960-80".

Table 2 **Percentage share of exports of manufactured goods in total current account receipts**

	1970	1980
Germany	75	76
Netherlands	62	60
Sweden	76	75
United Kingdom	57	54

Sources: OECD, 1982, "National Accounts", Vol. II.
United Nations, "Yearbook of International Trade Statistics", editions 1976 and 1980, Vol. I.

In Germany, Sweden and the Netherlands, industrial production increased rapidly during the 1960s and the first few years of the 1970s. A pronounced break in the growth trend occurred in all four countries in connection with the oil crisis in 1973/74. (See also Tables 4A - 4D.)

Figure 3 reveals some interesting deviations between the countries starting with the severe recession of the mid 1970s. The main objective of Swedish economic policy in 1974/75 was to bridge the recession. The expansionary measures taken seemed successful at first: Sweden was not as hard hit by the recession of 1975 as were the other countries. But prices and, in particular, wages rose by far more than in most competing countries. Thus, the competitiveness of Swedish industry deteriorated rapidly. As a result, Sweden saw a sharp "delayed" reduction in industrial activity in 1977, from which the country has not yet fully recovered. What was gained at first was more than lost in subsequent years.

Germany and the Netherlands, on the other hand, lived through the recession of 1975. Then, in 1976-80, the German and Dutch manufacturing industries followed a relatively favorable growth path.

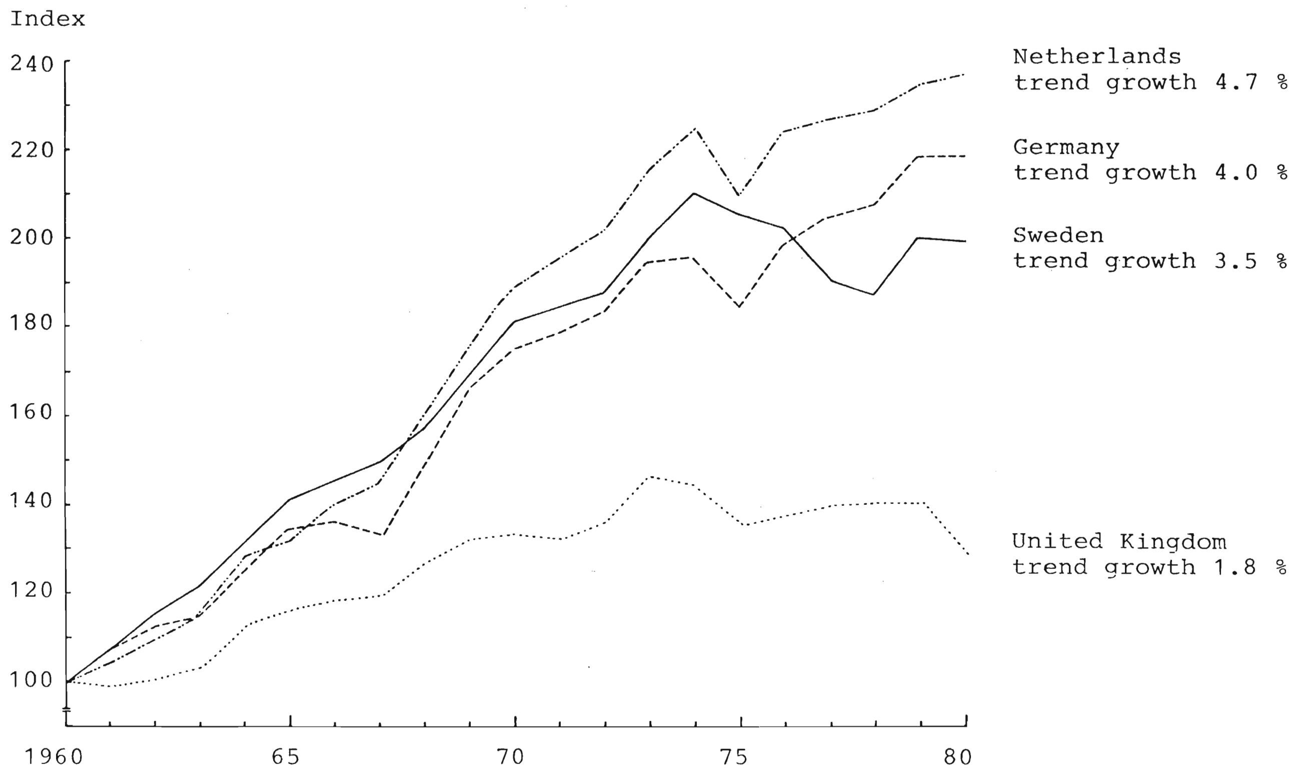
The unique development of the British manufacturing industry is rather ruthlessly exposed in Figure 2. The U.K. did not ride the boom of the 1960s. British industry followed a negatively diverging growth path compared to the other countries over the whole period studied. The general deterioration in business conditions of the mid 1970s implied for the U.K. economy that an already troublesome situation got even worse.

3.3 Employment Growth

Manufacturing employment and production developed quite differently in the 1960s and 1970s (see Figure 4). A striking feature is that it decreased over the two decades in each of the four

Figure 2 Total manufacturing production (at constant prices) 1960-80

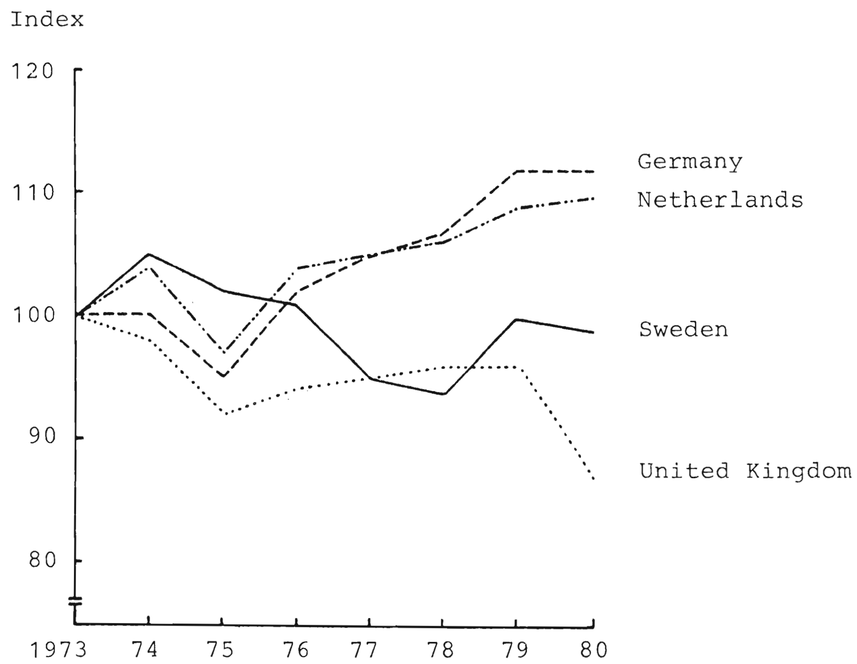
Index 100 = 1960



Sources: Germany: 10, 13, 21, Netherlands: 9, 10, 13, Sweden: 13, 17, United Kingdom: 10, 13, 19 (see Statistical Sources)

Figure 3 **Total manufacturing production (at constant prices) 1973–80**

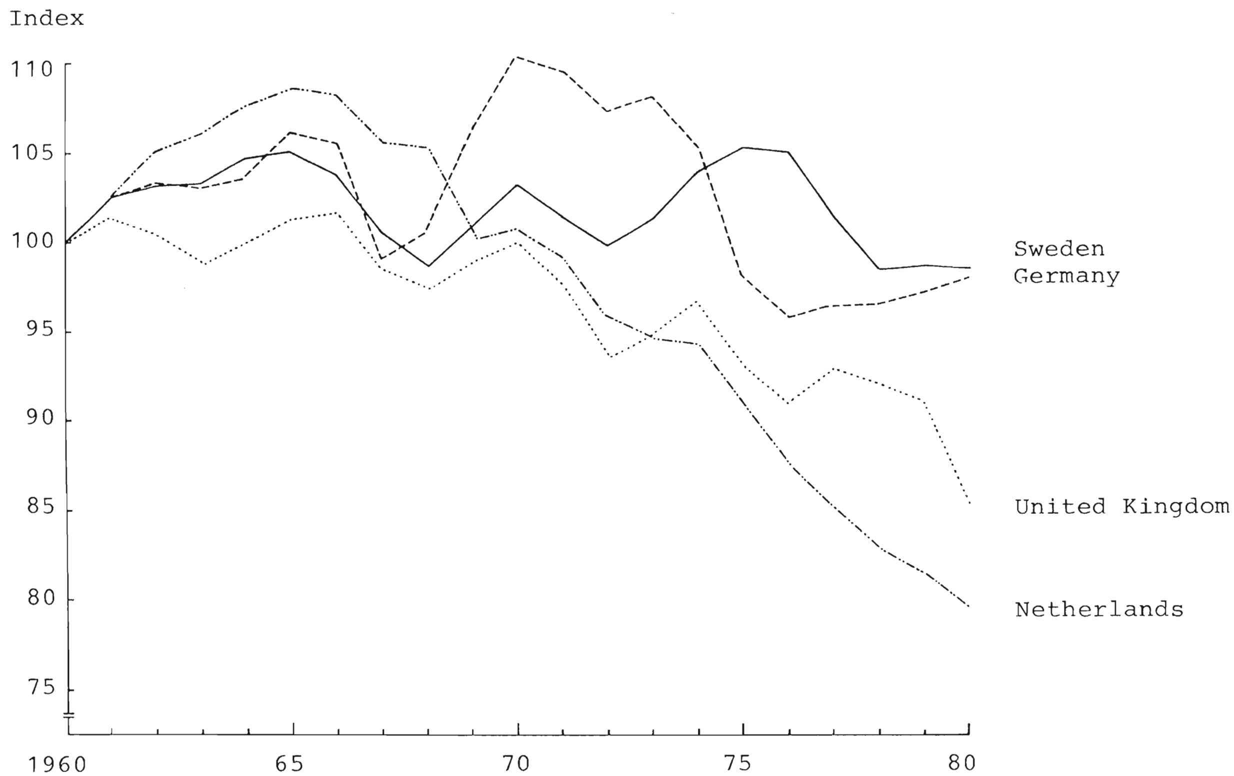
Index 100 = 1973



Sources: Same as in Figure 2.

Figure 4 **Total manufacturing employment 1960-80**

Index 100 = 1960



Sources: Germany: 6, 10, 11, 19, Netherlands: 6, 10, 11, 19, Sweden: 6, 17, 19, United Kingdom: 10, 11, 19, (see Statistical Sources).

countries. That decline was not set off by the deep recession initiated by the oil crisis. Tables 4A-4D show that Dutch, Swedish and U.K. manufacturing employment had a negative growth trend even in the industrially expansive period of 1960-73. And the corresponding German figure is just barely on the positive side.

The four countries show a similar pattern up through the mid 1960s. In the first half of the decade, employment increased in the manufacturing sector. It peaked around 1965. The decline that followed continued through the 1970s in the Netherlands and the U.K., halted only by a few cyclical upturns. The drop in the Netherlands is conspicuous. Following several years of steady increase, Dutch manufacturing employment decreased by more than 25 percent from 1966 to 1980. As we can see, out of those 15 years there was only one - 1970 - with an increase in employment. This development is even more striking given the fact that, in terms of volume of production, the Dutch manufacturing industry was the most expansive of the four in the period.

In contrast to the other two countries, Germany and Sweden have on the whole maintained their level of manufacturing employment since 1960, although it was slightly lower at the end of the period than at the beginning. Apart from a much stronger increase in Germany than in Sweden in 1969 and 1970, they followed essentially the same cyclical path up to 1974. From then, the curves quite nicely mirror the contrasting development of output in the two countries since the oil crisis. Swedish industrial employment rose substantially in the mid 1970s - much a result of the inflationary "bridging over" policy of the time. It then fell sharply in 1977 and 1978, before leveling out. In Germany, on the other hand, industrial employment declined markedly from 1970 to 1976, and then started to rebound. In each of the years 1977-80, German manufacturing employment increased.

A corollary of the diminished labor force in manufacturing is that the expansion in production has, on the whole, been achieved through gains in labor productivity.

To sum up, we have noted three salient features of the aggregate industrial development in the four countries during the two last decades:

- the abrupt and uniform deterioration in growth trends in 1973/74,
- the extremely poor growth performance of the British manufacturing industry over the whole period,
- the long-run stagnation in manufacturing employment.

4 GROWTH AND DECLINE AT THE SUB-SECTOR LEVEL

In this section, the growth performance of the eight manufacturing sub-sectors is examined and compared across the sectors and countries. We ask: Was the boom of the 1960s evenly spread out among the industries? Have some industries been able to maintain their momentum from the 1960s into the mid and late 1970s? What impact has the worsening business climate had on employment and productivity? What are the principal across-country differences and similarities in industry growth patterns?

4.1 The Growth Race over 1960-80

Indicators of the relative output[1] performance of the industry categories are the growth elasticities, defined and shown in Table 3. The winner and the loser in the growth race - chemicals and textiles, respectively - are easily identified.

The chemical industry's performance was outstanding. It shows the strongest growth in all countries. Several factors are important here (see Pousette, 1981). Foremost among these are relatively inexpensive raw materials (oil and natural gas) and the development of significant new products, e.g. plastics and other synthetics. Furthermore, the considerable improvements in living standards since the second world war have had more favorable demand effects on chemicals than on other industries.

The poor performance of the textile industry is almost as striking. This industry experienced the weakest growth in all countries except the U.K. where basic metals were even less vigorous. The textile industry has witnessed a rapid technological change in the last few decades. But that technology is internationally mobile, and less know-how is needed than in other industries (SOU 1980). This has enabled newly industrializing countries[2] with

Table 3 Industry elasticities of output growth[a] (1960-80)

ISIC code		Germany	Netherlands	Sweden	United Kingdom
31	Food	0.52	0.79	0.43	1.06
32	Textiles	0.18	-0.42	-0.28	0.11
33	Wood	1.00	0.62	1.14	0.94
34	Paper and printing	0.80	0.87	0.77	0.89
35	Chemicals	1.70	1.89	1.69	2.50
36	Non-metallic minerals	0.90	0.68	0.59	1.11
37	Basic metals	0.62	1.19	1.02	-0.61
38	Engineering	1.25	0.98	1.32	0.67

a The ratio of the growth rate of each industry to the growth rate of manufacturing as a whole.

Sources: Same as in Figure 2.

lower labor costs to enter and capture substantial market shares. World textile competition has thus tightened considerably at the expense of manufacturers in the industrially mature countries.

For the other industries, the picture is less clear-cut. The relative output performance of these industries differ considerably between the countries. An exception is the paper and printing sector; its growth elasticities in the four countries lie close to each other, and place the sector in the middle range of performance.

As for the across-country differences, the growth pattern of the U.K. deviates most strikingly from the norm.[3] In particular, the food and non-metallic mineral industries were notably more expansive in relative terms in the U.K., whereas the reverse holds for basic metals and engineering. The growth patterns of Germany, Sweden and the Netherlands are more alike. This is especially true for Germany and Sweden.

4.2 The Trend Break

We next divide the 1960-80 period studied thus far into two subperiods. The first covers the "golden" years of the 1960s and early 1970s, and the second covers the stagflation years that followed. This is to study the impact on the industries of the deteriorated business climate of recent years.

The cut-off point between the two periods is taken as 1974. Although Dutch and Swedish industrial production still increased strongly in 1974, this is the year that marks the beginning of the persistent slowdown in growth in most of the industrialized world. In Tables 4A-4D absolute growth rates of production, employment and labor productivity are exhibited.

It is clear from comparing growth rates of the two periods that we are dealing with a marked and general stagnation in industrial activity. In both Sweden and the U.K., total manufacturing actually had a negative trend growth in the period after 1973. Germany and the Netherlands did better in this respect, but the stagnation is evident. The extent of the deterioration is well illuminated by the fact that not one industry in any of the four countries came even close to equaling its first-period growth performance.

Growth of employment were, not surprisingly, lower for almost all industries in the latter period. But the reductions in employment growth rates were, in general, significantly smaller than the reductions in output growth rates. Consequently, labor productivity must have developed unfavorably in the mid and late 1970s. This is verified by the two last columns of Tables 4A-4D.

When calculating labor productivity growth rates, an adjustment must be made for changes in working time per employee. Over 1960-80, the average industrial worker in Germany, the Netherlands and the U.K. enjoyed an approximate 0.5 percent reduction

Tables 4A-4D **Annual percentage growth rates[a] of production,[b] employment[c] and labor productivity[d]**

Table 4A Germany

ISIC code		Production 1960-73	Production 1973-80	Employment 1960-73	Employment 1973-80	Labor productivity 1960-73	Labor productivity 1973-80
31	Food	3.0	1.2	-0.1	0.6	4.1	1.0
32	Textiles	1.7	-0.9	-1.9	-4.3	3.9	4.8
33	Wood	5.2	1.1	-0.1	-0.2	6.2	1.6
34	Paper and printing	4.3	2.9	1.5	-1.7	3.5	4.7
35	Chemicals	9.6	2.4	2.6	-0.6	7.7	3.1
36	Non-metallic minerals	4.8	2.2	-0.6	-0.3	5.7	5.4
37	Basic metals	3.1	1.1	-0.6	-5.2	3.9	6.5
38	Engineering	5.9	3.1	1.4	-0.7	5.0	3.8
3	Total manufacturing	5.1	2.1	0.5	-1.3	5.0	3.6

Sources: Production and employment: same as in Figures 2 and 4. Hours worked per em ployee: 6, 9, 12 (see Statistical Sources).

Table 4B The Netherlands

ISIC code		Production 1960-73	Production 1973-80	Employment 1960-73	Employment 1973-80	Labor productivity 1960-73	Labor productivity 1973-80
31	Food	4.3	1.7	-0.5	-2.3	5.6	4.5
32	Textiles	0.4	-5.2	-4.9	-9.6	5.9	5.3
33	Wood	4.6	0.0	0.5	-2.7	4.7	3.4
34	Paper and printing	5.4	2.7	1.2	5.0	4.1	-1.0
35	Chemicals	11.8	2.9	1.8	-1.3	10.8	4.3
36	Non-metallic minerals	4.5	2.0	-0.8	-2.8	5.8	5.6
37	Basic metals	8.8	-0.4	3.2	-1.5	6.1	1.9
38	Engineering	5.9	1.6	-0.4	-2.1	7.1	4.3
3	Total manufacturing	6.2	1.4	-0.6	-2.7	7.6	4.5

Sources: Production and employment: same as in Figures 2 and 4. Hours worked per em ployee: 5, 6 (see Statistical Sources).

Table 4C Sweden

ISIC code		Production 1960-73	Production 1973-80	Employment 1960-73	Employment 1973-80	Labor productivity 1960-73	Labor productivity 1973-80
31	Food	1.9	0.6	-0.8	0.3	4.3	1.8
32	Textiles	1.0	-6.0	-5.1	-6.8	7.4	2.3
33	Wood	6.1	-1.1	0.4	-1.4	6.8	1.4
34	Paper and printing	4.4	-0.4	-0.6	0.1	6.3	1.2
35	Chemicals	8.4	-0.1	2.1	-0.2	7.9	1.9
36	Non-metallic minerals	5.0	-3.0	-1.1	-3.0	7.4	1.3
37	Basic metals	6.3	-1.6	0.3	-1.4	7.4	1.7
38	Engineering	6.4	-0.3	1.0	-0.3	6.9	1.8
3	Total manufacturing	5.3	-0.7	-0.1	-0.8	6.7	1.7

Sources: Production and employment: same as in Figures 2 and 4. Hours worked per employee: 6, 12, 15, 17 (see Statistical Sources).

Table 4D The United Kingdom

ISIC code		Production 1960-73	Production 1973-80	Employment 1960-73	Employment 1973-80	Labor productivity 1960-73	Labor productivity 1973-80
31	Food	2.5	0.8	0.3	-0.8	2.5	2,0
32	Textiles	1.1	-2.4	-2.2	-3.1	3.8	1.3
33	Wood	3.1	-2.3	-0.1	-0.7	3.5	-0.9
34	Paper and printing	2.6	-0.5	0.2	-0.9	2.8	0.7
35	Chemicals	6.0	0.9	0.3	0.0	6.1	1.2
36	Non-metallic minerals	3.6	-2.2	-0.6	-1.8	4.6	0.2
37	Basic metals	0.6	-5.3	-1.3	-2.8	2.4	-1.7
38	Engineering	2.1	-1.2	-0.2	-0.9	3.0	0.4
3	Total manufacturing	3.0	-1.1	-0.4	-1.2	4.0	0.7

Sources: Production and employment: same as in Figures 2 and 4. Hours worked per employee: 6, 12 (see Statistical Sources).

[a] Logarithmic linear trend growth.

[b] At constant prices.

[c] Number of employees.

[d] Output per hour.

in working time per year. In Sweden, the corresponding figure was 1.5 percent. Those reductions in working time explain why growth rates of labor productivity are higher than what would be implied by a linear relationship between growth rates of production and employment (measured by the number of employees).

Note that the two most expansive economies of the four after the oil crisis - Germany and the Netherlands - experienced a larger decrease in manufacturing employment than the other two countries. This is reflected in their more favorable labor productivity growth rates for the period.

Turning to the individual industries, we find that the strength of the chemical industry has diminished quite considerably (both relatively and absolutely). In terms of output and productivity growth, the chemical industry has not maintained the unique position it enjoyed in the 1960s and early 1970s. Nevertheless, the chemical industry still ranks high in all countries. It stands out as the only industry which, in each of the four countries, has contributed to total employment growth by employing a larger labor force in 1980 than in 1960.

The food industry exhibits a reverse development. It performed poorly during the 1960s and early 1970s. Since then, food has fared better relative to the other industries. Besides chemicals, it is the only industry, which increased its output in each country over 1974-80, albeit at a very low rate. In Sweden it even shares with chemicals the top position in terms of output growth. Furthermore, the German and Swedish food industries were the only sub-sectors (not counting a tiny increase in Swedish paper and printing), which increased their employment in the period. Generous government assistance to the food industry has contributed in dampening the impact of the general recession in the economies.

In recent years one of the frequently-mentioned "crisis industries" has been basic metals. The mid and late 1970s saw a marked deterioration in its growth performance in the countries studied here, as well as in most other industrialized countries. Iron and steel manufacturing constitutes the main sub-activity of the basic metal industry. Productivity performance of basic metals was exceptionally poor in the Netherlands, Sweden and the United Kingdom in 1974-80. The decline in output growth rates was not matched by a proportional decline in employment growth rates. In sharp contrast to this, however, was the development in Germany. There, basic metal employment dropped to the extent that output per hour increased by more than in any other industry in the four countries in the period after the oil crisis.

To explain the decline of basic metals, it is crucial to understand that the growth of this sector in a country is closely linked to domestic industrial expansion. Due to heavy transportation costs and trade barriers of various kinds, the basic metal industry is a relatively home-market dependent industry. The rapid industrial upswing and the extensive reconstruction work that followed the second world war consequently fueled the growth of the basic metal industry in most OECD countries. But when the industrial machinery in these countries started to break down in the 1970s, the iron and steel and related industries were more severely affected than other industries. The slow growth of U.K. basic metals, already evident in the 1960s, foreshadowed the long-run stagnation in British industrial activity.

Indeed, there is more to the problem of the basic metal industry than a shrinking homemarket. The basic metal producers in the developed countries have lost considerably in competitiveness to manufacturers in newly industrializing countries. Many developing countries experienced an industrial boom in the 1970s. Demand conditions in these countries were thus favorable for building up a basic metal production capacity with best-practice technology and efficient scale. Aided by a relative fall in transportation costs, these more efficient manufacturers can successfully compete even within the OECD area.[4]

It is clear from the numbers in Tables 4A-4D that the problems of the textile industry are of older date than those of other industries. The trend growth rate of textile output was very low already in the 1960s. A high rate of liquidations, in combination with an extensive mechanization of surviving firms, led to a significant exodus of labor. This helps to explain why textile labor productivity growth was quite favorable in the 1960s and 1970s.

Wood products manufacturing is another industrial activity which has experienced severe problems since the oil crisis. As we shall see in a subsequent section, this industry is (relatively) far more important in Sweden than in Germany, the Netherlands or the United Kingdom. With an abundance of quality raw materials, and with proximity to the European market, the Swedish wood industry has traditionally supplied a large share of Swedish export revenues. But competition from North America has stiffened. And increasing exploitations of fast-growing forests in Latin America (Brazil), West Africa and parts of Asia represent major long-term threats to the traditional manufacturers.

Thus far we have dealt almost exclusively with the growth performance of the industries. The next step is to examine the structure and change in the manufacturing sectors of our four countries. This section unambiguously shows that a trend break in growth occurred in the mid 1970s. Of particular interest then is the question of whether a more rapid industrial transformation has followed in the wake of the worsened business conditions.

5 STRUCTURE AND CHANGE

The law of comparative advantages states that a country will specialize its production apparatus according to the country's relative cost advantage. Differences in cost structure exist since countries differ in raw material endowment, climate, skill and size of labor force, capital stock, etc. In this section the industrial specializations of Germany, the Netherlands, Sweden and the U.K. are studied. The characteristics of the change in each country's industrial composition in the 1960-80 period is examined. The "magnitudes" of the structural change are determined and compared across countries and between the growth and the stagflation periods.

5.1 A Standard for Comparison: The "Average" Developed Economy

Table 5 displays the relative size of the eight industry categories in two major groups of countries in 1963 and 1975. Looking at the sector weights in the developed market economies, which are the relevant ones in this context, we see that a dominant position is held by the engineering industry. Approximately 40 percent of total manufacturing production consists of the manufacture of engineering products, such as metal tools, office and computing machinery, electronics, motor vehicles and ships. The second largest sector is chemicals, which accounts for about 15 percent of total manufacturing. The food industry is third in size, and the other sub-sectors follow with gradually declining weights. The figures indicate that the two largest sectors are gaining in importance, whereas textiles and basic metals are regressing. But on the whole, the industrial structure in the developed market economies changed only marginally over the period 1963-75.

To show that the industrial structure sketched above is by no means universally applicable, corresponding figures are given for

Table 5 Percentage weights of industries in total manufacturing production in the world market economies

ISIC		Developed market economies[a] 1963	1975	Developing market economies[b] 1963	1975
31	Food	12	12	27	20
32	Textiles	10	8	20	15
33	Wood	4	4	4	3
34	Paper and printing	8	8	5	4
35	Chemicals	14	15	16	22
36	Non-metallic minerals	4	4	5	5
37	Basic metals	9	8	6	6
38	Engineering	40	16	22	
38	Engineering	38	40	16	22

Source: United Nations, 1982, "Yearbook of Industrial Statistics", Vol. I.

a Canada, the U.S., Europe (excluding centrally planned economies), Australia, Israel, New Zealand, Japan and South Africa.

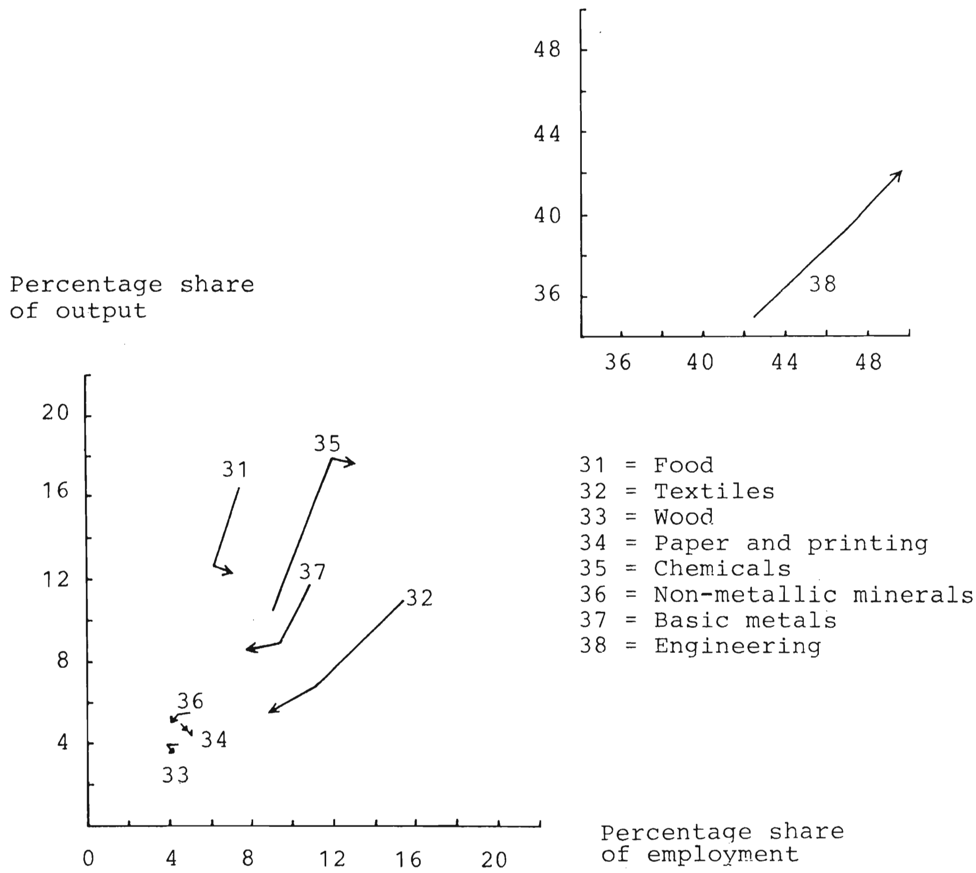
b Caribbean, Central and South America, Africa (other than South Africa), Asian Middle East and East and South-East Asia (other than Israel and Japan).

the developing market economies. In this group of countries, food and textiles play a much larger role. But a significant shift is evident, from these industries to the more technology-intensive chemicals and engineering. The large weight of chemicals is primarily due to large-scale petroleum based activities in oil-rich nations.

Now, let us redirect our attention to the manufacturing sectors of Germany, the Netherlands, Sweden and the U.K. A substantial amount of information is compressed into Figures 5A-5D. The arrows connect three points, with each point representing the output and employment shares of a particular industry in total manufacturing in the bench-mark years 1960, 1973 and 1980, respectively. Thus, the figures give an overall picture of the industrial structure and its change in each country since 1960.

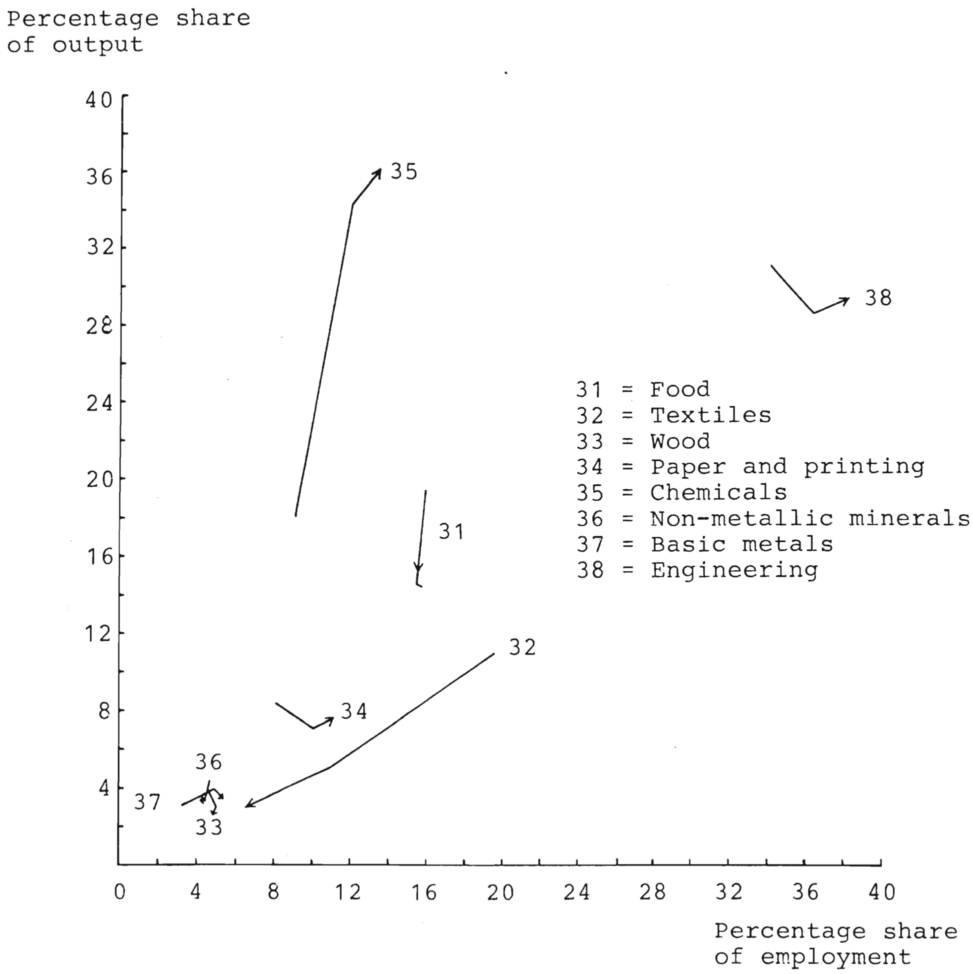
Figure 5A Germany

Percentage share of sub-sectors in total manufacturing output and employment 1960, 1973, 1980



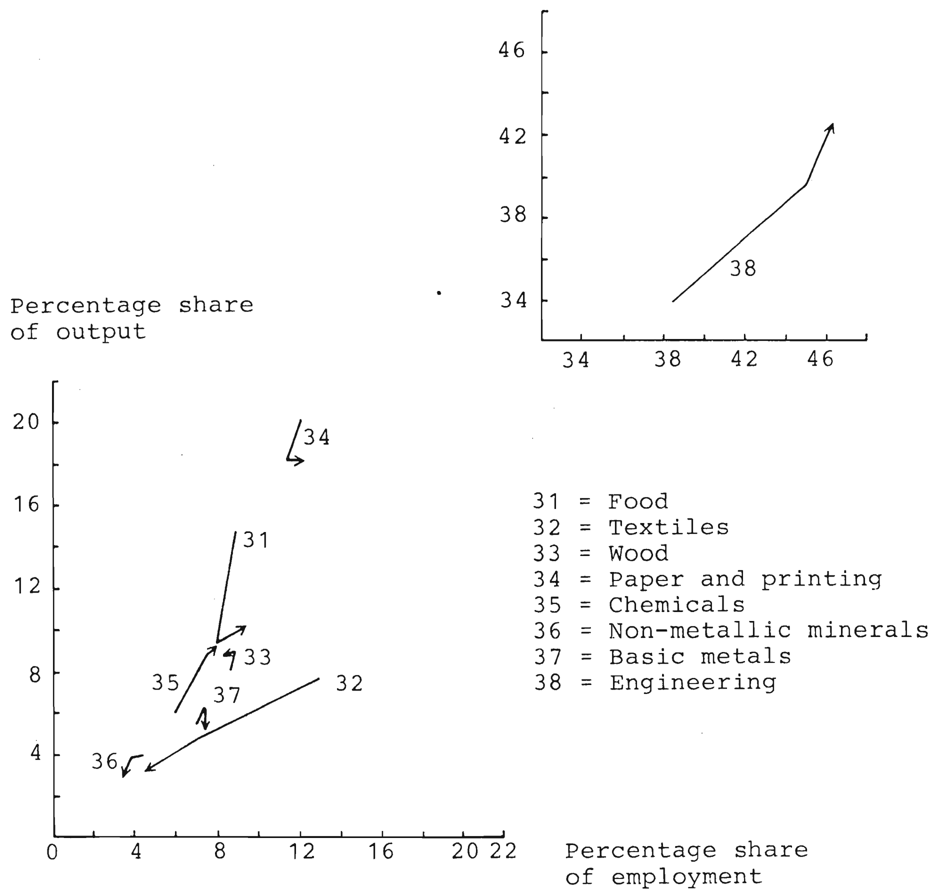
Sources: Same as in Figures 2 and 4.

Figure 5B **The Netherlands**
Percentage share of sub-sectors in total manufacturing output and employment 1960, 1973, 1980



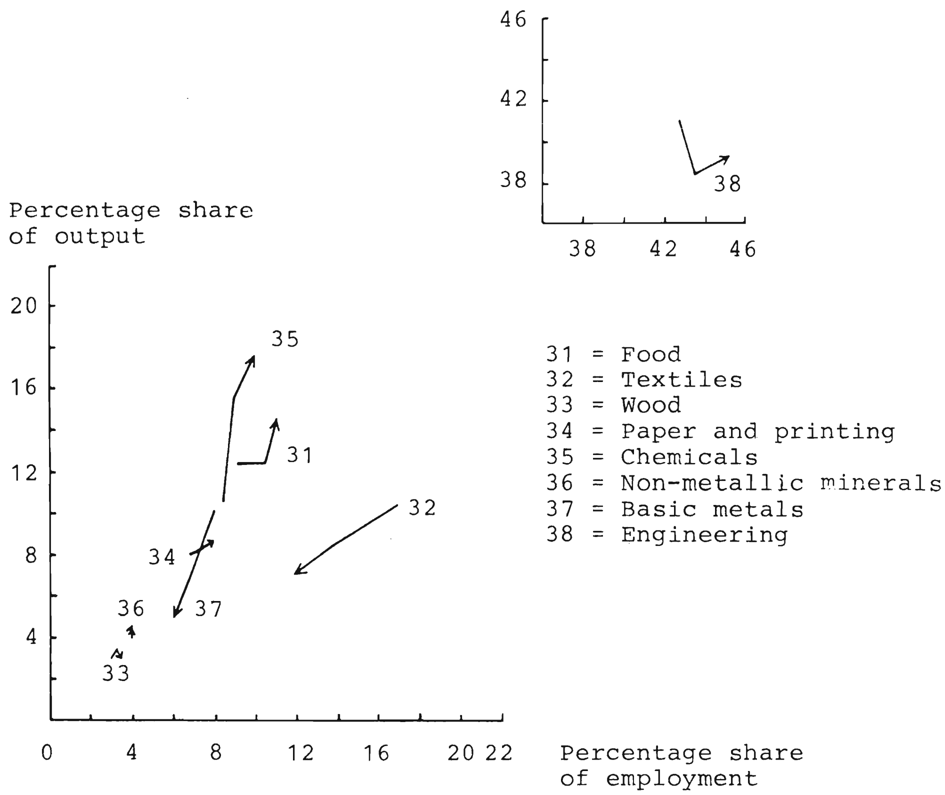
Sources: Same as in Figures 2 and 4.

Figure 5C **Sweden**
Percentage share of sub-sectors in total manufacturing output and employment 1960, 1973, 1980



Sources: Same as in Figures 2 and 4.

Figure 5D The United Kingdom
Percentage share of sub-sectors in total manufacturing output and employment 1960, 1973, 1980



Sources: Same as in Figures 2 and 4.

Not surprisingly, the pattern of industrial structure in the developed market economies combined is clearly recognizable in all four figures. The degree of conformity with the general pattern is particularly high in Germany and the U.K. In this sense, manufacturing is less specialized in these economies than in the Netherlands and Sweden.

5.2 Germany

The advance of engineering and chemicals, and the relative decline of food, textiles and basic metals, have characterized structural change in Germany since 1960. The engineering industry strengthened its already dominant position. In 1980, 42 percent of industrial production and practically half of industrial employment originated in engineering activity. With rapid growth in the 1960s and early 1970s, chemicals moved up from fifth to second place in terms of volume of production - past the stagnating food, textile and basic metal industries. Non-metallic minerals and the forest-based wood and paper and printing sectors, each accounted for approximately five percent of total manufacturing, with no significant changes over the period.

5.3 The United Kingdom

The U.K. appears to be cast from the same industrial mold as the "average" developed economy. The similarity in structure and change is striking. But in this seemingly "normal" picture of the U.K. industrial sector one can still see important characteristics of the British economic problems of recent decades. The U.K. economy has traditionally been heavily dependent on export revenues in textiles, basic metals and two engineering sub-sectors - shipbuilding and motor-vehicle manufacturing.[5] Those industries are the ones that have lost most ground since 1960. They have not been able to keep up with the technological advance in competing countries, and therefore have declined continuously in international competitiveness.[6]

But, a reorientation towards industries based on scientific and production skills can be discerned. The U.K. chemical industry, which exports such articles as cosmetics, pharmaceuticals and fertilizers, almost doubled its share of total manufacturing production over 1960-80. Machinery (office and computing in particular), electrical engineering and electronics are other relatively vigorous sectors. These are now major export industries, and their expansion in the 1970s has reversed the decline of the aggregate engineering sector.

5.4 The Netherlands

Turning to the two smaller countries we find that their industrial activity is more country-specific. With a small home market, these economies must rely more on specialization and foreign trade. The distinct features of their manufacturing structure clearly reflect differences in their comparative advantages.

A major trait of Dutch manufacturing is the extraordinary growth of the chemical industry. In 1960 it already accounted for almost one fifth of total industrial production. By the time of the oil crisis, chemicals had advanced to a leading position with over one third of manufacturing output. The employment share of the chemical industry, however, was at this time a mere 12 percent. Since then the Dutch chemical industry has lost a great deal of its momentum, but, as is noted above, it has continued to be the most expansive sub-sector of Dutch manufacturing.

The rise of chemicals in the Netherlands is closely associated with the country's function as a major sea gateway into Western Europe. Rotterdam is the world's top-ranking port, and receives much of Europe's imported oil. Some of the crude oil is passed on to other countries - for example by pipeline to Germany - but much is refined within the Netherlands before forwarding. Petrochemicals, made from products of the refinery operations, represent a principal sub-sector of the country's chemical industry. Other sub-sectors of Dutch chemicals have greatly benefited from significant discoveries of natural gas in the northeastern Netherlands at the end of the 1950s.

The Netherlands' comparative advantage in trading is based on historical and geographic grounds, as well as on sheer necessity, since trading is the way the Netherlands can make maximum use of a limited variety of domestic resources. The trading advantages spill over to many other parts of Dutch manufacturing.[7] Another industry particularly linked to the ports is basic metals. Cheap imported ores and coal provided a basis for the rapid growth of the iron and steel industry in the 1960s and early 1970s. But, as Figures 5A-5D show, the basic metal industry accounts for a smaller share of total manufacturing in the Netherlands than in the other countries studied here. The recent difficulties of this industry, felt throughout most of the industrially mature countries, are also evident in the Netherlands.

The combined engineering sector in the Netherlands today generates a lower value added than chemicals, but in terms of employment it is more than twice the size of any other industry. Good transport connections and a highly skilled labor force are key factors behind the growth of successful electrical and electronics industries. However, other parts of the engineering industry, most notably the once-flourishing shipbuilding sub-industry, are experiencing severe problems.

The food industry plays a more important role in the Netherlands than in most industrialized countries. It is based on the remarkably productive Dutch agriculture. A relative decline of the industry in the 1960s has come to a halt. The beverage industry, in particular, proved quite viable in the 1970s.

5.5 Sweden

Vast forests and a wealth in high-grade iron ore are pivotal factors behind the evolution of the Swedish industry. Forest-based industries, such as saw-milling, pulp-milling, paper-making, wood chemicals, plywood and lumber, yielded the bulk of Swedish export revenues for several decades. Sweden's specialization in those industries is plain from Figure 5C. The combined wood and paper and printing share of total manufacturing is more than twice as high in Sweden as in the average industrialized country. But for some decades, there has been a continuous trend toward greater forward integration, i.e. increasing the value added, in this sector of Swedish manufacturing. This is necessary to withstand the increasing competition from developing countries better endowed with raw materials.[8]

The rich iron deposits in northern Sweden were the basic source for a once world-dominant iron-ore industry. They also fostered the development of an important specialty and high-quality steel industry. The basic metal industry in Sweden is in fact smaller, relative to total manufacturing, than in most developed economies. Like the case in other industrialized countries, the Swedish iron and steel industry has experienced increasingly severe problems since the early 1970s, due to an erosion of competitiveness. The specialty steel industry has weathered the crisis in better shape than have related sub-sectors, thanks to a higher degree of specialization and quality.

The long emphasis on skill and quality in the Swedish steel industry carries over into those finishing and fabricating industries which process that steel. Among Swedish specialities are industrial and office machinery, electrical equipment and motor vehicles. These are the main elements of the Swedish engineering sector, which has throughout this century steadily increased its share of industrial production, employment and exports. Although the engineering sector did not grow, in terms of output, in the second half of the 1970s, its share of total exports continued to increase. The viable sub-sectors of engineering are expected to provide the expansion needed in the Swedish economy to offset the anticipated continued stagnation in basic industries.

Another important industry, also with roots in the forest and basic metal sectors, is chemicals. It has been the fastest growing industry in Swedish manufacturing since the second world war. In spite of this, chemicals in Sweden accounted for a smaller share of total manufacturing value added than in any other developed market economy in the late 1970s (United Nations, Yearbook of Industrial Statistics, 1978 edition). Pharmaceuticals and certain plastics represent the most vigorous sub-sectors, taking advantage of high quality research.

As for the textile industry, its position and development in Sweden has largely been the same as in the other three countries. It entered the 1960s still as a major industry. But its importance has continuously diminished due to the factors discussed above.

5.6 Structural Change Quantified

Significant structural changes occurred in Germany, the Netherlands, Sweden and the United Kingdom in the 1960s and 1970s. Some of the principal characteristics of those changes were highlighted in the previous sections. In this section, we define a summary measure to quantify the overall industrial transformations of the four countries. In particular, a measure of structural change with respect to output is compared, for each country, with the degree of change in the employment structure.

In Figures 6A-6D we can follow the extent of the year-by-year structural change that took place, in terms of both output and employment.[9] (Shifts within the sub-sectors are not accounted for.) Except for a few major fluctuations, there appears to have

Figures 6A-6D. Annual structural change[a] with respect to output and employment 1961-80

Figure 6A Germany

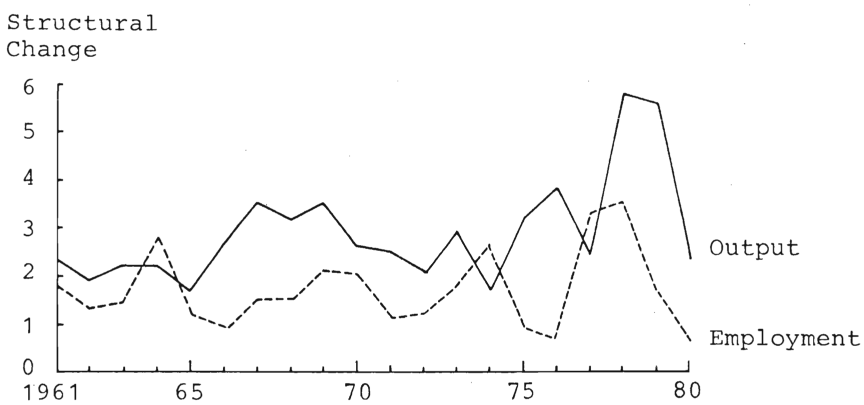
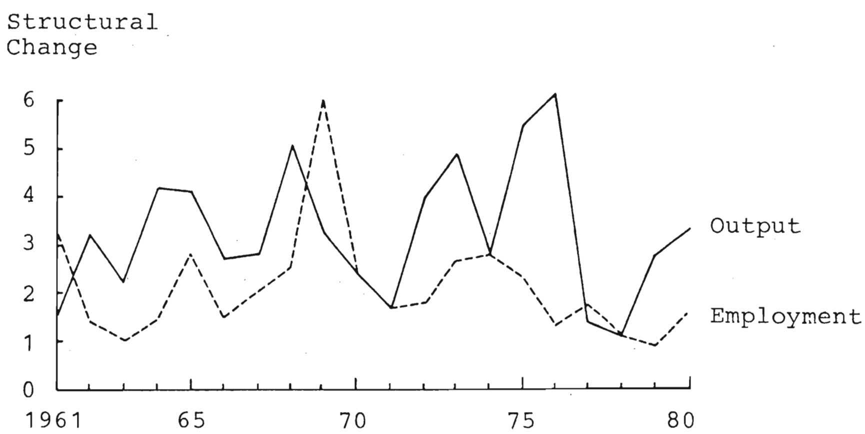


Figure 6B The Netherlands



Sources: Same as in Figures 2 and 4.

[a] Structural change is defined in note 9.

Figure 6C **Sweden**

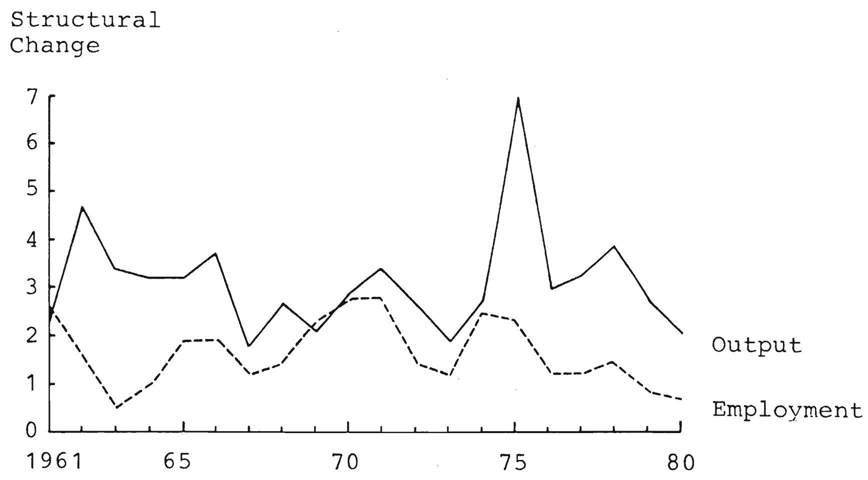
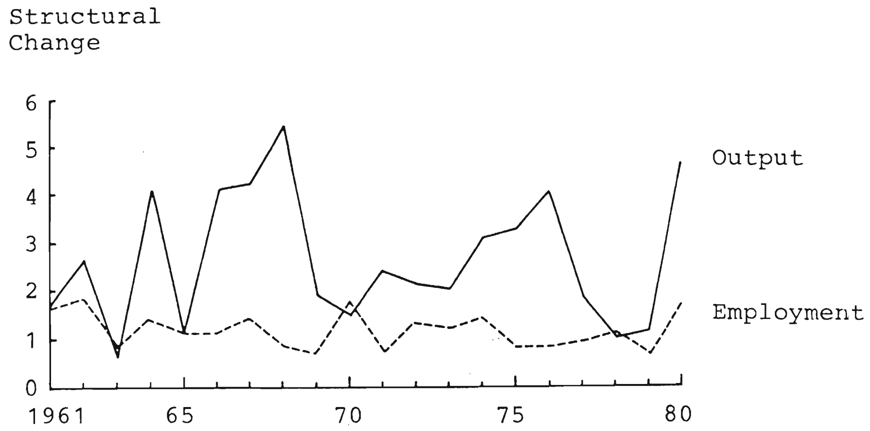


Figure 6D **United Kingdom**



Sources: Same as in Figures 2 and 4.

been no significant change in the rate of the transformation over the period. Nor are any conspicuous across-country differences readily suggested by the figures.

A comparison between output and employment structural changes yields some interesting results. We note that in the four countries the organization of manufacturing activity was clearly more rigid with respect to employment. A closer inspection of the curves indicate that this tendency was stronger in the United Kingdom and, to some extent, in Sweden than in Germany and the Netherlands. This can be checked for a given period by dividing the average yearly output transformation with the average yearly employment transformation. The greater the resulting ratio, the "more rigid" (on average) was the employment structure relative to the output structure. Such ratios are displayed in Table 6.

All our ratios increase between the first and second period. That increase is particularly marked for Sweden, whereas Germany accounts for the smallest rise. For both periods, the U.K. shows the highest "relative rigidity" of employment structure.

Table 6 Ratio between average yearly output transformation and average yearly employment transformation[a]

	1960-73	1973-80
Germany	1.63	1.89
Netherlands	1.40	1.95
Sweden	1.67	2.45
United Kingdom	2.14	2.59

[a] See note 9 for a definition of structural transformation.

Sources: Same as in Figures 6A-6D.

Part of an explanation of these across-country differences can be found in the industrial policy carried out by the respective governments.[10] Massive post oil-crisis government subsidies to Swedish "crisis industries" (shipbuilding, steel, textiles) have slowed adjustments in the Swedish employment structure (Carlsson, Bergholm and Lindberg, 1981). In contrast to the Swedish orientation of industrial policy, German government support has to a large extent promoted promising knowledge-intensive industries, primarily in the chemical and engineering sectors. Germany's pool of migrant "guest workers" may also have fostered a greater correspondence between output and employment transformation.

In the United Kingdom, plans for an active industrial policy, with emphasis given to promoting growth-sectors, were formulated in the early and mid 1970s. But by the end of the decade, little progress along these lines had been made. Large-scale government rescue operations were still common.

6 PROFIT MARGINS AND TRANSFORMATION PRESSURE

Previous chapters have given an overview of the direction and speed of changes in the manufacturing sectors of each of the four countries. In the remainder of this paper, some underlying determinants are discussed. In particular we focus on the roles of profits (this chapter) and investment activity (next chapter).

6.1 An Operational Profitability Measure

Data limitations force us to use crude measures of industry profitability. The measure used here is the gross profit margin (or operating surplus). It is defined as

$$M = \frac{PQ - WL}{PQ} = 1 - \frac{W}{P \cdot Q/L} = 1 - \frac{ULC}{P}$$

where

M = gross profit margin
P = value added price index
Q = value added at constant prices
W = hourly labor costs (including all social charges)
L = hours worked
Q/L = labor productivity
ULC = unit labor cost

The measure is then standardized by transformation into index form. Index 100 denotes the average level for the period 1963-73, which we regard as an approximation of a "long-run equilibrium level" of the rate of return on total capital. A useful feature of this measure is that it is easily decomposed into prices, labor costs and labor productivity (or prices and unit labor costs). This facilitates the analysis of changes in profitability.[11]

To use the gross profit margin as a measure or an indicator - which is the point here - we have to assume that the value added share of depreciation charges on fixed capital[12] remains constant over time. If that share is actually rising (falling) then M gives a positively (negatively) biased picture of changes in profitability. National account statistics of the four countries suggest that the share of depreciation charges on fixed capital in the total economy has been fairly stable since 1960, with a slight tendency to rise in the 1970s. Figures available for the Swedish manufacturing sector show the same development. Hence, it seems reasonable to assume that M gives a fair picture of profitability over time. The measure should at least not exaggerate the negative development of profit margins in the 1970s.

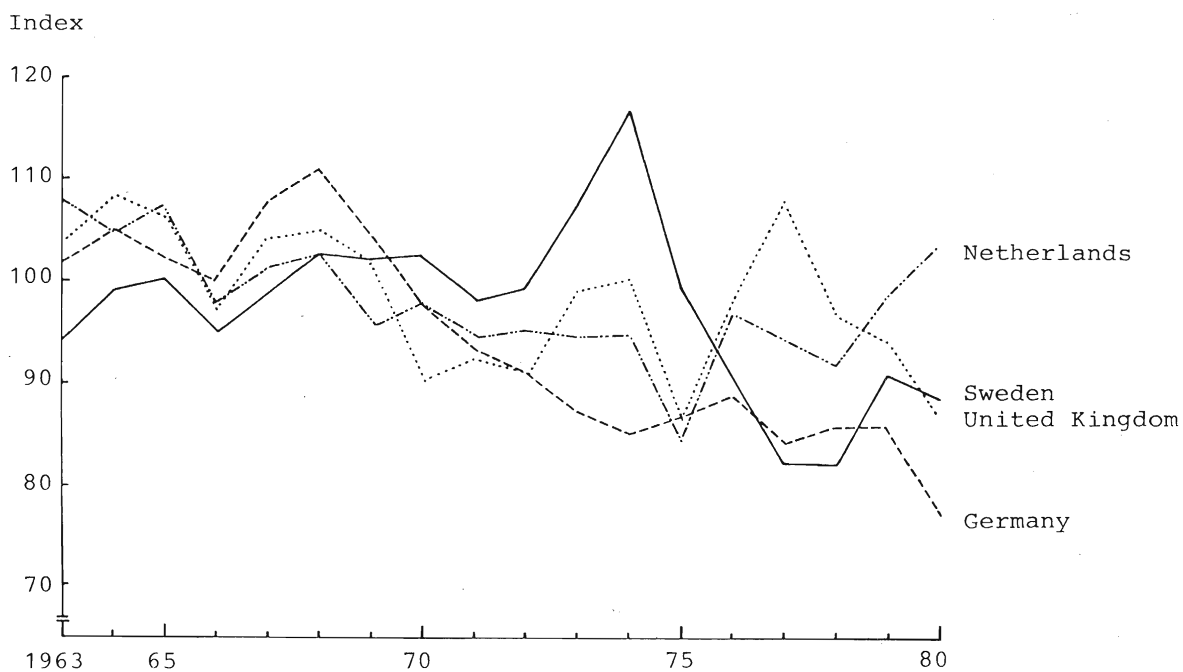
6.2 Manufacturing Profit Margins in 1963-80

Figure 7 exhibits the development of total manufacturing profit margins in Germany, the Netherlands, Sweden and the U.K. It must be stressed that the graph should not be used to compare levels of profit margins; here we are studying the development over time.

Over the whole period 1963-80, profit margins are declining. Up through 1972, profit margins in the four countries moved together quite closely, with relatively moderate fluctuations. Then they became more volatile and unsynchronized.

We can observe some interesting differences between the countries. Swedish manufacturing profit margins developed more favorably up through 1974. But the conspicuous profit boom of 1973/74, attributable to rapid price increases in raw material products of particular importance in Swedish manufacturing, was followed by several years of extreme wage escalations and small positive, or even negative, productivity changes.

Figure 7 **Profit margins in total manufacturing 1963-80**
Index 100 = average for 1963-73



Sources: Germany: 6, 9, 10, 11, 12, 13, 14, 18, 19, 21,
Netherlands: 1, 2, 5, 6, 10, 11, 13, 18, 19, 21,
Sweden: 6, 12, 13, 15, 16, 17, 18, 19,
United Kingdom: 4, 6, 9, 10, 11, 12, 18, 19,
(see Statistical Sources).

Dutch profit margins followed a somewhat different path. From 1963 to 1975 they decreased more than in Germany, Sweden and the U.K. But in the second half of the 1970s, Dutch profits rebounded strongly, thanks to good productivity performances and moderate labor cost increases.

In Germany, a deflationary economic policy with a revalued DM kept inflation in the 1970s at lower levels than in most competing countries. But wages were not checked to a corresponding degree. And since productivity growth was not sufficient to offset the gap between the wage and price increases, profit margins developed unfavorably.

Aggregate profit margins in British manufacturing fluctuated greatly during the 1970s. But on the whole, rapid price increases offset poor productivity performance and substantial wage escalations.

6.3 Prices, Profits and Structural Change

What roles do prices and profits play in structural change? In a market economy the price system fulfills an important signaling function in the resource allocation process. A decrease in the demand for a product, for example, puts downward pressure on the product's price. This is a signal to existing and potential producers to reduce output. In that case, a decrease in price is accompanied by a decrease in quantity.

But one should not expect to find that the relationship between relative prices and output is always positive. Whether the two variables change in the same or opposite direction over a period depends, to a great extent, on changes in relative production costs. In the example above, a cost-saving technical break-through in the manufacture of the product leads to an increase in supply. If this increase in supply is greater than the decrease in demand, the end result will be that the price dropped and the quantity increased.

In principle, the price-output relationship is positive if the market disturbance primarily derives from the demand side, and negative if the disturbance is primarily due to changes in relative costs (the supply side). Hence, the development of relative prices is, in isolation, a poor indicator of the direction of structural change. This is underlined by Table 7, which shows that there was no systematic long-run correlation between the relative development of sub-sector prices and output in the four countries included in this study.[13]

A more fruitful approach to "explaining" structural change would begin with an examination of relative profit performance across industries. After all, producers generally try to allocate their resources in the most profitable way. And since changes in both prices and costs are captured by the profit concept, the relationship between relative profit performance and output growth should be unambiguously positive. But because, for instance, of imperfect foresight, government intervention and rigidities in factor mobility, the ex post relationship may not be monotonic.[14]

According to this line of reasoning, the most expansive industries over a period should be the ones which performed most favorably in terms of profitability, and vice versa. Table 8 shows that this holds well for Germany, the Netherlands and the U.K. The low correlation coefficient for Sweden is to a large extent due to the fact that a sharp fall in basic metal profit margins in the second half of the 1970s was not matched by a corresponding decline in output growth. The level of operations in the Swedish basic metal industry in the period was artificially sustained by massive government support. In fact, if the basic metal industry is deleted from the calculation, the coefficient for Sweden becomes highly significant.

Table 7 **Correlation between the relative development of sub-sector prices and output**

	Germany 1960-80	Netherlands 1963-80	Sweden 1960-80	United Kingdom 1963-80
Correlation coefficient	-0.24	0.54	-0.10	-0.33
Level of significance	-	0.10	-	-

Table 8 **Correlation between the relative development of sub-sector profit margins and output**

	Germany 1963-80	Netherlands 1963-80	Sweden 1963-80	Sweden 1963-80: Basic metals deleted	United Kingdom 1963-80
Correlation coefficient	0.65	0.66	0.11	0.81	0.75
Level of significance	0.05	0.05	-	0.025	0.025

6.4 Transformation Pressure

An interpretation of the discussion and the empirical evidence presented in the previous section is that the greater the spread of profitability across the industries, the greater the "structural tension" in the manufacturing sector. Lacking proper data on profitability the dispersion in profit margins should be an appropriate measure of the degree of transformation pressure.

In this section our profit margin indices (defined on p. 148) are used to construct proxies for "transformation pressure" in the four countries. As a measure of dispersion, we take the sum of the weighted absolute differences between the profit margin index of each sub-sector and the index of the aggregate manufacturing sector. It seems plausible that structural change in one year is affected by the dispersion in industry profitability in previous years. This is taken into account by defining the transformation pressure in year t as the arithmetic average of the dispersion in profit margins in the years t, t-1 and t-2.[15]

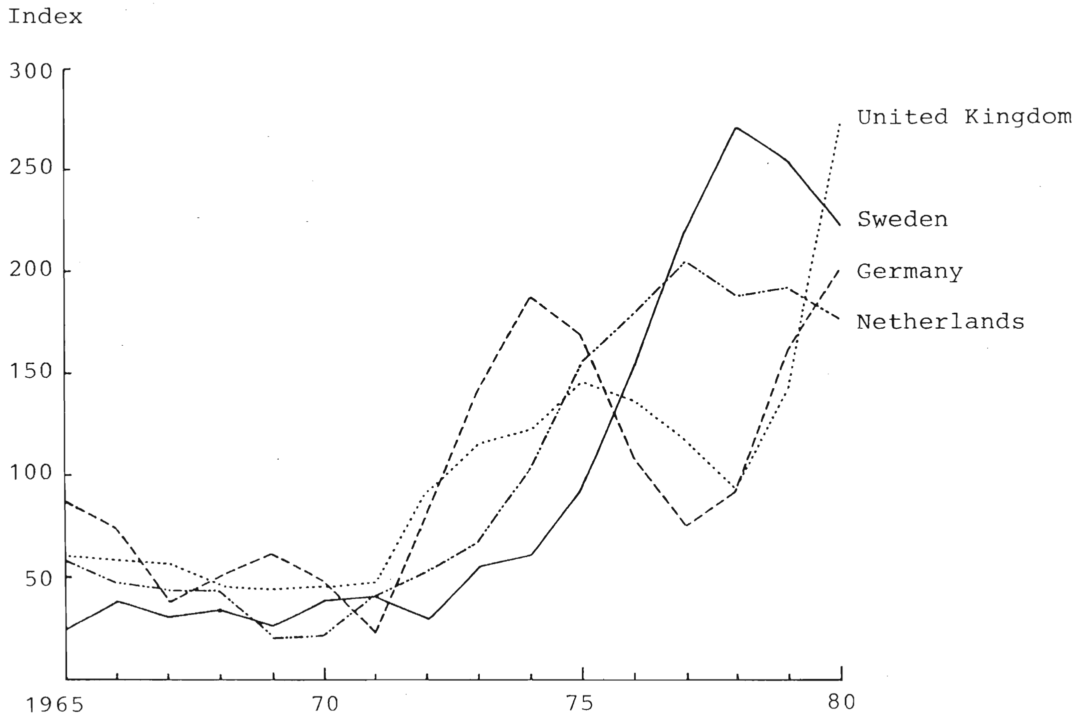
Thus defined, the year-by-year transformation pressure in the four countries is presented in index form in Figure 8. It is important to note that the curves represent crude approximations of the changes in transformation pressure over time. They cannot be used for across-country level comparisons. Nevertheless, at least one conclusion follows from Figure 8. Concurrently with the general deterioration in business climate in the mid and late 1970s, pressure for structural change increased considerably in all four countries.[16]

Recall from section 5.6 that a corresponding increase in the rate of actual transformation did not take place. On the contrary, the extent of employment structural change generally decreased somewhat in the period. To explain this seemingly contradictory development - that high transformation pressure went hand in hand with low transformation response - one has to deal with the delicate problem of a possible two-way causality. Certainly, one can readily suggest that in the sluggish economic climate, in which the expansive sectors cannot soak up unemployed resources, factor mobility tends to decrease even if transformation pressure is high. On the other hand, it is also quite plausible that the rigidity of the economic structure is a principal cause - not an effect - of the economic imbalances, which, in turn, are manifested in a rise in transformation pressure. In other words, as long as the industrial structure does not adjust according to transformation pressure, the fundamental imbalances will persist and may even get worse.[17]

As a final remark we add that the tendency to low factor mobility in periods of low economic activity is frequently enhanced by government actions aimed at curbing short-run unemployment.

Figure 8 **Annual transformation pressure,[a] 1965-80**

Index 100 = average for 1965-80



Sources: Same as in Figure 7.

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[a] Transformation pressure is defined in note 15.

7 INVESTMENTS AND GROWTH

Investment is a key element of the growth process. Besides adding directly to aggregate demand in the economy, investments lay the foundation of future production growth. The "good old years" of the 1950s and 1960s were to a large extent the result of a vigorous investment activity. Today, it is frequently said that to get the wheels spinning as they used to, capital formation must increase significantly.

In this chapter we take a broad look at the industrial investment development in Germany, the Netherlands, Sweden and the United Kingdom and relate investment growth to output growth. We want to highlight statistically a few widespread "beliefs" about investments. The ambition is not to explain investment behavior. Finally, we discuss the importance of the allocation of a given amount of aggregate investments between sectors.

7.1 Manufacturing Investments in 1963-80

Figure 9 displays the growth of the volume of manufacturing investments from 1963 to 1980. It is evident that investment activity was, on the whole, strong up through 1970. For Germany, the Netherlands and the U.K. the first half of the 1970s saw a dramatic drop in annual investments. It is worth noting that this drop started before the oil crisis of 1973/74. Swedish industrial investment, on the other hand, continued for several more years along the trend from the 1960s.

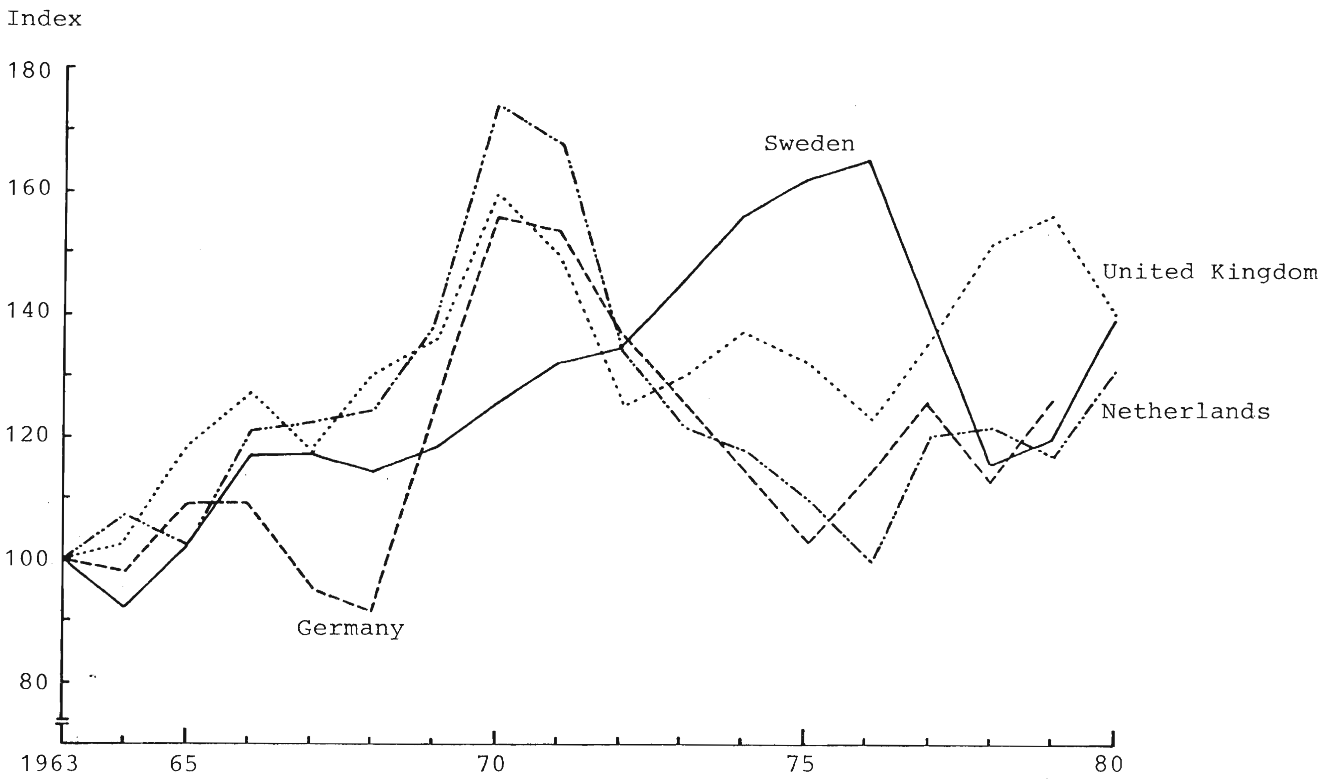
In 1977 the investment trend turned upward again in Germany, the Netherlands and the U.K., whereas Swedish investments fell sharply in the last three years of the 1970s.

7.2 Investments, Investment Ratios and Growth

With the development in the last decade as shown in Figure 9, it is not surprising that an increase in investment activity is fre-

Figure 9 **Total manufacturing investments (at constant prices) 1963-80**

Index 100 = 1963



Sources: Germany: 7, 10, 13, 14, 19, 21, Netherlands: 1, 2, 3, 9, 10, 12, 19, 21, Sweden: 13, 15, 17, 19, United Kingdom: 4, 9, 10, 13, 19, (see Statistical Sources).

quently called for as a remedy for economic stagnation. In this section we ask whether the most expansive industries in each country (in the years since 1963) are the ones which showed the strongest growth of investment, and vice versa.

Correlation coefficients between the relative growth of industry output and investments are presented in Table 9. In Germany and Sweden a strong positive correlation is evident. The coefficient for the United Kingdom is significant only at a .25 level. The extraordinary output growth of the Dutch chemical industry in the 1960s and early 1970s was achieved despite low levels of investment. To a large extent this explains why the correlation between the growth of investments and output is so weak in the Netherlands. If the chemical industry is deleted from the calculation we find that the correlation becomes highly significant.

Frequently, investment development is discussed in terms of investment ratios, i.e. capital formation related to production. The investment ratio is sometimes casually taken as equivalent to "willingness to invest". Since industrial investment ratios have generally fallen in the 1970s, it is accordingly concluded that "willingness to invest" has diminished. This, so the argument goes, is one reason for the current economic stagnation. For the economies to return to the old growth path, investment ratios must be raised to their former levels. That means that investments must increase by more than production.

If this line of reasoning is valid, there should be a long-run positive relationship between the relative development of industry output and investment ratios. In other words, industries with the strongest development of their investment ratio should, in principle, grow faster than the other industries.

This has not been the case in the four countries since 1963, according to Table 10. The relationship actually seems to be negative. A plausible explanation is that the most expansive industries are the ones that tend to become more and more knowledge-intensive.

Table 9 **Correlation between the relative development of sub-sector investments and output**

	Germany 1963-79	Netherlands 1963-80		Sweden 1963-80	United Kingdom 1963-79
			Chemicals deleted		
Correlation coefficient	0.65	0.27	0.61	0.94	0.37
Level of significance	0.05	-	0.10	0.005	0.25

Table 10 **Correlation between the relative development of sub-sector investment ratios and output**

	Germany 1963-79	Netherlands 1963-80	Sweden 1963-80	United Kingdom 1963-79
Correlation coefficient	-0.53	-0.60	-0.35	-0.39
Level of significance	0.15	0.10	0.25	0.25

Table 11 **Correlation between the relative development of sub-sector investments and profit margins**

	Germany 1963-79	Netherlands 1963-80	Sweden		United Kingdom 1963-79
			1963-80	1963-73	
Correlation coefficient	0.68	0.61	0.10	0.81	0.11
Level of significance	0.05	0.10	-	0.01	-

Substantial increases in fixed capital formation in these industries, large enough to raise investment ratios, could very well be detrimental to those industries.

7.3 Investment Allocation and Growth

Growth in investments in machinery and buildings is certainly necessary for long-run output growth. But the quantity of investments is not the only important explanation. One should not only ask the question How much?, but also Where?. That is, not only the level, but also the allocation of investments among firms and industries, should be studied. This could be called the "quality" aspect of investments. For favorable long-run growth, it is crucial that uncompetitive firms and industries do not account for a "disproportionally" large share of total capital formation. In principle, investment resources should be allocated in proportion to the competitiveness of the industries. A misallocation of investment resources is likely to impede the expansion of viable sectors, and to postpone an inevitable adjustment of the structure of the economy.

We now examine the allocation (or the "quality") of the manufacturing investments made since 1963 in the four countries. We regard relative profitability as equivalent to competitiveness. Ideally, the industries with the strongest investment growth over a period should be the ones with the most favorable development of profitability. Thus, a suitable measure for this study of the quality of investments within the manufacturing sector is the correlation between the sub-sector development of investments and profit margins. The stronger the positive correlation, the higher the "quality" of the combined investments made in the period.

We see from Table 11 that in Germany and, to a lesser degree, in the Netherlands, there is a clear positive association between relative growth of investments and profit margins. In Sweden and the U.K., on the other hand, there is no significant correlation. If we choose the period 1963-73, however, the Swedish correlation coefficient becomes highly significant.

Hence, given that the coefficients in Table 11 are appropriate measures of the quality of investments, we can conclude that Germany and the Netherlands in 1963-80, and Sweden in 1963-73, benefited from a growth-conducive allocation of investments. By this definition, a considerable misallocation of resources must have taken place in Sweden in the last decade. This appears to be true for the whole period 1963-80 in the U.K.

The results provide a plausible explanation of two "inconsistencies" between aggregate investment and output growth in the British and Swedish manufacturing sectors. The first inconsistency (compare Figures 2 and 9) is that the British manufacturing investments followed the same growth path as did the German and Dutch investments, and yet the British output growth was much below the others.

The second inconsistency is that the very strong Swedish investment activity from 1970 through 1976, relative to the other countries, did not lead to a correspondingly favorable growth in industrial production. In fact, since the mid 1970s, Swedish industrial growth has been lower than in most developed economies. In Örtengren (1981) it is shown that the seemingly favorable growth of Swedish manufacturing investments in the first half of the 1970s was to a large extent based on vigorous investment activities in government-owned industries which are now considered crisis industries.

In conclusion, an inference to be drawn from this section is that some of the sluggishness in the British economy in the last two decades, and in the Swedish economy in recent years, is due to a misallocation of investments.

8 SUMMARY AND CONCLUSIONS

The most significant aspect of manufacturing growth in Germany, the Netherlands, Sweden and the United Kingdom in the last two decades is the sharp break in output growth trends which occurred in connection with the oil crisis in 1973/74. The deterioration is evident for all industries.

The German, Dutch and Swedish manufacturing sectors experienced a similar development in terms of production growth up through the first half of the 1970s. Thereafter German and Dutch industries outgrew Swedish industries. British manufacturing followed a considerably slower growth path throughout the whole period.

Total industrial employment in the four countries dropped over the period 1960-80. It peaked in the mid 1960s (in 1970 in Germany) and the subsequent decrease was most notable in the Netherlands and the U.K. The rate of decline did not increase appreciably in the period after the oil crisis, despite the marked slowdown in output growth. This circumstance reflects an unfavorable labor productivity growth in the mid and late 1970s.

Regarding performance of individual industries, knowledge-intensive industries gained in importance at the expense of labor and raw-material intensive industries. In the last two decades, the chemical industry was the by far most expansive, whereas textiles declined considerably in both absolute and relative terms. More recently, the basic metal industry has run into severe problems.

The industrial structure and its change in Germany and the U.K. correspond closely to that of the average industrialized economy. Engineering accounts for about 40 percent of total manufacturing production, and the chemical industry is growing in relative size.

In the Netherlands, chemicals, and to some extent the food industry, play a larger role than in the other three countries. Sweden has a strong specialization in forest-based and investment-goods industries.

Transformation pressure (measured as dispersion in profit margins) increased considerably in the stagflation period. But structural change did not "follow" transformation pressures. In fact, the rate of employment structural change appears to have fallen in the second half of the 1970s. Throughout the period 1960-80, the industrial structure was cleary more rigid with respect to employment than to output.

A correlation analysis shows that relative growth rates of the various industries were positively associated with profit performance and investment activity. Investment ratios, on the other hand, appear to have been negatively correlated with output growth, whereas no systematic relationship is found between the relative development of sub-sector output and prices.

Empirical evidence presented in the study suggests that the poor industrial performance of the United Kingdom since 1960, and of Sweden since the mid 1970s, is to some extent a result of a misallocation of resources. Section 5.6 indicates that the structural adjustment of employment was relatively slow over the whole period in the U.K., and slow also in Sweden in the period after the oil crisis. Furthermore, section 7.3 shows that in the U.K. over the whole period, and in Sweden in the period 1973-80, the allocation of investment resources to a relatively large extent went to uncompetitive industries.

[1] The term output is used interchangeably with volume of production throughout the paper.

[2] Such as Brazil, Mexico, Singapore, South Korea, Taiwan and Hong Kong.

[3] This observation coincides with one made in United Nations (1977) where the manufacturing industries in a group of European countries are studied for the period 1958-70.

[4] For a thorough discussion on the recent development in the steel industry in a historical perspective, see Carlsson (1981).

[5] Coal mining is another historically vital industry. But it is not dealt with here, since it is not part of the manufacturing sector.

[6] See Pavitt (1981) for a thorough exposition on innovation activity and British economic performance.

[7] See Wheeler (1975) for a discussion on the significance of trade for the economic life in the Netherlands.

[8] See Rhenmann (1979) for an examination of the new conditions for the Swedish forest industry.

[9] Overall structural change S in period t is here defined by

$$S = \sum_{i=1}^{n} \left| x_{i,t} - x_{i,t-1} \right|$$

where n = number of sub-sectors

$x_{i,t}$ = percentage share of sub-sector i in total manufacturing in period t.

[10] Boston Consulting Group (1979) contains a comparative review of the industrial policy in Germany, Sweden and United Kingdom.

[11] See Eliasson (1976) for a discussion on the merits of using gross profit margins as an approximation of profitability.

[12] Depreciation charges on fixed capital is synonymous with consumption of fixed capital, which is the term often used in national accounts statistical sources.

[13] See Josefsson-Örtengren (1983) for a thorough investigation into the relationship between relative prices and output growth in the Swedish industry disaggregated into 42 sectors.

[14] Two variables are monotonically related if they always change in the same direction.

[15] Transformation pressure TP in period t is thus defined by

$$TP_t = \frac{1}{3} \sum_{a=0}^{2} \sum_{i=1}^{n} x_{i,t-a} \left| (m_{i,t-a} - M_{t-a}) \right|$$

where n = number of sub-sectors

$x_{i,t-a}$ = percentage share of sub-sector i in total manufacturing production in period t-a

$m_{i,t-a}$ = profit margin index of sub-sector i in period t-a

$M_{i,t-a}$ = profit margin index of aggregate manufacturing sector in period t-a.

[16] This is in agreement with Josefsson-Örtengren (1980), in which the dispersion in relative price changes is used as a measure of transformation pressure in Swedish industry in 1913-77. Josefsson and Örtengren found a marked rise in the transformation pressure for the first half of the 1970s.

[17] This discussion is further elaborated in, for instance, Carlsson, Bergholm & Lindberg (1981) and Eliasson & Lindberg (1981).

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PRICE ELASTICITIES IN SWEDISH FOREIGN TRADE

by Eva Christina Horwitz

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I INTRODUCTION

The origin of this paper was the need to provide import and export functions for the IUI-model of the Swedish economy used in the 1979 forecasting exercise, later on extended to support the analysis in the KRAN-project. This paper summarizes the results of the estimates of price elasticities in foreign trade in that exercise. It also surveys results for Sweden obtained by others and briefly compares results for other countries.

The final section of this paper presents estimates of Swedish import and export price elasticities at a disaggregated level. The results are exploratory, looking more for the specification sensitivity of estimated coefficients than for any firm results. The results are, however, close to those obtained for Sweden in most studies using single equation methods of estimation. When aggregating over the commodity groups we find a price elasticity of about -1.4 for total Swedish exports, the main impact falling in the year after the relative price change. Price elasticities seem to be much lower for exports to the Nordic Countries than for exports to Western Europe and North America, where price elasticities for Swedish goods tend to be around -2. The price elasticity for aggregate imports seems to be just below 1 in this exercise.

II TIME SERIES ESTIMATION OF PRICE ELASTICITIES IN INTERNATIONAL TRADE

a) The Theoretical Background

Empirical work on estimating export and import functions and price elasticities in foreign trade is based on the assumption that goods in international trade can be distinguished from goods produced domestically. The measurement of price elasticities follows the standard approach in consumer theory. It is assumed that the consumer allocates his income among commodities in an effort to achieve maximum satisfaction. Total imports will be the outcome of a process whereby the quantity import goods purchased by any consumer is decided by his income, the price of imports and the price of other consumable commodities.

Aggregate import demand for the economy is expressed as

$$M = f(Y, P_m, P_y) \qquad (1)$$

where Y could be nominal GDP of the country for which imports are estimated, P_m the price of imports and P_y the price of domestic commodities.

The export function can be written analogously as

$$X = f(W, P_s, P_w) \qquad (2)$$

where W and P_w refer to income and prices in the rest of the world and P_s is the domestic export price.

Most empirical work on the determination of income and price elasticities in foreign trade has been done on the basis of (1) and (2).

An attempt at providing a rationale for an import demand function like (1) is discussed by Armington (1969) in his article "A Theory of Demand for Products Distinguished by Place of Production". Armington makes a distinction between goods and products. Products are characterized by kind as well as by place of production, whereas a good is a group of products from different geographical locations as illustrated in figure 1.

Figure 1 The trade matrix

		Supplying countries		
	1	2	...	m
Goods 1	X_{11}	X_{12}	...	X_{1m}
2	X_{21}	X_{22}	...	X_{2m}
.	.			.
.	.			.
.	.			.
n	X_{n1}	X_{n2}	...	X_{nm}

Product demand is derived by assuming consumers (in this case consuming nations) maximize utility subject to a budget constraint.

The demand for a particular product X_{ij} by any particular country C_i is

$$X_{ij}=X_{ij}(D,P_{11},P_{12},\ldots,P_{1m},P_{21},P_{22},\ldots,P_{2m},\ldots,P_{n1},P_{n2},\ldots,P_{nm})$$

where D is an income variable, n the number of products and m the number of countries. Since there are m demands for each product, and since there are mn products, the demand side is comprised of m^2n product demands of which mn are domestic demands and mn(n-1) are export or import demands.

If many countries or areas are distinguished in the model the equations would be too complicated for practical use.

Several simplifying assumptions are made to get the extremely simplified import demand function (1).

In particular we use the fact that products of the same kind are closely associated and assume that demand for any particular product X_{ij} can be written as a function of X_i and the relative product price in the ith market. (Armington (1969), pp. 164-165.) Formally Armington assumes weak separability of the utility function which implies that the demand for product X_{ij} is the outcome of minimizing the cost of purchasing the volume X_i.

Typically all foreign countries are grouped together, and the demand for total imports of the ith good (X_{ij}) is expressed as a function of demand for the ith good, wherever produced (X_i) and the ratios of the average import price (P_{ij} to the price level in the market (P_i), where j stands for the jth group of countries.

Armington discusses only the theory of consumer choice. However, final consumption goods are less important than intermediate goods in international trade. For example, only about 25 percent of Swedish imports are classified as consumer goods. The most important class of commodities by value are industrial input goods, about for 40 percent. Fuels add another 10-15 percent. Clearly a model of import behavior must draw on the theory of firm demand for inputs.

It is usually assumed that imports of raw materials and unfinished goods can be explained by a similar equation. (Leamer (1970), p. 12.)

$$M = f(Q, P_m, P_q) \qquad (3)$$

where Q is the level of production of the industry, P_m import prices and P_q prices of goods produced in the country. Such an equation can be derived from the cost function of the industry or firm.

A model that attempts to explain trade flows will involve other explanatory variables affecting demand besides prices and income. It is common practice to include explanatory variables for non-price rationing, waiting time, dummy variables for unusual events, seasonal variables and lagged variables that capture responses through time.

b) The Least Squares Bias in Single Equation Estimation

Although the questions have been raised long ago, (Orcutt (1950)) only recently (Goldstein and Khan (1977) and Artus and Sosa (1978)) have studies of export- and import price elasticities payed serious attention to the least squares bias and simultaneous equation problem. The "normal" procedure has been to run OLS regressions of the "demand" equations, assuming that the results will not be too far from a true estimate of the demand price elasticities. (Stern, Francis and Schumacher (1976), p.7.)

Equation (1) and (2) intend to capture the demand relation. But data on prices and quantities, are connected by both a demand and a supply equation. A set of observations on prices and quantities tells us little about either equation. The equations are not identified. More information will have to be added. If we know something about the relative stability of the supply and demand curves, for example, if other influences on demand remain unchanged over time while those of supply varied, the observations would trace out a price-quantity demand curve. In practice, however, both sets of influence are likely to vary and the price quantity scatter reflects demand as well as supply shifts. In other words, the ordinary least square method will not give unbiased estimates of the parameters, because the explanatory variables are not generally uncorrelated with the error term.

Only if prices are truly exogenous - i.e. if import and export prices are given parameters, not affected by the actions of agents that decide import and export quantities, will OLS estimates yield unbiased estimates of the price elasticities. This amounts to the assumption of perfect elasticity of supply.

The assumption of totally elastic supply may hold for imports to a small country like Sweden. Estimates of import demand price elasticities on the basis of OLS regressions can be an acceptable method as far as small countries are concerned. In the case of estimates of export demand the assumption of a perfectly elastic supply curve is harder to defend. We have nevertheless estimated export price elasticities by OLS regressions in this paper. The results can be interpreted as demand price elasticities under the assumption of perfectly elastic supply or as weighted averages of the supply and demand price elasticities.

c) Some Empirical Results

Surveying the results of empirical studies on price elasticities gives the overall impression that most national studies and international comparisons are based on a single equation specification like (1) and (2).

"Price elasticities in international trade" by Stern, Francis and Schumacher (1976) extensively surveys the results of studies of export and import price elasticities.[1] Table 1, taken from that publication, summarizes the "best" results obtained for several industrialized countries - i.e. results that give price and income variable coefficients with the expected sign and of "reasonable" magnitudes.

The results in general give price elasticities in the range from -0.5 to -2.5. On a disaggregated basis there is a clear tendency for price elasticities to be lower for raw materials and input goods than for finished manufactures and consumer goods.

From a Swedish perspective it is worth noting that export price elasticities seem to be the highest

Table 1 Summary of selected elasticity results

Imports						Exports				
SITC 0+1	SITC 2+4	SITC 3	SITC 5-9	Total imports	Country	SITC 0+1	SITC 2+4	SITC 3	SITC 5-9	Total exports
-0.80	-0.47	-0.96	-1.84	-1.66	United States	-0.85	-0.86	n.a.	-1.24	-1.41
-0.80	-0.58	-0.52	-2.06	-1.30	Canada	n.a.	n.a.	n.a.	n.a.	-0.79
-0.66	-0.91	-0.57	-1.42	-0.78	Japan	n.a.	n.a.	n.a.	1.77	-1.25
-0.58	-0.80	-1.11	-2.36	-1.08	France	n.a.	n.a.	n.a.	n.a.	-1.31
-0.78	-0.25	-1.17	-2.53	-0.88	W. Germany	n.a.	n.a.	n.a.	n.a.	-1.11
-0.87	-0.25	-0.44	-1.22	-0.65	United Kingdom	n.a.	n.a.	n.a.	-2.00	-0.48
-1.06	-0.22	-1.35	-1.34	-0.83	Belgium-Luxembourg	n.a.	n.a.	n.a.	n.a.	-1.02
-1.52	-0.47	-1.00	-2.61	-1.05	Denmark	n.a.	n.a.	n.a.	n.a.	-1.28
-1.59	-0.93	-0.44	-2.64	-1.37	Ireland	n.a.	n.a.	n.a.	n.a.	-0.86
-0.96	-0.50	-1.16	-1.02	-1.03	Italy	n.a.	n.a.	n.a.	n.a.	-0.93
-0.26	-0.94	-0.01	-0.88	-0.68	Netherlands	n.a.	n.a.	n.a.	n.a.	-0.95
n.a.	-0.27	-n.a.	-0.74	-1.32	Austria	n.a.	n.a.	n.a.	- n.a.	-0.93
-0.09	-0.50	-0.33	-0.99	-0.50	Finland	n.a.	n.a.	n.a.	n.a.	-0.78
-0.58	-1.15	-1.36	-1.65	-1.19	Norway	n.a.	n.a.	n.a.	n.a.	-0.81
-0.47	-0.52	-0.24	-1.05	-0.79	Sweden	n.a.	n.a.	n.a.	n.a.	-1.96
-0.15	-0.17	-2.78	-1.21	-1.22	Switzerland	n.a.	n.a.	n.a.	n.a.	-1.01
-0.73	n.a.	n.a.	n.a.	-0.42	Australia	n.a.	n.a.	n.a.	n.a.	-0.74
-1.12	-0.75	-0.34	-1.23	-1.12	New Zealand	n.a.	n.a.	n.a.	n.a.	-0.70

Source: Stern, Francis and Schumacher (1976), Table 2.2.

Note: "Best" Point Estimates of Long-run Elasticities of Demand for Imports and Exports, by SITC Commodity Group and Country.

for Swedish exports. This is a finding that deserves a more extensive analysis than can be presented in this brief survey.[2]

Estimates of total export price elasticities for Swedish foreign trade in different studies most often point to values in the -1 to -1.5 range. Studies in which supply considerations are taken into account explicitly suggest price elasticities around -2. (Ettlin (1977), Axell (1979), Jansson (1979).) But "two equation" studies also differ in assuming that the lagged effects of price changes will take longer to work through the system.

Table 2 summarizes the result of some recent studies of import and export price elasticities made for Sweden.

Lindström (1980) estimates export price elasticities for Sweden by explaining Swedish shares of imports to 13 OECD markets for three commodity groups - intermediate goods, investment goods and consumer goods - by the present and lagged relative prices and relative tariffs. The aggregation of the 39 elasticities obtained results in an estimate of the total elasticity of -1.4.

Hamilton (1979) estimates import price elasticities for 28 commodities. Changes in the share of imports in total domestic purchases (i.e., imports /production less exports) are explained by relative prices, i.e. Swedish import price and the domestic price. This study exploits the availability of Swedish production statistics on a SITC (i.e., trade statistics) basis, in addition to the standard (ISIC) classification basis.

Table 2 Summary of price elasticities for Sweden

	Period	Level of disaggregation	Price elasticities	
Lindström	1963-74	3 classes	1. Intermediate goods	-1.3
(Exports)	yearly data	13 countries	2. Investment goods	..
			3. Consumer goods	-2.2
			Total	-1.4
Hamilton	1960-75 yearly data	28 commodity groups	5. Textiles and Clothing	-1.7
(Imports)			6. Manufactures...	-1.5
			3. Iron and Steel	-2.0
			2. Glass	-0.8
			4. Chemicals	-0
			1. Food	-0.7
			Total	-1.7
Ettlin (Exports)	1965-74 quarterly	Manuf.goods	Exports	-2.2
(Imports)	data	Manuf.goods	Imports	-2.2
Horwitz (Exports)	1973-78 quarterly data	Manuf.goods		-1.6 -2.2
Axell (Exports)	1965-78 quarterly data	Total		-2.6
Jansson (Exports)	1963-77 yearly data		Engineering Chemicals	-2.1 -1.1

The price elasticity for total exports obtained by Horwitz (1979) is based on a OLS regression of Swedish market shares in total exports of manufactured goods from industrialized countries on Swedish relative export prices for manufactured goods.

Axell (1979) estimates reduced-form demand and supply price elasticities of total exports from Sweden. His results, together with those of Ettlin and Jansson, support the idea that demand price elasticities are significantly higher when the supply side is taken into account explicitly.

Ettlin (1977) also takes the least squares bias into consideration by estimating two export functions, depending on whether exports can be considered to be constrained from the demand or from the supply side.

Jansson (1979) estimates export price elasticities for two manufacturing sectors, chemicals and engineering, using full information maximum likelihood. Supply elasticities in his estimate are high, which indicates that the bias in estimates obtained by OLS might not be too severe. However the demand elasticities are higher than those obtained by others.

III DISAGGREGATED PRICE ELASTICITIES IN SWEDISH FOREIGN TRADE

a) The Data

In the model, for which estimates of import and export price elasticities were a required input, productive activity is broken down into 17 sectors, 1-3 cover agriculture, forestry and mining, and 4-17 cover manufacturing industry proper. We have made an effort to estimate price elasticities on goods following this breakdown, but due to poor data on prices in international trade estimates at such a disaggregated level must be considered extremely tentative.

Data for import relations were obtained from Swedish official statistics used in the Swedish Long Term Surveys. Domestic production as well as imports and exports for each sector were given in constant 1975 prices. Export data has also been collected from international trade statistics. (OECD Trade By Commodities, Series B.) The classification to match trade statistics to production data is shown in Table 3. Collection of more detailed data was not feasible given the number of countries and products involved.

Implicit price indices have been calculated using data for current value imports and exports and the 1975 constant prices series in the above mentioned data base.

The price indices normally used in the estimation of foreign trade price elasticities are the so called unit values, implicit prices obtained from

Table 3 Classification of trade statistics used for calculation of export market shares

Sector		ISIC	SITC Rev
7	Textile and clothing industry	32	61, 65, 83-85
8	Wood, pulp and paper industry	33, 341	24, 25, 63, 64, 82
11	Chemical industry	351, 352, 356	51-59, 26, part of 89, part of 4
14	Basic metal industries	37	67, 68
15	Engineering excl shipyards	38 excl 3841	69, 7 excl 735, part of 81
17	Other manufacturing	39	-

customs statistics, where total value is divided by quantity, and quality differences neglected. The use of this proxy price index may give results very different from those obtained with a proper price index. (Kravis, Lipsey and Pushe (1980).)

Due to the lack of data on prices for the commodity groups corresponding to those used in the model, export functions were only run for 5 commodity groups for which an international price thus defined, could be relatively easily obtained. And even in those instances the relative price for exports is obtained by comparison of a Swedish export price and an international price index at a somewhat higher level of aggregation.

b) Import Price Elasticities

Equations for imports to Sweden for each sector were expressed as the import share of total supply as a function of the relative price between import prices and Swedish producer prices.

The regression run was

$$\frac{M}{Y} = f(P_y/P_m)$$

where Mand Y are expressed in volume and Y stands for domestic supply i.e. total production plus imports less exports, P_m the price of imports and P_y the domestic price index.

The price coefficient is expected to be positive in this formulation since an increase in the relative price (i.e., in domestic prices relative to the foreign prices) increases the level of imports.

Three equations were estimated: The import share explained by relative prices the same year and the two previous years; import shares explained by relative prices and a trend; import shares explained by the relative price and the lagged import share (Koycklag). A summary of the results are found in Table 5, where the price coefficients in col. 1 and 2 refer to the sums of the first and second years.

The results are rather robust against changes in the specification of the lag-structure. The results reported in the appendix suggest, however, that better estimates of import demand could be obtained using a more elaborate specification than equation (1). It is also evident that the present level of aggregation is not well suited to the task of estimating import equations.

c) Export Price Elasticities

The export market share regressions were performed using a somewhat different approach. Five sectors, in which exports constitute a substantial part of total production and for which a relative price seemed relevant in explaining export performance were included. The 1963-77 pattern of market shares of Swedish exports in total OECD-imports (Sum of 14 OECD-countries) for those sectors are given in Figure 2. A more detailed analysis of export shares in current prices by market and commodity groups is found in Horwitz EC (1979).

Swedish relative prices in the current and previous year were used to explain the Swedish market share of imports to three markets: the Nordic market, Western Europe excluding the Nordic countries, and North America. The equation tested was

$$\frac{X}{W} = f\left(\frac{P_s}{P_w}\right)$$

where X and W are expressed in volume.

The results in table 5 point to a price elasticity of about -1.4 for total Swedish exports, the main impact falling in the year after the relative price change. This result holds for the total of the sectors included, as well as for the most important sector - the engineering sector.[3]

Table 4 Summary of import price elasticities using three specifications of the import function

	2yearlag	2yearlag and trend	Koycklag
Sector 5 Food industry	-	0.3	1.2
Sector 6 Beverages	1.8	1.8	1.1
Sector 7 Textile	5.8	2.1	6.2
Sector 8 Wood, pulp, paper	1.7	-	2.2
Sector 9 Printing	0.8	0.9	1.9
Sector 10 Rubber products	2.6[a]	1.4	-
Sector 11 Chemicals	-	0.3	-
Sector 12 Petroleum	-	-	-
Sector 13 Non metallic minerals	-	0.3	-
Sector 14 Basic minerals	1.1	0.4	2.1
Sector 15 Engineering (excl. shipyards)	-	0.9[b]	0.5
Sector 17 Other manufact.	2.3	0.5	1.4

[a] Only one year lag included

[b] Only first year effect

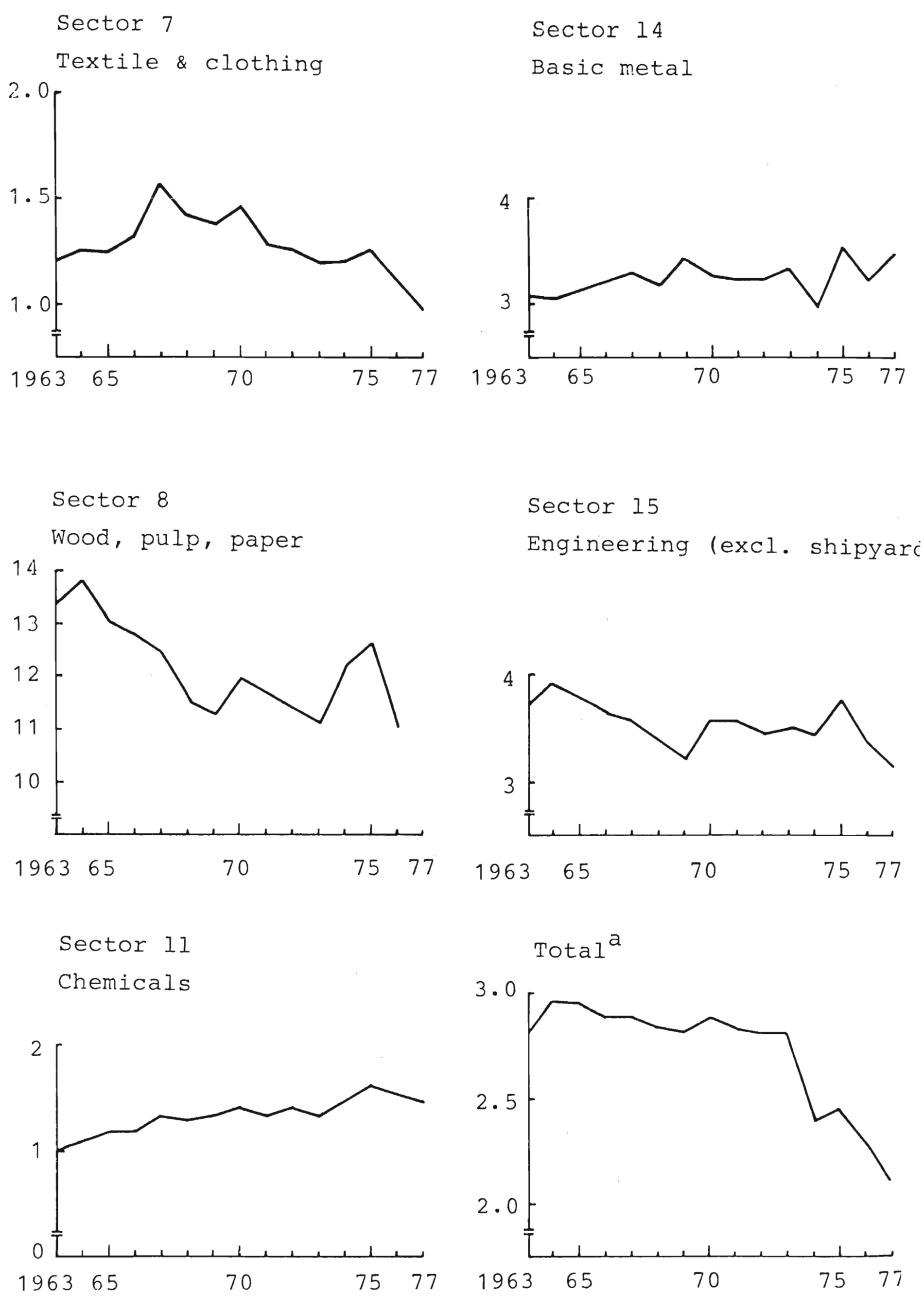
Price elasticities seem to be much lower for exports to the Nordic countries than for exports to Western Europe and North America, where price elasticities tend to be around -2. More detailed results giving commodity and market breakdowns are found in the appendix.

Table 5 Export price elasticities
For detailed results see Appendix

	Nordic Countries	Western Europe	North America	Total
Sector 7 Textile & clothing	-3.7	-1.9	0.8	-
Sector 8 Wood, pulp, paper	-1.3	-2.5	-5.3	-
Sector 11 Chemicals	1.0		-4.1	-
Sector 14 Basic metal	0.6	0.1	-0.5	-
Sector 15 Engineering (excl. shipyards)	-0.5	-1.0	-2.4	-1.4
TOTAL[a]	-0.2	-1.8	-1.8	-1.4

[a] Estimate for total export.

Figure 2 The Swedish market share in OECD[a] imports



[a] The sum of imports to 14 countries.

APPENDIX

SWEDISH IMPORTS

$$\log \frac{M}{Y} = C + \beta_1 \log\left(\frac{P_y}{P_m}\right)_t + \beta_2 \log\left(\frac{P_y}{P_m}\right)_{t-1} + \beta_3 \log\left(\frac{P_y}{P_m}\right)_{t-2}$$

(Standard error in brackets)

	C	β_1	β_2	β_3	SEE	R^2
Sector 3	-0.203	0.014 (0.05)	-0.060 (0.06)	-0.058 (0.057)	0.04	0.35
Sector 4	-2.43	0.169 (0.014)	-0.07 (0.17)	-0.006 (0.144)	0.07	-0.09
Sector 5	-1.32	-0.166 (0.21)	0.133 (0.26)	-0.100 (0.21)	0.05	-0.20
Sector 6	-1.55	1.119 (0.25)	-0.543 (0.40)	1.265 (0.29)	0.04	0.83
Sector 7	-0.66	2.611 (0.40	0.92 (0.49)	2.32 (0.40)	0.05	0.96
Sector 8	-2.385	3.09 (1.35)	-2.62 (2.37)	1.186 (1.55)	0.14	0.65
Sector 9	-2.96	0.006 (0.30)	0.362 (0.39)	0.433 (0.32)	0.04	0.98
Sector 10	-1.05	2.206	0.382	-1.44	0.18	0.40
Sector 11	-0.77	-0.137 (0.11)	-0.065 (0.14)	0.052 (0.14)	0.03	-0.06
Sector 12	-0.30	-0.117 (0.27)	0.036 (0.33)	-0.161 (0.27)	0.11	-0.18
Sector 13	-1.84	4.103 (1.46)	-5.708 (2.09)	-0.732 (1.30)	0.14	0.48
Sector 14	-1.08	0.454 (0.48)	0.659 (0.56)	-0.332 (0.49)	0.09	0.14
Sector 15	-0.99	-0.084 (0.77)	1.516 (1.12)	-3.198 (0.69)	0.05	0.74
Sector 16	-0.76	1.625 (0.93)	-0.327 (1.04)	-0.139 (0.97)	0.50	0.10
Sector 17	-0.38	0.439 (0.52)	0.980 (0.89)	0.918 (0.92)	0.14	0.21

SWEDISH IMPORTS

$$\log \frac{M}{Y} = C + \beta_1 \log\left(\frac{P_y}{P_m}\right)_t + \beta_2 \log\left(\frac{P_y}{P_m}\right)_{t-1} + \beta_3 \log\left(\frac{P_y}{P_m}\right)_{t-2} + \text{trend}$$

(Standard error in brackets)

	C	β_1	β_2	β_3	trend	SEE	R^2
Sector 3	-0.204	0.002 (0.06)	-0.069 (0.07)	-0.068 (0.06)	-0.002	0.04	0.30
Sector 4	-2.35	-0.036 (0.16)	-0.040 (0.149)	-0.198 (0.159)	0.012 (0.01)	0.06	0.15
Sector 5	-1.288	-0.016 (0.13)	0.146 (0.16)	0.167 (0.15)	0.009 (0.002)	0.03	0.54
Sector 6	-1.547	1.101 (0.27)	-0.526 (0.43)	1.240 (0.34)	0.001 (0.003)	0.04	0.32
Sector 7	-0.547	1.019 (0.35)	0.363 (0.27)	0.718 (0.35)	0.037 (0.006)	0.03	0.99
Sector 8	-2.28	0.724 (0.61)	-1.686 (0.93)	1.024 (0.602)	0.050 (0.006)	0.05	0.95
Sector 9	-2.96	0.086 (0.307)	0.362 (0.40)	0.433 (0.32)	0.041 (0.01)	0.04	0.98
Sector 10	-0.72	0.332 (0.31)	0.691 (0.59)	0.383 (0.55)	0.042 (0.004)	0.05	0.94
Sector 11	-0.76	0.005 (0.157)	0.076 (0.17)	0.189 (0.17)	0.005 (0.003)	0.03	0.00
Sector 12	-0.49	-0.044 (0.09)	0.053 (0.11)	0.112 (0.09)	-0.024 (0.002)	0.04	0.87
Sector 13	-1.59	0.704 (0.72)	0.305 (0.13)	-0.756 (0.51)	0.038	0.05	0.92
Sector 14	-0.97	-0.007 (0.22)	0.413 (0.25)	0.020 (0.21)	0.018 (0.002)	0.04	0.84
Sector 15	-0.87	0.887 (0.44)	-0.315 (0.69)	-0.422 (0.64)	0.019 (0.003)	0.03	0.93
Sector 16	-0.83	0.853 (1.04)	-1.088 (1.129)	-0.883 (1.07)	-0.883 (0.07)	0.48	0.18
Sector 17	-0.36	0.391 (0.225)	0.154 (0.37)	-0.027 (0.37)	0.041 (0.005)	0.06	0.38

SWEDISH IMPORTS

$$\log \frac{M}{Y} = C + \beta_1 \log \frac{P_Y}{P_m} + \beta_2 \log \frac{M}{Y}_{(t-1)}$$

(Standard error in brackets)

	C	β_1	β_2	SEE	$\bar{R}^2$
Sector 3	-0.17	-0.05 (0.30)	0.236 (0.30)	0.04	0.20
Sector 4	-1.87	0.065 (0.14)	0.230 (0.36)	0.07	-0.01
Sector 5	-0.164	0.145 (0.11)	0.884 (0.21)	0.03	0.56
Sector 6	-1.23	0.882 (0.33)	0.203 (0.18)	0.06	0.41
Sector 7	-0.022	0.647 (0.30)	0.895 (0.06)	0.03	0.98
Sector 8	-0.15	0.198 (0.37)	0.911 (0.21)	0.08	0.87
Sector 9	-0.82	0.545 (0.22)	0.717 (0.11)	0.05	0.97
Sector 10	0.108	-0.03 (0.25)	1.054 (0.09)	0.04	0.96
Sector 11	-0.54	-0.085 (0.09)	0.294 (0.28)	0.02	0.05
Sector 12	-0.005	0.048 (0.07)	1.075 (0.12)	0.04	0.85
Sector 13	0.16	-0.164 (0.35)	1.065 (0.09)	0.05	0.92
Sector 14	-0.23	0.515 (0.21)	0.751 (0.15)	0.04	0.75
Sector 15	-0.04	0.031 (0.36)	0.934 (0.13)	0.05	0.77
Sector 16	-0.67	0.995 (0.74)	0.151 (0.29)	0.50	0.13
Sector 17	-0.04	0.147 (0.225)	0.898 (0.119)	0.06	0.84

SWEDISH EXPORTS

$$\log \frac{X}{W} = C + \alpha_1 \log\left(\frac{P_s}{P_w}\right)_t + \alpha_2 \log\left(\frac{P_s}{P_w}\right)_{t-1}$$

(Standard error in brackets)

	C	α_1	α_2	SEE	$\bar{R}^2$	DW
Nordic Countries						
Total exports	3.8	0.39 (0.4)	-0.59 (0.7)	0.07	-0.9	0.50
Sector 7	3.7	-1.69 (1.3)	-1.97 (1.4)	0.12	0	0.76
Sector 8	9.4	-0.53 (0.3)	-0.68 (0.4)	0.12	0.31	0.74
Sector 11	-1.99	1.25 (1.1)	-0.27 (0.2)	0.11	0.31	0.91
Sector 14	0.16	-0.86 (0.5)	1.46 (0.9)	0.15	0	0.91
Sector 15	5.27	0.42 (0.7)	-0.92 (1.4)	0.06	0.25	1.00
Western Europe						
Total exports	9.68	-0.89 (-1.7)	-0.91 (1.7)	0.05	0.90	0.89
Sector 7	8.5	-0.49 (0.7)	-1.45 (1.9)	0.07	0.82	1.58
Sector 8	14.25	-0.92 (2.1)	-1.56 (3.3)	0.04	0.95	1.51
Sector 14	0.73	-0.24	0.34	0.076	-0.14	2.19
Sector 15	5.46	0.16 (0.3)	-1.12 (1.7)	0.059	0.60	1.47
North America						
Total exports	8.68	0.18 (0.2)	-2.00 (1.9)	0.097	0.68	0.94
Sector 7	-8.5	3.3 (1.5)	-2.55 (1.1)	0.20	0.08	1.1
Sector 8	24.2	-5.3 (1.6)	0.03 (0)	0.30	0.65	0.84

	C	α_1	α_2	SEE	$\bar{R}^2$	DW
Sector 11	-2.7	-2.3 (0.9)	-1.8 (0.8)	0.22	0.05	1.23
Sector 14	3.18	0.61 (0.4)	-1.14 (0.7)	0.14	-0.05	1.49
Sector 15	11.4	0.04 (0.03)	-2.40 (1.9)	0.11	0.72	0.88
<u>Aggregate estimates</u>						
Sector 15	7.6	0.06 (0.7)	-1.4 (1.7)	0.07	0.68	1.04
TOTAL	7.9	-0.27 (0.6)	-1.13 (2.2)	0.045	0.86	1.17

NOTES

[1] Estimates obtained in direct connection with general model building exercises are not included.

[2] Similar results are obtained by Horwitz (1982) OLS estimates of demand price elasticites for export of manufactured goods from 11 industrialized countries. The results rest heavily on the assumption of perfect elasticity of supply. When supply elasticities are allowed to be less than infinite, Swedish export demand price elasticities are more compatible with those of other countries.

[3] Results using a similar approach by Lindström (1980) gave no significant result for investment goods, the price elasticity of which was assumed to be -1.0.

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OVERSHOOTING AND ASYMMETRIES IN THE TRANSMISSION OF FOREIGN PRICE SHOCKS TO THE SWEDISH ECONOMY

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I INTRODUCTION

This paper is concerned with the relationship between an exogenous foreign price shock and the subsequent (and consequent) movement in the domestic price level. The reason for approaching this topic again, given the existing abundant literature, was a desire to investigate empirically three hypotheses suggested recently by simulations of a model of the Swedish economy[1]. Specifically, (1) does the Swedish price level adjust smoothly to a foreign price shock or does it overshoot and oscillate?, (2) does the size of the foreign price shock matter for the speed of the adjustment process?, and (3) does the domestic price level react differently to a foreign price increase than to a foreign price decrease? These questions are addressed here using a modified version of a price equation commonly used in studies of the transmission of inflation, and using data on Swedish consumer prices and import prices for the period 1947 to 1979.

The next section discusses the price equation which will be used and takes up some theoretical arguments concerning overshooting and asymmetries of adjustment. In section III the empirical results are presented, evaluated and compared to those of the simulation model refered to above. In the final section the principal limitations of the study are taken up together with suggestions for extensions.

II THEORETICAL CONSIDERATIONS

The Domestic Price Equation

A common specification for an equation, determining the domestic rate of inflation in a small open economy, with a fixed exchange rate is

$$\Pi_t = a_0 + a_1\Pi^*_t + a_2F_{t-1}\Pi_t + a_3Z_t. \tag{1}$$

where

Π_t = the domestic rate of inflation

Π^*_t = the foreign rate of inflation (measured for instance by the rate of change in import prices)

$F_{t-1}x_t$ = the expectation formed at time t-1 of the value of the variable x at time t.

Z_t = a vector of variables capturing the effects of domestic and foreign monetary and fiscal policies.

Special cases of equation (1) have been proposed and estimated in the literature. The parameter a_2 has, for instance, been assumed to equal zero in which case the domestic rate of inflation is determined solely by the actual rate of foreign inflation (maybe with a distributed lag effect) and monetary and fiscal policies[2]. It is also possible to assume that $a_1 = 0$ and that the expected rate of inflation depends on the expected foreign rate of inflation. In that case the domestic rate of inflation will be determined by the expected foreign inflation rate in addition to policy variables[3].

It can be argued that both of the above special cases represent misspecifications of a more general model in which the foreign influence on the domestic rate of inflation comes from both expected and unexpected foreign price shocks but with different coefficients and lag structures. In line with the well-known Phillips curve analysis, expected inflation should influence domestic price-setting behavior directly and with a unit coefficient. Expected inflation may in turn be a function of expected foreign inflation. Unexpected foreign inflation influences domestic prices either by a direct arbitrage mechanism or by more indirect influences on demands and supplies of traded and non-traded goods. This indirect influence is likely to operate more slowly than the expectations-based one, and hence the coefficient, and the distributed lag, attached to the unexpected part of foreign inflation will be different from the unitary coefficient on the expected part. Thus we can write

$$\Pi_t = E_{t-1}\Pi_t + \Phi(L)[\Pi_t^* - E_{t-1}\Pi_t^*] + f(Z_t) \qquad (2)$$

where $\Phi(L)$ is a polynomial in the lag operator L which in turn is defined by $Lx_t = x_{t-1}$

In order to illustrate how the implications of equation (2) differ from those of a model in which foreign disturbances affect domestic inflation only via actual values of Π^*, consider the following two examples. In both cases assume that foreign inflation increases from 5 percent to 10 percent per annum, but that in case one the increase was expected to occur, whereas in case two it was totally unexpected. In the model where only actual values of the foreign inflation rate mattered, there would be no difference between the two cases. In the model summarized by (2), however, case one would inply an immediate increase in domestic inflation from 5 percent to 10 percent, whereas case two would imply a slower upward adjustment in the inflation rate. Econometric and policy analyses which do not take into account the distinction between expected and unexpected foreign price shocks will treat the two situations as equivalent and lead to erroneous coefficient estimates and conclusions.

Overshooting

In his simulations of the effects of unexpected export-price shocks on the Swedish consumer price index, Eliasson (op. cit.) found that the adjustment path involved oscillations of the CPI around its new equilibrium path. He thus observed periods when the domestic price level overshot the long run equilibrium level implied by the price increase of exports. Such overshooting may have undesirable consequences for resource allocation as a result of shifts in profitability between different domestic industrial sectors. Hence it is of interest to find out if it is an empirically verifiable feature of the Swedish economy.

Two different kinds of overshooting in response to a foreign price shock should be distinguished: overshooting of the price level and overshooting of the inflation rate. Suppose that in full equilibrium the relative price of imports to domestic goods will return to its initial level.[4] Then, as a matter of simple arithmetic, it follows that the domestic rate of inflation must necessarily overshoot the foreign rate (except in a very special case mentioned below), whereas the domestic price level need not do so.

Consider Figure 1. It depicts a once-and-for-all change in the price of imports. In panel A two possible paths of the domestic price level are shown. Both converge on the new price of imports, as they must if the relative price is to return to the initial level. The dotted path represents a monotonic convergence and the dashed path an oscillatory one involving overshooting. In panel B the rates of change of prices are shown for the same price shock. Unless Π reacts fully and immediately to Π^*, there must be some period of time during which Π is higher than Π^* during the adjustment process.

Figure 2 shows the adjustment path to a once-and-for-all increase in the foreign rate of inflation. Again, panel A indicates that the domestic price level may or may not overshoot, and panel B shows that the inflation rate necessarily does. To repeat, this overshooting of the inflation rate follows automatically from the assumption that relative prices will ultimately return to their initial level and that the domestic price adjustment is not instantaneous.

Asymmetric adjustments

The proposition that the adjustment process to price shocks is different for price increases than for price decreases and for large as opposed to small price changes has often been stated. As applied to price increases versus price decreases the argument is usually that many prices and wages

Figure 1 Domestic price transmission paths from once-and-for-all change in import price

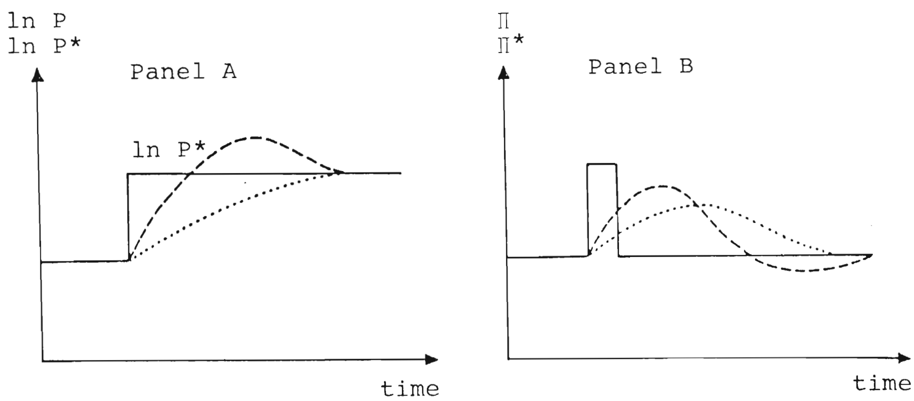
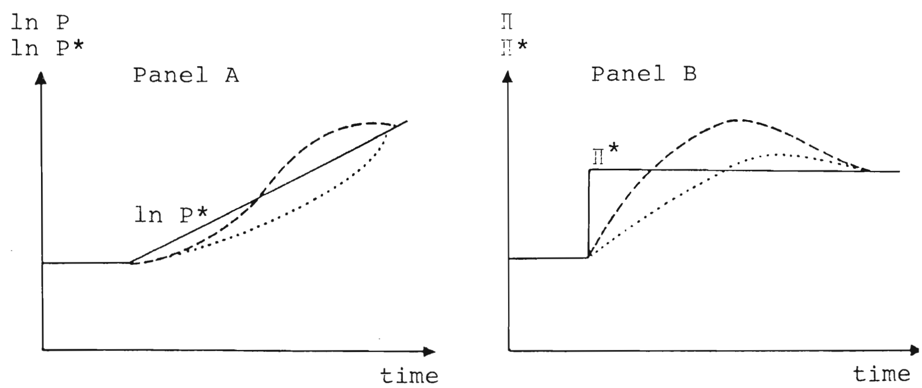


Figure 2 Domestic price transmission from once-and-for-all increase in the rate of change of foreign prices



are sticky in the downward direction and that one should therefore expect a longer adjustment path for a negative price shock than for a positive one.

A theoretical argument for a differential effect of large versus small price shocks can be built on the idea that there are costs attached to altering prices, and that these costs increase with the speed with which the adjustment is carried out. The adjustment costs may be associated with changing price lists and informing retailers about these changes. They can also be due to loss of goodwill among customers if changes of prices take place too frequently.

Facing such costs, the rational firm which has some short-run power to set its price, will weigh the present value of the benefits from changing the price with the present value of the adjustment costs. If the former is greater the firm will decide to adjust its price. If the adjustment cost is fixed and independent of the size of the change and of the speed with which the change occurs, then the above argument implies that the firm will either adjust or not, but if it has decided to adjust it will do so immediately. Since the present value of the benefits of adjusting depends positively on the size of the foreign price shock, the larger the shock, the more likely it is that firms will adjust, but there is no reason to believe that they will do so slowly. In order to establish this kind of behavior it is necessary to assume that the cost to the firm of changing its price depends on the speed at which it does so. In that case, it will follow that a larger foreign price shock will lead to quicker adjustment than a smaller one.

III PRELIMINARY EMPIRICAL ANALYSIS

In a preliminary attempt to estimate the parameters in equation (2), some simplifying assumptions had to be made concerning the influence of policy variables, the formation of expectations, and the lag structure implicit in the ϕ (L) function. As a first step the policy variables denoted by Z in (2) were left out completely. Expectations concerning the rate of increase in foreign prices were assumed to be formed according to the adaptive, error-learning, process defined by

$$E_{t-1}\Pi_t^* = \frac{\alpha}{1-(1-\alpha)L}\Pi_{t-1}^* \qquad (3)$$

The expected rate of domestic inflation was assumed to be made up of two components, the first an adaptive process similar to that in (3), and the second a distributed-lag function of the relative price of domestic to foreign goods. The latter variable was included with the idea that an increase in the relative price of domestic goods would lead economic agents to expect the domestic rate of inflation to slow down somewhat because of shifts in demand away from domestic goods. The two components of the expected rate of inflation are combined in (4)

$$E_{t-1}\Pi_t = \frac{\alpha}{1-(1-\alpha)L}\Pi_{t-1} + \beta\Phi(L)\ RELP_{T-1} \qquad (4)$$

The definition of the relative price variable was

$$RELP_t = \ln p_t - \hat{a}_0 - \hat{a}_1 \ln p_t^* - \hat{a}_2 t$$

where the estimates of the a's were obtained by regressing the logarithm of the domestic price level, p, on the logarithm of the foreign price index, p^*, and a time trend[5]. Note also that the error learning coefficient α is assumed to be the same in (3) and (4), and that the distributed lag function on the relative price variable is the same as that on unexpected foreign inflation in (2) up to a multiplicative constant β. From the argument given above concerning the effect of relative prices, β should be negative. Combining (2), (3) and (4) and defining

$Y_t = \Pi_t - \Pi_{t-1}$ and $x_t = \Pi_t^* - \Pi_{t-1}^*$ yields

$$Y_t = \Phi(L)x_t + \beta[1-(1-\alpha)L]\ \Phi(L)RFLP_{t-1} \tag{5}$$

Attempts were made to estimate the lag function in equation (5) both without restrictions and with the Almon-lag technique. The former failed in the sense that the coefficients on the individual lagged variables were very poorly determined, probably because of the relatively large number of parameters involved compared to the number of observations. The Almon-lag procedure, which did produce coefficient estimates of "correct" sign and plausible value, was abandoned because it proved cumbersome when it came to testing for the presence of asymmetries in the adjustment process. The lag pattern finally settled on assumed that the lag distribution took the form

$$\Phi(L) = \frac{1 - b_1 - b_2}{1 - b_1 L - b_2 L^2} \tag{6}$$

It can be shown that this formulation is equivalent to the infinite series

$$\Phi(L) = (1-b_1-b_2) \sum_{i=0}^{\infty} d_i L^i$$

where

$$d_o = 1$$
$$d_1 = b_1$$
$$d_{i-1} = b_1 \; d_{i-1} + b_2 \; d_{i-2} \qquad \text{for } i \geq 2.$$

The function defined by (6) allows for a flexible lag structure, and is still relatively simple to estimate since it involves only two parameters. Note also that (6) implies that the sum of the lag coefficients is equal to unity, ensuring full transmission of foreign inflation in the long run.

Combining (5) and (6) gives

$$y_t = b_1 y_{t-1} + b_2 y_{t-2} + (1-b_1-b_2) x_t$$

$$+ \beta(1-b_1-b_2) \lfloor 1-(1-\alpha)L \rfloor \; RFLP_{t-1}$$

which in turn can be rearranged to read

$$y_t - x_t = b_1(y_{t-1}-x_t) + b_2(y_{t-2}-x_2) - c_1 RFLP_{t-1} +$$

$$+ c_1(1-\alpha) RFLP_{t-2} \qquad (7)$$

where $c_1 = -\beta(1-b_1-b_2)$.

Equation (7) is the form which was confronted with the data[6]. The results for the whole sample period 1951-1979 and three subperiods are presented in Table 1.

Table 1 Estimation results

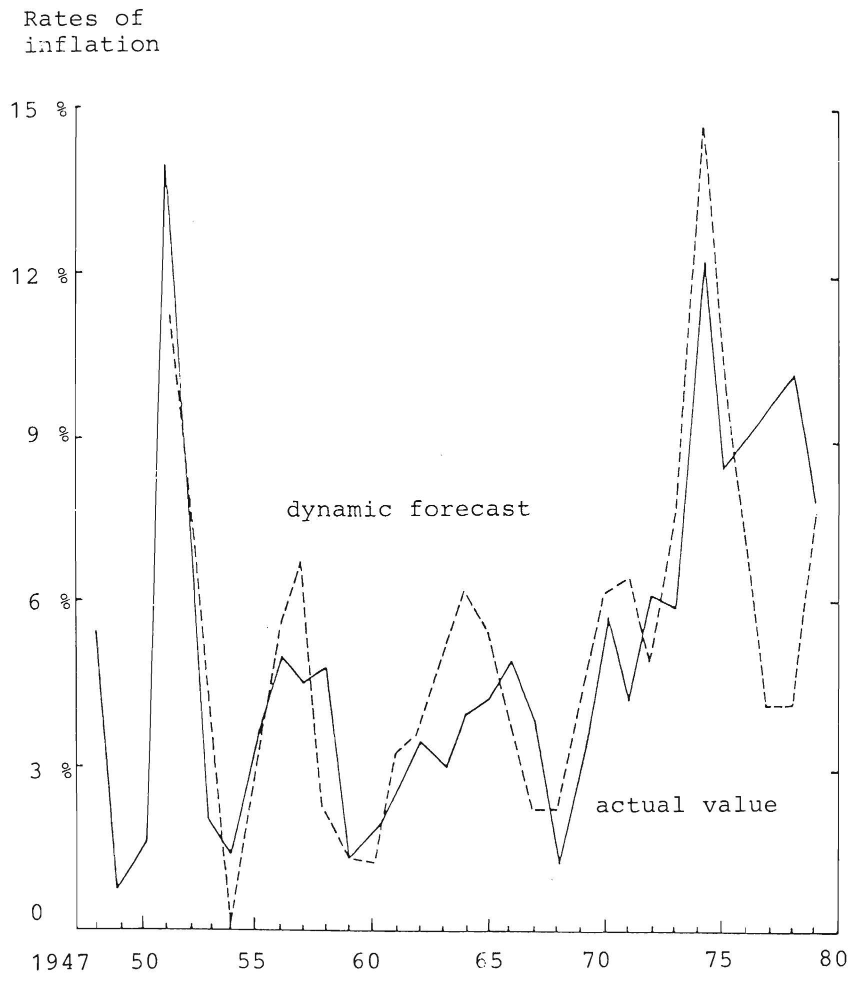
$$y_t - x_t = b_0 + b_1(y_{t-1}-x_t) + b_2(y_{t-2}-x_2) +$$

$$+ b_3 \; RELP_{t-1} + b_4 \; RELP_{t-2}$$

Sample period	b_0	b_1	b_2	b_3	b_4	R^2	D·W
1951-1979	.0018 (.45)	.3078 (3.96)	.3530 (4.06)	-1.0260 (-6.58)	.9135 (5.34)	.94	1.81
1951-1965	.0062 (1.09)	.2681 (2.98)	.3270 (3.26)	-1.2134 (-6.02)	.8955 (3.89)	.95	2.25
1956-1972	-.0025 (-.58)	.3636 (2.71)	.4821 (3.04)	-.9092 (-3.91)	.9659 (4.26)	.92	2.49
1966-1979	-.0026 (-.35)	.3037 (1.99)	.4329 (2.44)	-.7090 (-2.70)	.5670 (1.78)	.94	2.23

The first thing to notice in this table is that all coefficients[7] have the expected signs and are highly significant, especially for the full sample period. b_1 and b_2 both lie in the interval zero to one, which the theory predicted; b_3 is negative and b_4 positive as the discussion around the effect of the relative price term implied. The estimate of the error-learning parameter α in the adaptive expectations formulae also has a plausible value. From (7) it can be seen that $\alpha = 1 + b_4 / b_3$ which, given the parameter estimates of the first row of Table 1, implies $\hat{\alpha} = .11$. The goodness of fit of the equation is satisfactory and, again for the full sample in particular, there is no sign of any serial correlation in the residuals. In order to check the ability of the model to track the domestic rate of inflation Π, the estimates in the first row of the table were used to calculate a predicted inflation rate. The correlation coefficient between that predicted rate and the actual inflation rate was .86. Figure 3 presents another measure of the model's ability to track the actual inflation rate during the sample period. The dashed line represents the model's dynamic ex post forecast of the rate of inflation. That is the forecast based on the actual movement of the import price index during the whole sample and the actual value of the consumer price index for the period 1947 to 1950. From 1951 onwards, the model uses its own forecasts of Π_t when it calculates Π_{t-i}. Hence it represents a better test of the dynamic structure of the model than the correlation coefficient between the actual and fitted values of the regression itself. As can be seen from the figure, the model again does quite well in tracking the actual inflation rate (solid

Figure 3 Actual values and dynamic forecasts of the domestic rate of inflation



line)[8]. The only notable exception is 1977 and 1978, when the model significantly underpredicts.

Returning to the results in table 1, it appears that the coefficients of the independent variables vary with the sample period. Several explanations seem plausible. One possibility is that the simple expectations schemes underlying the formulation of the estimated equations are inadequate, and that more sophisticated mechanisms are necessary. This will be emphasized again in the last section of the paper. Another possibility is that the size of the price shock influences the speed of adjustment. In fact, the splits of the sample were determined by the criterion that the first and third subperiods would be ones with relatively large foreign price shocks, and the middle subperiod one with relatively small ones. Without pretending that the periods actually chosen are free of objection, it appears from these results that larger price shocks result in more rapid adjustment as measured by the shape of the ϕ (L) function in (2).[9] Using the estimates of b_1 and b_2 to calculate the lag structure according to the formulae just below equation (6), it turned out that the cumulative effect after five years of a unit disturbance was .82 for the first subperiod, .45 for the second, and .65 for the third. These estimates as far as they go, thus support the theoretical argument presented above.

To test for the influence of the size of the price shock more formally, the following modification to equation (7) was introduced. It was hypothesized that the coefficients b_1 and b_2 were funcions of both the size and sign of the foreign price shock.[10] Based on a need to limit the number of coefficients to be estimated and on some preliminary tests, the functions defining b_1 and b_2 were chosen so that the sum of b_1 and b_2 was unaffected by the size or sign of the shock. The specific functional form was

$$\left.\begin{aligned} b_1 &= b_1^0 + b_1^1 \left|\Pi_t^*\right| + b_1^2 D_t \\ b_2 &= b_2^0 - b_1^1 \left|\Pi_t^*\right| - b_1^2 D_t \end{aligned}\right\} \qquad (8)$$

where $\left|\Pi_t^*\right|$ indicates the absolute value of Π_t^* and where

$$D_t = \begin{cases} 1 \text{ if } \Pi_t^* < 0 \\ 0 \text{ if } \Pi_t^* \geq 0 \end{cases}$$

With these modifications the equation which was fitted to the data took the form

$$\begin{aligned} y_t - x_t &= b_0 + b_1^0 (y_{t-1}-x_t) + b_2^0 (y_{t-2}-x_t) + \\ &+ b_1^1 (y_{t-1}-y_{t-2}) \left|\Pi_t^*\right| + b_1^2 (y_{t-1}-y_{t-2}) D_t - \\ &- c_1 \, RELP_{t-1} + c_1 (1-\alpha) \, RELP_{t-2} \end{aligned} \qquad (9)$$

where, as before, $c_1 = -\beta(1-b_1-b_2)$. According to the theory that the price adjustment is faster for large compared to small and for positive compared to negative price shocks, the estimate of b_1^1 should be positive and that of b_1^2 negative. The result of ordinary least squares estimation for the full sample period was

$$y_t - x_t = \underset{(.45)}{.0018} + \underset{(1.14)}{.1811}\,(y_{t-1}-x_t) +$$

$$+ \underset{(2.91)}{.5073}\,(y_{t-2}-x_t) + \underset{(1.77)}{2.60}\,(y_{t-1}-y_{t-2})\,|\Pi^*_t| -$$

$$- \underset{(1.02)}{.1478}\,(y_{t-1}-y_{t-2})\,D_t - \underset{(-5.93)}{.9379}\,RELP_{t-1} +$$

$$+ \underset{(4.86)}{.8334}\,RELP_{t-2}$$

R^2 = .95, D-W = 2.07, (t-values in parentheses).

As before, all the coefficients have the expected sign, but this time the significance level of some of them is rather low, especially for the coefficient of the variable capturing the effects of the sign of the price shock. The size coefficient is significant at the 90 percent level, however, lending some support to the idea of an asymmetric adjustment process.

Taking the above point estimates at face value, Figures 4 and 5 illustrate the differences that the size of the price shock makes for the adjustment path. Figure 4 shows the cumulated weights of the $\Phi(L)$ function calculated as before, whereas Figure 5 also takes into account the feedback through the relative price variable. Figure 5 thus shows the complete adjustment path following a price shock in period 5.[11] A number of observations are prompted by these figures. Beginning with the weights in the $\Phi(L)$ function (Fig. 4), it is clear that the distribution associated with the larger price shock (the solid line) indicates a faster response than the one associated with the smaller price shock.[12] Again, this is what the theory in section II suggested. Second, it is noteworthy that the lag distributions in Fig. 3

show a smooth convergence towards the long run value of unity, indicating that any overshooting in the adjustment process must be due to feedbacks through changes in relative prices. This is confirmed in Figure 5, which captures the full adjustment process including this feedback. Here, a marked tendency for domestic prices to increase above the long run equilibrium is shown. What seems to be happening is that the initial shock increases the relative price of imports, which in turn sets up forces that drive the domestic price level above its long run value - even though the adjustment path indicated by $\Phi(L)$ is monotonic.

Concerning the difference between the adjustment process for large and small shocks, Figure 5 confirms the conclusion from Figure 4 that adjustment is faster the larger the price shock. Put another feature is also evident. The larger price shock also leads to wider (less damped) oscillations around the long run value.

Figure 4 Cumulative weights in the (L) function

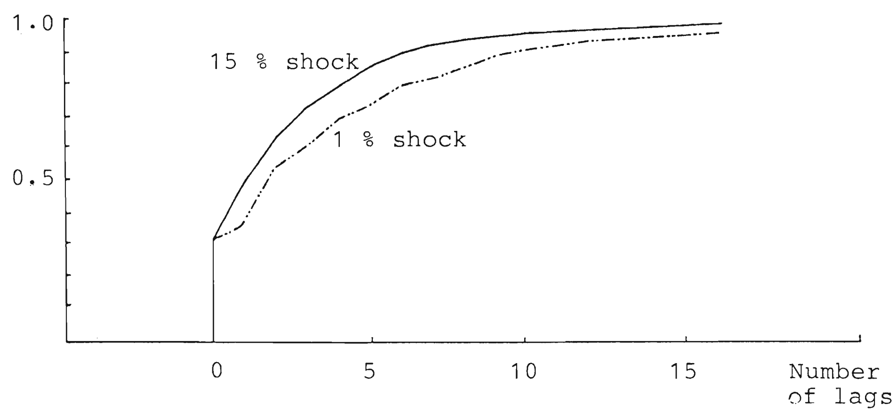
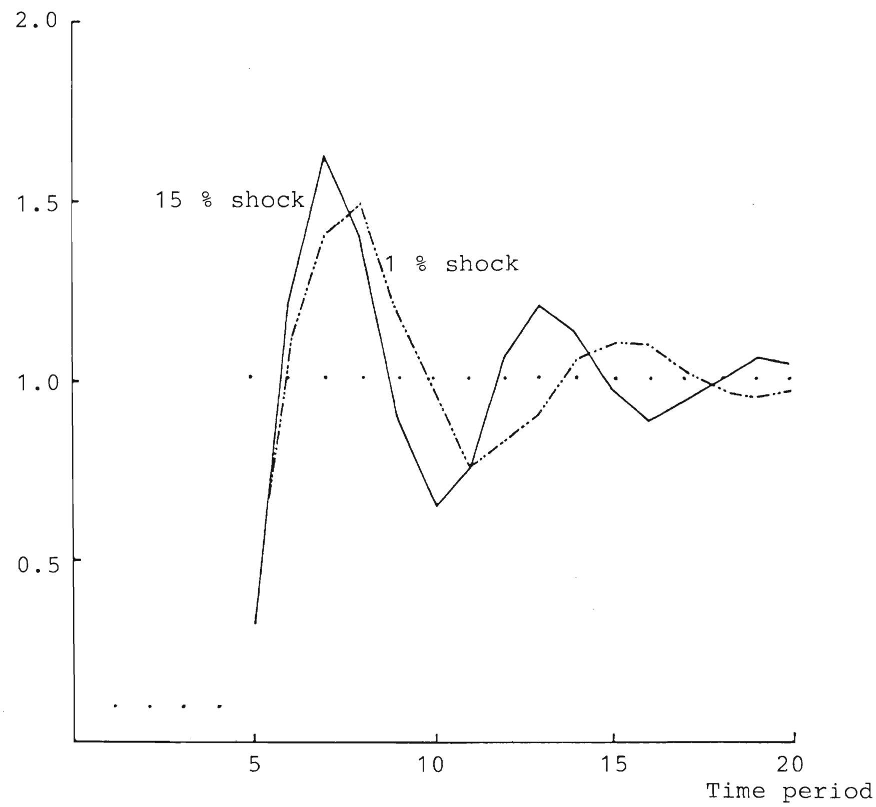


Figure 5 Normalized adjustment paths of the domestic price level to a foreign price shock in period 5



This suggests that even though agents react faster to a larger shock, their reactions to changes in relative prices lead to relatively larger fluctuations in the domestic price level.[13] This conclusion is intuitively appealing. Larger shocks create more noise in the system which should lead to larger swings in relative prices.

Finally, comparing the adjustment patterns in Figure 5 with those obtained by Eliasson shows that the overshooting property of his simulation model does seem to exist also in actual post-war data on import and consumer prices in Sweden. The oscillations are very much larger (I would argue that they are too large) in Eliasson's model than in the present one. Furthermore, the effect of the size of the disturbance is the opposite there than here. A possible reason for this might be that Eliasson uses export prices as a measure of the foreign price variable instead of import prices used in this study. This remains a conjecture, however, and should be investigated further both theoretically and empirically.

In summary, it appears from the present study that the transmission of price changes from import prices to domestic prices in Sweden's post-war experience has involved both overshooting and asymmetric response to large vs. small foreign price shocks. The asymmetry hypothesis applied to the sign of the price shock was rejected on standard statistical confidence grounds.

Extensions

At a theoretical level an important extension of the present paper would be to consider alternative hypotheses concerning the formation of expectations. Of particular interest might be the rational expectations hypothesis which would undoubtedly imply that, in forming expectations about next year's rate of inflation, agents look not only at current and past domestic policy and rates of inflation but also at the current and past rates of foreign inflation.

Another challenge for theory would be to work out in more detail a rationale for the empirical finding (if it stands up to further scrutiny) that the size and, to some limited extent, the sign of the foreign price shock alters the transmission process.

At an empirical level the most obvious shortcomings of the present paper are, on the one hand, the exclusion of domestic policy variables from the regression and, on the other hand, the fact that the relevance of the distinction between expected and unexpected price shocks has not been determined empirically. This remains to be done in future work.

NOTES

1 See Gunnar Eliasson "How Does Inflation Affect Growth? - Experiments on the Swedish Micro-to-Macro Model", in Micro-Simulation Models, Methods and Applications (B. Bergmann, G. Eliasson, G. Orcutt, eds.), Stockholm: The Industrial Institute for Economic and Social Research, 1980.

2 See, for instance, Calmfors, Lars, 1977, Swedish inflation and international price influences, in: L. Krause and W. Salant, eds., Worldwide inflation: Theory and recent experience (The Brookings Institution, Washington, D.C.).

3 See Laidler, David, 1976, Inflation - Alternative explanations and policies: Tests on data drawn from six countries. in: Karl Brunner and Allan Meltzer, eds., Institutions policies and economic performance, Carnegie-Rochester Conference Series on Public Policy, Vol. 4 (North-Holland, Amsterdam) 251-306.

4 This is indeed what one should expect to happen in the case where the foreign price shock is the result of pure foreign inflation and not of a real change such as a change in the terms of trade.

5 The sample period was 1947 to 1979, p was the Swedish consumer price index adjusted for indirect tax changes, and p* was the import price index. The result of the regression was

$$\underset{}{\ln p_t} = \underset{(24.6)}{2.54} + \underset{(14.6)}{0.423} \ln p_t^* + \underset{(28.10)}{0.30t}$$

$R^2 = .19$, D-W = .33, (t-values in parenthesis).

6 The raw data were observations on the Swedish consumer price index adjusted for indirect tax changes and on the Swedish import price index for the period 1947-1979. Data sources: The Swedish Economy, Stockholm; Konjunkturinstitutet, various issues.

7 The exception is the constant b_0, for which there were no strong prior expectations concerning sign and size any way.

8 The correlation coefficient between the actual and predicted series is .81.

[9] This is not an entirely unobjective measure since the relative price variable will be affected by differences in the speeds of adjustment and will in turn influence the overall adjustment process.

[10] Two measures of the price shock were tried, Π^*_t and $(\Pi^*_t - \Pi^*_{t-1})$. The former gave uniformly more satisfactory statistical results.

[11] The paths are normalized on the size of the foreign price shock.

[12] The weights are calculated for a price shock of 15 percent and 1 percent respectively.

[13] Note the word "relatively". What is being described is not the absolute variation around the long-run value since the figures have been normalized to a unit shock.

PART III

SIMULATION STUDIES

OIL PRICES AND ECONOMIC STABILITY*

The Macroeconomic Impact of Oil Price Shocks on the Swedish Economy

by Bengt-Christer Ysander

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* Reprinted from Energy, 1982, Pergamon Press, Ltd.

ABSTRACT

In simulation experiments for the Swedish economy, the impact of a future oil-price shock was measured in terms of the required stabilization policies, and the possibility of insuring against such price shocks by way of a gradually increasing oil tax was evaluated.

INTRODUCTION

The small, open Swedish economy depends on imported oil for roughly 2/3 of its use of primary energy. It is, thus, particularly vulnerable to sharp increases in the price of oil. A major concern in current Swedish energy policy is the adjustment and stabilization problems that a future oil price hike would create. This paper reports on a simulation study of these problems and of the possibility of easing them by the use of oil taxes. The emphasis is on the methodological approach which is exemplified by some numerical results.[1]

THE PROBLEMS POSED

In a policy-oriented study, the choice of a suitable measure of the macroeconomic impact of a large future oil-price hike depends on the focal problem or dominant threat posed by increased oil-prices. If the main worry is the unavoidable long-term welfare losses resulting from unfavorable terms-of-trade development, one may want to measure these losses, e.g., in terms of equivalent variations around a reference consumption path, assuming that the Swedish adjustment policies are efficiently planned and executed.[2] It may be, however, that the major perceived threat is not so much the new high level of oil prices as the abrupt and unexpected way it rises. The general experience of the two price hikes of the 70s seems to point that way.[3] In particular, many of Sweden's present difficulties, manifested by a mounting deficit both in public budgets and in external exchange and by a shrinking and underutilized export industry, can be viewed as arising from a failure to cope with the stabilization problems caused by the oil price hikes (cf. Eliasson and Ysander, 1981). If the paramount concern is to reduce the risk of again losing control of the stabilization problems and having the economy degenerate into stagflation, then the relevant impact measure should, instead, use as a benchmark the policy adjustments required to restore balance in the economy.

We have chosen to gauge the impact, primarily in terms of the adjustments in wages and in private and/or public consumption, required to restore balance both in external exchange and in the labor market within 3 years. The task of minimizing some social loss function for stabilization policies, of the kind surveyed in e.g. Gramlich, 1979, is here avoided since targets are specified in advance and the successive solutions turn out to be unique or nearly unique within the respective policy space assumed. Instead, we concentrate on trying to register how the necessary adjustments will appear to the households and voters, thus measuring the political strains involved in coping with the stabilization task, and the corresponding risk of not coping. This criterion is then applied to the following three types of question.

How big can the impact or the policy adjustments required be and how does it vary with the kind of policies actually pursued in Sweden and abroad? How does the impact of a sudden price hike compare with that of a correspondingly large but gradual oil-price increase? How much of the impact on the Swedish economy can be directly attributed to the increased oil bill and how much is caused indirectly by repercussions on other world markets? To what extent do various possible restrictions on domestic policies, i.e., limited flexibility in fiscal and budgetary policy, affect and exacerbate the problems? One might think of the alternatives as a kind of ladder of political feasibility. On top is the first-best solution, where all countries, including Sweden, adjust smoothly and swiftly, leaving the world markets largely unperturbed. At the bottom of the ladder is a situation where the Swedish government is not only faced with world market repercussions, but also has its hands tied by political commitments to various groups of consumers and wage earners.

The second type of question is concerned with the costs and benefits of an oil tax buffer, i.e., of anticipating an eventual future oil price hike by a gradually increasing oil tax. The third type of question, finally, deals with the effects of possible increases and of the policies of adjustment or insurance they call forth on the use of oil and other kinds of primary energy.

THE EXPERIMENTAL SET-UP

The model we have used in the simulations is a 23-sector growth model for the Swedish economy, designed for medium- and long-term policy analyses. Besides import and export functions, it incorporates various mechanisms for dynamic adjustment, such as a vintage approach to capital formation in industry, a Phillips curve-like determination of wages, domestic price-setting depending on cost and capacity utilization and on world-market prices, and a sub-model for local government taxing and spending behavior. The model was also particularly tailored to allow for both long-run and short-run energy substitution.[4]

Our choice of instruments for controlling the model economy has been guided by priorities and practice in current Swedish policy. We employ three main policy instruments: wage policy, income tax and public consumption. Wage policy means controlling the long-term growth trend of nominal wages. The income tax can be looked upon as a representative of a wide variety of tax and transfer measures. Finally, we assume full control both of central and local government expenditures. We have not included an active exchange policy among our policy instruments since it appears in the model to be a substitute rather than a complement to wage policy.

The 9 base-case simulations are listed in Table 1. Around these base-case simulations, various kinds of sensitivity analyses have been carried out.

As a measuring rod for our simulations, we have used a reference case, i.e., a standard scenario for the development of the Swedish economy in the '80s and 90s. A detailed discussion of this case and of alternative conditions and strategies for Sweden is given in Nordström-Ysander, 1980. In the reference case, the present imbalances in the Swedish economy have been eliminated by 1990, in accordance with current government policy objectives. The price of oil is assumed to increase annually by 1.5 percent relative to the price of finished goods in international trade. The coal price is assumed to adjust proportionately, although with a certain lag, to changes in the oil price.

Below the reference case and the case of a gradual oil price increase in the left-hand column of Table 1, different variations of the oil crisis scenario are listed in order of increasing adjustment problems. The oil crisis itself is modeled as a 60 percent rise in the relative oil price, occurring early in 1991. In the gradual price increase scenario (GO), the same total relative price increase is reached in 1991 by a steady rise throughout the eighties. In the first oil crisis simulation (OI), the oil price hike occurs without interrupting world trade. In the second (OS), various cyclical repercussions on other world markets are taken into account. Based on the experience of the 70s and on some experiments carried out for this purpose on the LINK model,[5] the resulting world trade cycle is modeled as a 3-year pattern led by a short-lived speculative boom in raw material and investment goods, of dominant importance still for Swedish exports, followed by a general trade slump. Over the first 4 years of the 90s the annual increase in the volume and price of world trade (excepting services) will be, on the average, multiplied by a factor of 0.6 and 1.2 respectively, compared to the reference development. To facilitate comparisons, we let, in both cases, public consumption develop as

Table 1 Nine simulations 1980-2000.

		No oil tax	Oil tax
No oil price hike		REF - The reference case	TREF - Oil tax without oil price hike
		GO - Gradual oil price increase	
Oil price hike	Increasing economic and political adjustment costs	OI - Oil price hike without world market repercussions	
		OS - Oil price hike with world market repercussions but without policy restrictions	TOS - Oil tax with oil price hike
		MW - Minus wage policy	
		MP - Minus also public consumption policy	
		MR - Minus also the possibility of lowering real wages	

in the reference case, registering the shrinking room for increased consumption in terms of private consumption.

The 3 variations MW, MP, and MR in Table 1 simulate the effect of successively taking into account restrictions on the use of economic policy instruments which, judging from the experience of the 70s, may well be perceived as binding by Swedish decision-makers. In MW, we take away the wage policy instrument, making it impossible to influence the long-term trends in nominal wage increase. This must then be compensated for by a more active use of the control of public consumption. In MP, this policy instrument is also blocked, public consumption again being prescribed to follow the reference pattern. Finally, in MR, the need for trade union support is supposed to force the government to guarantee no decline in real wages, thus increasing the unemployment needed to ensure external balance.

Two additional cases, in which an oil tax is used as a buffer against the possibility of an oil-price hike are listed in the right-hand column of Table 1. The oil tax we study has a very simple construction. It is successively stepped up during the 80s, annually adding an extra oil price increase of around 5 percent, so that by the beginning of 1991 it has raised the domestic oil price as much as the assumed size of an eventual oil price hike.

If the oil crisis materializes, the TOS-case, the tax is used as a buffer, the lifting of the tax neutralizing the raised import price. We then measure the benefits by comparing the resulting development during the 90s with the uninsured case, OS, assuming the same access to policy instruments. If the oil crisis does not come (the TREF-case), the oil tax remains and causes some retardation in growth during the following decade. The cost of the tax insurance is evaluated by comparison with the outcome in the reference case which, apart from the tax, rests on identical assumptions.

THE IMPACT OF AN OIL-PRICE SHOCK

The difference between alternative impact measures can be shown by comparing the effects of a gradual price rise (GO) with that of an oil price hike, which does not affect world markets (OI). To reach the goal of balanced external payments in 1990, in spite of a continuous deterioration of terms-of-trade in the gradual price rise case, means that private standards must increase slower while export sales are further boosted. Rising energy bills will be compounded with a sharper rise in income tax for the households but will be offset for industry by more moderate wage developments. Compared to the reference case, private consumption will be down ~7 percent by the beginning of the 90s, while the set-back in GNP during the 80s will be negligible but will increase somewhat in the 90s, when the export-drive is allowed to slacken while structural effects on industrial productivity successively matures. In terms of intertemporal consumption standards, the drawn-out sacrifice needed for a gradual adjustment in the 80s are undoubtedly greater than the sharp but short set-back experienced during a policy-contained oil price hike in the 90s. If, however, we measure instead the impact in terms of the political strains imposed by the necessary adjustments, we get a quite different picture.

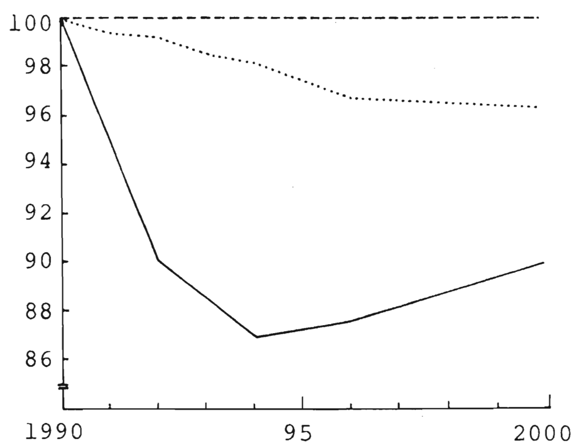
The adjustments in wage and tax policy needed to accommodate the gradual price rise are rather marginal. On the other hand, the policy adjustments required to restore balance in 3 years after an oil-price shock turn out to be quite drastic. This is true even when no account is taken of possible world market repercussions, the OI-case. The high oil price must be compensated for by holding back private consumption, budget policy will have to be so tight-fisted that the level of 1990 is regained only by 1994. That parsimonious regime will be reflected in a temporary increase in unemployment. The rate of nominal wage increase drops from almost 10 percent in 1990 to about 3 percent in 1991 while the rate of inflation goes up from 6 to 9 percent, implying an almost 6 percent cut in real wages instead of the 3-4 percent increase of the preceding years. Balance in the external payments is reached in 1993, but continuing concern for the external payment situation will make it impossible to recover more than a small part of the relative losses in consumption before the turn of the century.

Figure 1 shows how stabilization problems are exacerbated in the more realistic case (OS), where world market repercussions are also taken into account. To regain balance in external accounts in spite of stagnating tendencies in world trade will require even more herculean efforts in stabilization policy. There will have to be a wage freeze in 1991, and wage earners must accept an 8 percent cut in real wages that year and expect another 1 percent cut in the following year. The relative reduction in private consumption and GNP levels over the decade will be more gradual but altogether about one third larger than before. The direct effects of the primary oil price shock still dominate the picture but the simulation results show that the various problems and policy strains during the adjustment period have all grown by something like one third through the indirect effects transmitted by the world market.

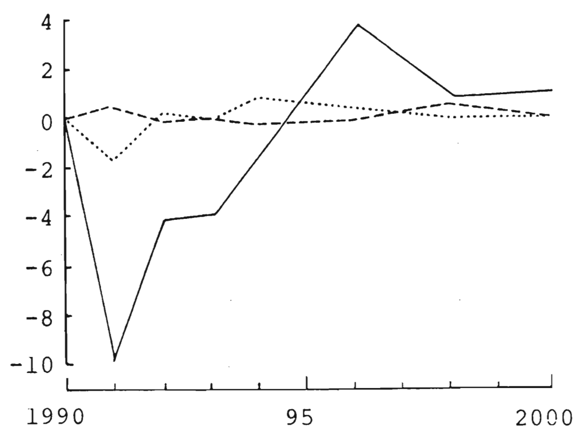
Our situation after an oil price hike becomes even worse if we climb further down the feasibility ladder introducing, successively, various restrictions limiting the policy space.

Without access to wage policy, i.e., without being able to influence long-term trends in nominal wages, the government will have to use public expenditures as a substitute instrument. If we cannot rapidly improve our competitive position, the only way to eliminate the external deficit within a few years is to save imports by substituting public for private consumption on a large scale. We can see what this means by comparing this restricted case (MW) with the case (OS), where no constraints were placed on

Figure 1 Oil-price hike with world market repercussions (OS).



—— private consumption
---- public consumption
.... GNP
REF = 100



—— change (in percent) of the nominal wage increase
---- change (in percent) of unemployment
.... change (in percent) of the external deficit/GNP
REF = 0

the policy instruments. Instead of just freezing private consumption for a couple of years, taxation must now force it down almost 10 percent below the 1990 level while, at the same time, encouraging an extremely rapid increase of public consumption at the rate of around 7 percent annually. Moreover, this policy would have to be completely reversed from 1994 onwards if we want to let private consumption regain its previous share of total consumption. A concomitant effect would be a very high rate of wage inflation in the first years after the price shock.

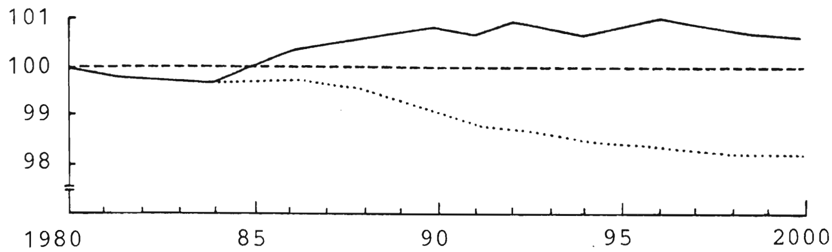
If public consumption cannot be treated in this cavalier fashion but must be left to develop according to its preset pattern in the reference case, we are left with taxation as our only available stabilization tool, the MP-case. External balance in 1993 can then only be reached at the price of an almost doubled unemployment rate in 1992-93. The further decline of private consumption in the MW-case can now be avoided -- which also means that, despite increased unemployment, GNP-development will be slightly more favorable.

If, on top of all this, we add the restriction that real wages should not be allowed to fall, we will end up with unemployment rates for 1991-93 that are as much as 3 times as high as the normal values that could be attained when there were no restrictions on stabilization policy. The fluctuations in wage increase and in inflation will, at the same time, be much larger. What these simulations illustrate is simply the fact that political limits on feasible policies or flexibility can make a difficult stabilization problem unmanageable or impossible.

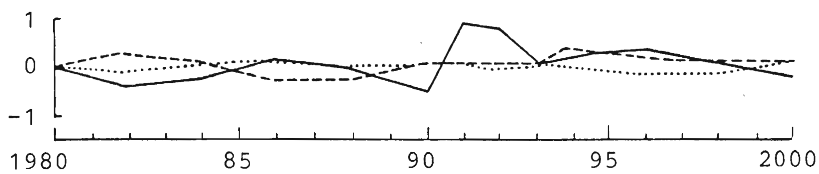
THE USE OF AN OIL TAX AS INSURANCE

The effects of introducing a gradually increased oil tax during the 80s without any oil crisis occurring are shown in Figure 2. The increased energy costs reinforce the industrial problems, increasing unemployment and shrinking the available room for private consumption increases compared to the reference case. Due to

Figure 2 **Oil tax without oil price hike (TREF).**

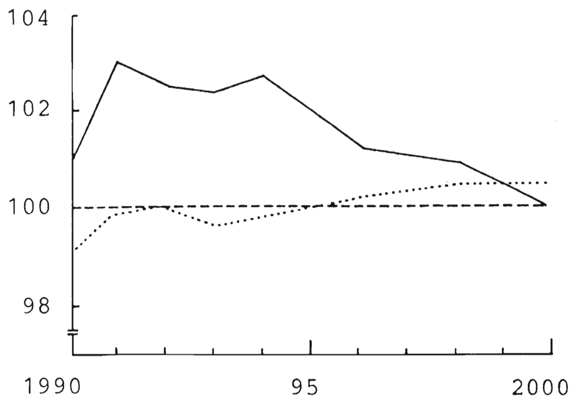


—— private consumption
---- public consumption
········ GNP
REF = 100

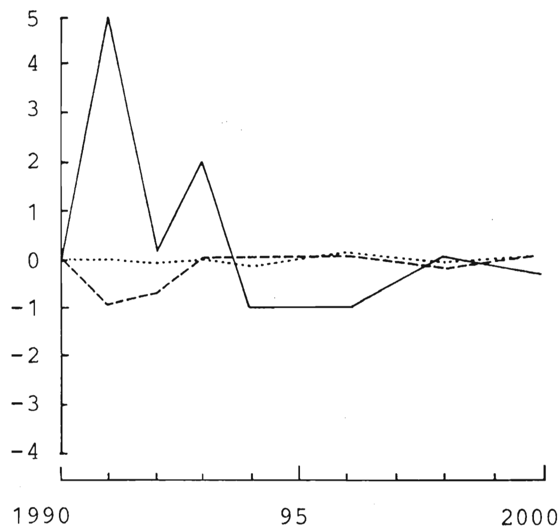


—— change (in percent) of the nominal wage increase
---- change (in percent) of unemployment
········ change (in percent) of the external deficit/GNP
REF = 0

Figure 3 Oil tax with oil-price hike (TOS).



—— private consumption
---- public consumption
······· GNP
OS = 100



—— change (in percent) of the nominal wage increase
---- change (in percent) of unemployment
······· change (in percent) of the external deficit/GNP
OS = 0

Figure 4 The use of oil and other primary energy.

the low estimated price elasticities in Swedish foreign trade, however, oil substitution turns out to make it easier to handle our balance of payment problem, even enabling us to raise our private consumption standards temporarily in the 90s a bit further than what would otherwise have been possible. We will nevertheless pay a price in the form of reduced growth in GNP and in investments, finishing the century with a somewhat smaller and less modern industrial capacity.

If the insurance costs do not seem very impressive, the benefits, in terms of reduced stabilization problems, if an oil crisis occurs, may be quite dramatic, as shown by Figure 3. Instead of asking wage earners to accept an 8 percent cut in real wages in 1991 with more sacrifices to follow, it is now enough to have them accept a very slow increase over two years. Domestic inflation rates are reduced in '91 by as much as a third, and GNP, employment and private consumption develop slightly more favorably. All this is due to the forced reductions in oil use and to the slower increase of our dependence on world markets, achieved by the oil tax in the 80s.

THE IMPACT ON ENERGY USE

The development of the use of oil and other forms of primary energy, implied by four different simulations (REF, TREF, OI and OS) is illustrated in Figure 4. We see that the stagnation of primary energy consumption is expected to continue over the 80s, due to gains from conservation, low economic growth and an ongoing shift towards less energy-intensive industrial branches. An oil tax would call forth further savings in the 80s, while an unbuffered oil-price shock would keep energy demand stagnant during the 90s.

For the use of oil, shown by the lower curve, a substantial reduction is foreseen for the 80s. Naturally, changes in the oil-price will have even more dramatic effects here. The expected reduction in oil use in these cases is only marginally due to slow economic growth. Besides energy conservation and structural change, substitution by coal, nuclear power and indigenous fuels such as peat and wood are major contributing factors particularly in the projections with sharply rising oil-prices.

A more detailed account of the projected composition and development of the use of various forms of primary energy in terms of TWh is given in Table 2.

Table 2 The use of primary energy 1980-2000.

	GNP	TWh				TWh/GNP	
	Billions of Sw.cr. 1975 prices	Oil	Coal	Indigenous fuel	Total	Total	Oil
1980	322.0	297	18	40	445	1.38	0.92
1990 REF	396.8	219	43	68	456	1.15	0.55
2000	496.5	258	70	112	545	1.10	0.52
1990 TREF	393.1	162	59	76	425	1.08	0.41
2000	487.8	141	125	138	509	1.04	0.29
1990 OS	396.8	219	43	68	456	1.15	0.55
2000	481.0	175	75	122	476	0.99	0.36
1990 TOS	392.0	152	62	78	419	1.07	0.39
2000	479.0	157	85	129	475	0.99	0.33

NOTES

[1] The study has been conducted by the author and T. Nordström. Some further results are presented in Nordström-Ysander (forthcoming). The study forms part of a larger project dealing with various aspects of energy crises and economic adjustment. A preliminary report on this whole project is given in Ysander, 1981.

[2] The theoretical analysis by Svensson, 1981 and the simulation experiments by J.D. Sachs reported in Bhandari and Putnam, 1982, exemplify studies that focus on intertemporal welfare and balance-of-payment effects.

[3] Comparisons made between the effects of gradual vs. abrupt oil price increases in this and other studies (e.g., Jacobson and Thurman, 1981) also lend support to this interpretation.

[4] A detailed description of the model is given in Jansson, Nordström, and Ysander, 1982. How the impact of an oil-price hike depends on various kinds of inertia in the form of sticky prices and wages has also been studied by i.a. Giavazzi, Odekon, and Wyplosz, 1982.

[5] Cf. Sarma, 1981, whose interpretation and measurement of the impact on the Swedish economy, however, differ from ours.

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AN EXAMINATION OF THE IMPACT OF CHANGES IN THE PRICES OF FUELS AND PRIMARY METALS ON NORDIC COUNTRIES USING A WORLD ECONOMETRIC MODEL

by K.S. Sarma*

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* This study was carried out with the help of Dr. Peter Miovic who was the Director of the World Economic Forecasting Service at Wharton EFA at the time the work was carried out. The IBM affiliation is indicated only for purpose of identification. The views expressed are those of the author. I am grateful to Professor Lawrence R. Klein for his advice and permission to use WEFA's World Econometric Model, to Dr. Gunnar Eliasson for his suggestions in organizing this paper and to Dr. Roger Bird and Mr. William S. Cassels for their comments on the final draft.

I INTRODUCTION

This paper deals with an analysis of the global economic aspects of (a) changes in the prices of fuels and primary metals, and (b) deterioration of inflationary conditions in the United States. The quantitative basis of this study is the world econometric model of the Wharton Econometric Forecasting Associates (WEFA).

This study was carried out during November 78 - April 79. Since then there have been many revisions not only in the data but also in the specification of WEFA's world model itself. As the results shown here do not take account of these revisions they may be somewhat outdated. Nevertheless these results are presented here in the spirit of on-going researach into the effects of shocks on world-wide trade and economic activity.

The WEFA system consists of a set of national econometric models. These models are inter-connected by means of a linking mechanism. In the linking system there are two important channels which capture some of the interdependencies that exist among countries. The first is through flows of goods between different countries; the second through their associated prices. A description of the linkage mechanism is given in section II.

Section III consists of a discussion of how imported fuels influence domestic prices in the countries included in the model.

Section IV gives the details of the alternative scenarios under which the simulations were carried out.

Section V presents the main results of the simulation exercises. Results are for several key economic variables. The countries are aggregated into three major groups:

(1) the world,
(2) the OECD countries, and
(3) NORDIC countries

The Nordic countries include Denmark, Finland, Iceland, Norway and Sweden. In the simulations involving petroleum prices the Nordic group excludes Norway, which is a net exporter of petroleum. In all other simulations the Nordic group includes Norway.

II LINKAGE MECHANISM IN THE WEFA SYSTEM

The basic idea of interdependence on the goods flow side can be expressed by the identity:

$$X_{it} = \sum_{j=0}^{n} a_{ijt} M_{jt} \tag{2.1}$$

In this identity X_{it} stands for the volume of exports by country i to the n countries or regions of the world in any period t, and the M_{jt}'s are the imports of the jth country or region from all its trading partners. The a_{ijt}'s are, therefore, the import market shares:

$$a_{ijt} = \frac{X_{ijt}}{M_{jt}} \tag{2.2}$$

$X_{j}t$ represents exports of ith country to jth country in period t. In simplest terms, equation (2.1), when aggregated across i, is the identity total exports of the world equals total imports. This identity must also hold in value terms:

$$\sum_{i=1}^{n} X_{it}\, PX_{it} = \sum_{j=1}^{n} M_{jt}\, PM_{jt} \tag{2.3}$$

where PX_{it} and PM_{jt} are the export and import prices of countries i and j. Using the above identities, it can be shown that:

$$PM_{jt} = \sum_{i=1}^{n} a_{ijt}\, PX_{it} \tag{2.4}$$

This, in a way, is the dual to equation (2.1), expressing import prices as weighted averages of the jth country's trading partner's export prices. Equations (2.1) and (2.4) use the same import-share coefficient matrix, but in (2.4) it is in its transposed form: the summation in (2.4) is over a column index, and not over a row index as in (2.1).

When applying equation (2.1) to the real world, a serious problem arises in generating a_{ijt}'s in the forecast period. One expects the a_{ij}'s to change in the future, but it is difficult to know in what way. In the WEFA system, this is handled by applying a version of the Linear Expenditure System (LES) to a set of equations based on (2.1). The advantage of the LES procedure is that it preserves the overall balancing identity (2.3) in the process of obtaining estimates of parameters in each individual export function.

The basic equation used is:

$$VX_{ijt} = x^0_{ijt}PX_{it} + b_{ij}\left[VM_{jt} - \sum_{k=1}^{n} x^0_{kjt}PX_{kt}\right] + dummies + lags + error \tag{2.5}$$

Here VX_{ijt} is the value of exports from ith country to jth country in period t, VM_{jt} the total value of imports of jth country, and b_{ij} is a regression coefficient. $x_{ijt}{}^0$ is an estimated volume of exports of ith country to jth country, using a base-year trade-share matrix. In actual simulations, the above equation is summed over j, to get total value of exports (VX_{it}) of ith country. For ease of interpretation we have omitted the nonessential terms at the end of the above equation. The corresponding linkage on the price side comes through the price of imports:

$$PM_{jt} = \sum_{i=1}^{n} a_{ij}\, PX_{it} \tag{2.6}$$

On the basis of some assumed, initial values for the VX_i's and the PM_j's, along with a full set of exogenous variable assumptions, each country's model is iterated to convergence. The variables obtained from this solution include the VM_j's and PX_i's for each country. These, along with sample period estimates of a_{ij}'s and b_{ij}'s, are then entered into equations (2.5) and (2.6) to obtain a new set of VX_i's and PM_j's, in general different from the initial assigned values. The individual country models are now resolved with the new values, and the procedure repeated until convergence is obtained among countries as well as within countries.

In the WEFA system used in the simulations reported in this paper, the above linkage procedure is applied only to trade in manufactured goods (SITC 5-9).[1]

For primary goods the procedure is less direct. It is assumed that the SITC 0-4 group is one commodity with a single world market. The price of that commodity is related to an exogenously assumed set of prices of ten important commodities, all given relative to the overall commodity prices.[2]

Quantities, on the other hand, are modeled on the import side, and assumed to be exogenous (trended) on the export side. Disequilibrium between total world imports and total world exports is removed by adjusting the overall commodity price.

There is yet another set of international linkages in the system. A few equations, particularly those relating to the foreign trade sector -- volumes and prices of traded goods and capital flows -- contain "world" variables, converted to a common unit of account. Where that conversion would not make sense (prices, interest rates), weighted averages of national variables are used. Those "world" variables, where endogenous in the national models, can be recomputed on each linkage ("among countries") iteration. Since equations within each country model use the same "world" variable, this type of linkage is of a "pool" variety. All countries draw on the same world "pool".

III THE PRICE SECTOR

Since we are particularly interested in the impact of a change in fuel prices on the world economy it is convenient to respecify some of the equations in the price sector of the WEFA world model. To introduce the price of fuels directly into the price-information mechanism of each country, we respecify the equation for the domestic demand deflator as

$$PDD_t = A\left(\frac{YW}{GDP}\right)_t^{\alpha}\left(\frac{VMG}{GDP}\right)_t^{\beta} PDD_{t-1}^{\gamma}\, e^{ut} \qquad (3.1)$$

where PDD = Domestc demand deflator
YW = Total wage bill
GDP = Gross domestic product
VMG = Value of imported goods
u = Error term

The domestic demand deflator is thus related to unit labor costs, unit import costs, and to its own lag. The imports, VMG, are the sum of the imports of primary goods (VM04) and imports of manufactured goods (VM59), where each value in turn is the product of the appropriate volumes and prices. This brings the influence of import prices more directly to the heart of the price mechanism.

The particular functional form chosen may be justified on a number of grounds.[3]

Once this key price is determined, it affects the model in a number of ways. It occurs as an argument in equations for implicit deflators for other end-use categories of GDP, and the GDP deflator is computed as an identity and thus contains it implicitly. It enters the import demand equations as a relative price, plays a strong role in wage determination, and can be found implicitly in several other equations in the system.

The estimation results obtained for this key price are quite satisfactory and are reported in Table 1; the parameters correspond to those of equation (3.1). The tests, reported in parentheses below the coefficients, are always highly significant for A and α. For β, they are weak for Australia and Denmark. However, since they still had the correct sign, we retain them in the equation for simulation. Parameter γ is not significant in a number of cases (Ireland, New Zealand, Switzerland, and Turkey), and the equations have been re-estimated without it. The overall fits, as is common with price equations estimated in level form, are good, as shown by the adjusted R^2's. Finally, we compute the long-term elasticity of price with respect to unit import cost and report it in the ($\beta/1-\gamma$) column. In a number of cases this elasticity is considerably larger than its short-term counterpart β.

Table 1 **Estimates of the domestic demand deflator equations**

Country	A	α	β	γ	$\beta/(1-\gamma)$	R^2	DW
Austria	.4423	.2520	.2047	.4847	.3972	.998	1.46
	(4.7)	(2.5)	(3.8)	(3.4)			
Belgium	.3866	.6017	.0786	.1838	.0963	.999	1.85
	(13.5)	(7.8)	(2.8)	(2.2)			
Canada	.455	.245	.1788	.5173	.3704	.999	1.45
	(12.5)	(3.0)	(7.4)	(5.9)			
Denmark	.3226	.5903	.0254	.3296	.0379	.999	1.52
	(7.2)	(6.3)	(0.7)*	(3.3)			
Finland	.4836	.5499	.1131	.2996	.1615	1.0	1.64
	(15.0)	(9.7)	(5.3)	(4.8)			
France	.4685	.395	.1169	.4299	.2051	.999	2.2
	(11.4)	(5.6)	(5.3)	(5.9)			
Germany	.4384	.5087	.0792	.316	.3432	1.0	1.67
	(9.2)	(14.1)	(3.3)	(5.6)			
Italy	.4415	.2765	.1438	.518	.2983	.999	.9
	(14.6)	(3.7)	(6.0)	(7.0)			
Japan	.3959	.3121	.0802	.5895	.1954	.996	.88
	(3.5)	(1.9)	(1.2)	(4.7)			
Netherlands	.3212	.3147	.1531	.5137	.3148	.999	1.69
	(8.0)	(5.7)	(3.5)	(7.0)			
Norway	.4195	.5429	.1255	.3123	.1825	.999	2.01
	(7.1)	(4.4)	(2.7)	(2.3)			
Sweden	.3158	.232	.1091	.662	.3228	.999	1.37
	(6.9)	(2.3)	(4.3)	(5.9)			
Switzerland	.6482	.7402	.216	..	..	.998	1.22
	(22.5)	(20.4)	(6.3)				
U.K.	.3769	.5508	.0644	.3814	.1041	.999	0.46
	(7.1)	(6.6)	(1.7)	(4.6)			
U.S	.4168	.4621	.0674	.4114	.1145	.999	1.2
	(5.8)	(3.6)	(2.1)	(4.4)			

IV SCENARIOS

For an assessment of the total effect of the simultaneous changes in the various economies and in the inter-country flows of goods, we constructed a baseline solution and then solved the model under six additional scenarios. We took 1978 as the starting point and let the model run forward in time for seven years, through 1985.

A Base Case

At the time the study was made, this was our best guess as to where the different industrialized countries, the developing countries and the centrally planned economies would be over the period 1978-85. The assumptions were that the price of internationally traded fuels[4] would rise on the average 10 percent from 1978 to 1979 and 8 percent in each year thereafter, with the average prices of internationally traded goods rising at about 7-8 percent per annum. The assumption on the absolute price of fuels meant that, except for 1978-79, the average real price of fuels would remain roughly constant.

B Alternatives I, II, and III

In these scenarios we want to examine the impact of changes in fuel prices on various economies and groups of economies. Alternative I represents a situation in which the price of fuel was assumed to be 10 percent below that of the base case for the entire period of simulation.

In effect that means no increase in the price of fuels from 1978 to 1979 and 8 percent per year thereafter.

Alternative II is, in a sense, the mirror image of Alternative I. Instead of lowering, we raised the price of fuels by 10 percent in relation to the base case. We want to see whether the simulated effects are symmetric to those of Alternative I: i.e. whether the economies adjust differently to upward and downward price shocks.

In Alternative III we raise the price of fuels 50 percent relative to the base case. We consider this to be significant shock. It is meant to see what the system, as represented by the World Model, can withstand, if the effects are nonlinear. In other words, we wanted to see if a 50 percent increase in fuel prices is 5 times worse than a 10 percent increase. To further facilitate inter-country and inter-country group comparisons, we construct a set of what we call "Indices of Response" (IR). They are computed as

$$IR_i = \frac{X_i^a}{X_i^b} \tag{4.1}$$

where i refers to the country, or country group, in question. The superscripts stand for alternative and base cases (b to the baseline and a to the alternative) and X stands for the variable of interest. These indices are set to 1.0 in 1978, and vary thereafter in response to the shock in question.

V INDICES OF RESPONSE FOR SELECTED ECONOMIC VARIABLES

In this section we analyze the impacts of the changes in the various alternatives on each of a number of chosen variables. Indices of response for these variables are presented in diagrams for three major country groups: the Nordic countries (Norway is excluded in Alternatives I, II and III), the OECD group and the World.

A Gross Domestic Product (GDP)

Impacts of changes in fuel prices are presented in Diagrams 1/I, 1/II and 1/III. As might be expected, a drop in fuel prices is mildly stimulative for the world economy, while a rise in prices has the opposite effect.

Results for the subgroups of OECD and the Nordic countries are quite different, however. Gross Domestic Products of the OECD group respond more strongly than the average to lower fuel prices. An overwhelming portion of this is due to a strong response of the fuel-dependent Japanese economy. Other OECD countries also respond positively except for the U.K. But even there, the negative impact begins to take place only after 2-3 years, in line with Britain's recently acquired status of a net oil exporter.

The Nordic countries, on the other hand, react negatively to the drop in oil prices. This is due to the behavior of the Swedish economy but for what we consider to be quite different reasons. For Norway, a substantial oil producer and a net oil exporter, a drop in oil prices has a depressing effect on GDP. In fact, it is not before 1982 that this effect bottoms out (relative to the Base Case), and that the rate of growth of GDP begins to move back towards the world average.

Diagram 1/I Indices of response: Real GDP
(Alternative I)

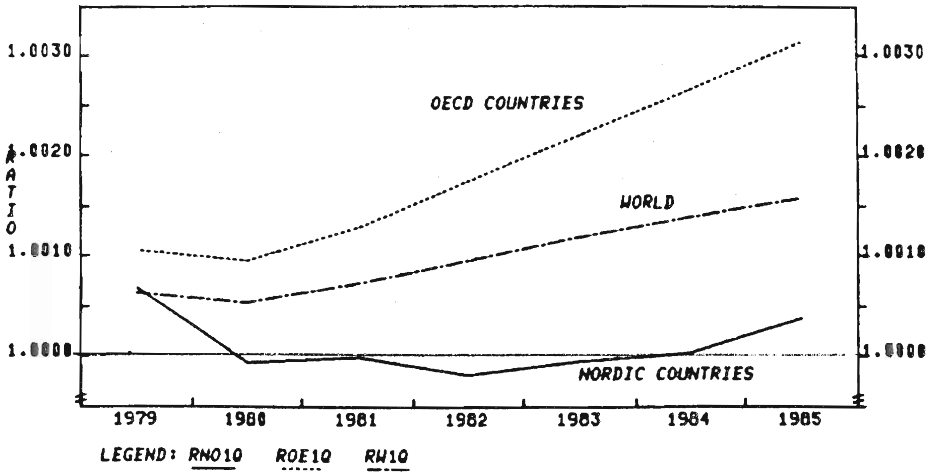


Diagram 1/II Indices of response: Real GDP
(Alternative II)

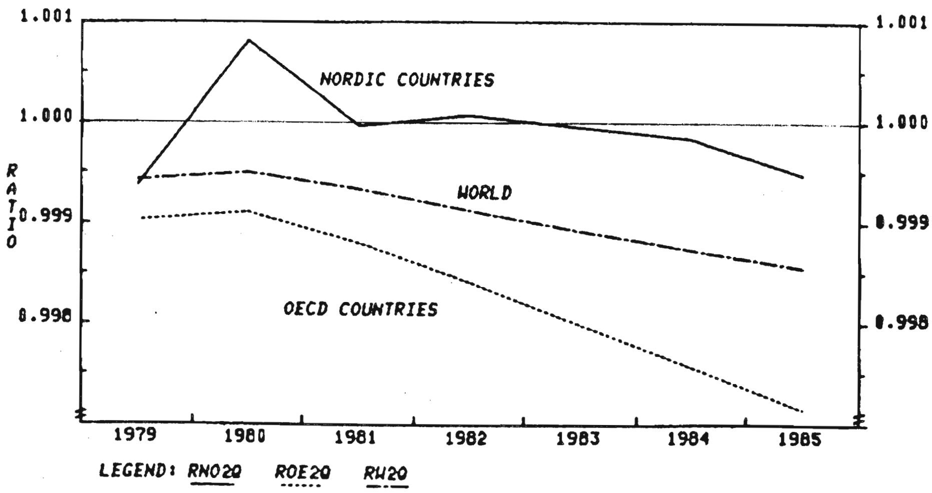
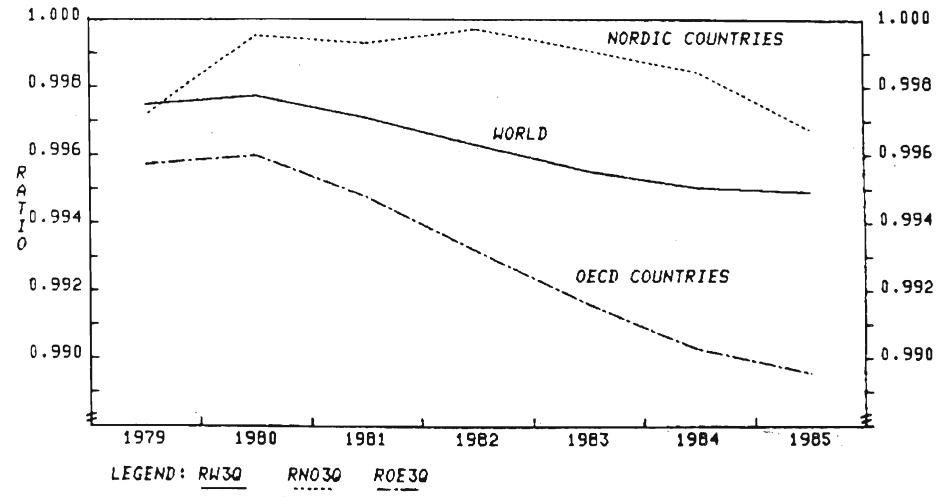


Diagram 1/III **Indices of response: Real GDP**
(Alternative III)



To explain the behavior of the Swedish economy (a relatively strong negative effect of GDP from a drop in fuel prices) one has to look at a number of factors. Total impact of a change in fuel prices on GDP (and other variables in the model) is a combination of a variety of responses whose importance varies from country to country. There are country-to-country differences in import and export price elasticities; varied impacts of the inflow of international reserves on total reserves and hence on the creation of money; different degrees of dependence on imported oil; different degrees of openness of the various economies; and, finally, differences in the way productivity influences the formation of wages and prices with the resultant impact on volumes and composition of demand.

In the case of Sweden, when fuel prices are decreased by 10 per cent, imports rise substantially while exports change only slightly. Volume effect outweights the terms of trade effect resulting in a strong deterioration on the balance on current account. While this is offset somewhat by a counter in-flow of capital, the net result is still a decrease in reserves. This decrease has a negative impact on money supply despite the usual attempts by monetary authorities to sterilize the outflow of foreign reserves through an increase in the domestic reserve base.

The decrease in foreign reserves also decreases the reserve-import ratio which for some countries has a negative effect on investment and hence growth. The decrease in the money supply decreases domestic credit on the one hand and on the other causes an increase in the short and eventually in long term interest rates. These two have a negative effect on the real side of the model. Interest rates usually affect capital formation through the user cost of capital while domestic credit enters directly as a financial variable in both consumption and investment functions. In both cases the effect on the rate of growth and on employment is negative.

There also seems to be an unusually strong dampening effect from the income side. Once GDP is negatively affected through the channels described above, capacity utilization falls which holds down prices. At the same time, the rise in productivity is slowed as Swedish firms do not slow down their employment in step with the reduced growth in GDP. The productivity effects tend to slow down increases in wages and total incomes and ultimately have an adverse impact on consumption. If to this one adds a slow-down in government transfer payments which seem to be quite responsive to the wage and price trends, it seems that in Sweden all forces combine to give a somewhat atypical and unexpected response for an oil-importing nation.

There is yet another reason for the unusual results for Sweden. One only has to look at the Swedish growth pattern in the last 5-6 years. When the oil prices quadrupled in 1973-74, GDP growth in most countries slowed down and by 1975 just about all OECD countries (except Sweden, Norway, Australia and New Zealand) experienced at least one year of negative growth rates. Yet, during

1976-77 when most other countries were on recovery paths from the recession, Sweden slumped, recovering only in 1978. Since most models build into their projections the behavior of the past, it should not be surprising to find the unusual results for Sweden.

Results of Alternative II suggest a certain symmetry in comparison to Alternative I. Country-by-country effects are almost completely symmetric as far as GDP is concerned, an impression which is dispelled when one looks at a wider assortment of variables. It is quite clear, however, from Diagram 1/III that whatever the case is on symmetry, when the shock is quintupled, the effect on even the aggregate is nonlinear. The OECD group and the world as a whole, after a sharp slide in the first 5 years begin to catch themselves.

B Gross Domestic Product Deflator (PGDP)

A change in the cost of imported fuels works its way through the domestic production sectors and effects various segments of the final demand deflator. Changes in final demand prices often induce movements in wage rates and prices of other factors of production. The simulations presented here captured both the direct effects as well as the induced effects of fuel price changes on PGDP through the central price equation presented in the previous section and through the other price and wage equations of the model. The limitations of PGDP as an indicator or general price movements should, however, be kept in mind when interpreting the results.

A 10 percent decline in fuel prices has an initial effect of reducing the average rate of inflation in the world by 0.2 percent from the base case; the drop in the inflation rate for the OECD group is much smaller - less than 0.1 percent (Diagram 2/I). A 10 percent decline in fuel prices initially results in a slight increase in PGDP for Nordic countries. This result is due to the unusual response of Sweden to changes in fuel prices. A decline in fuel prices has an initial adverse impact on Swedish GDP through the channels described earlier in this paper. The negative impact on real GDP is accompanied by a slow-down in productivity growth contributing to a rise in the general price level. However, in the long-run the response of PGDP in Nordic countries is in the expected direction (Diagrams 2/I, 2/II and 2/III).

The time profile of PGDP under Alternative III is quite different from that under Alternative II (Diagram 2/II). The effect of a 50 percent rise in imported fuel prices on world inflation seems to wear off by 1983, except for the Nordic group. Also PGDP simulations under Alternative III do not seem to bear any linear relation with those under Alternative II over a period of time.

Diagram 2/I Indices of response: GDP deflator
(Alternative I)

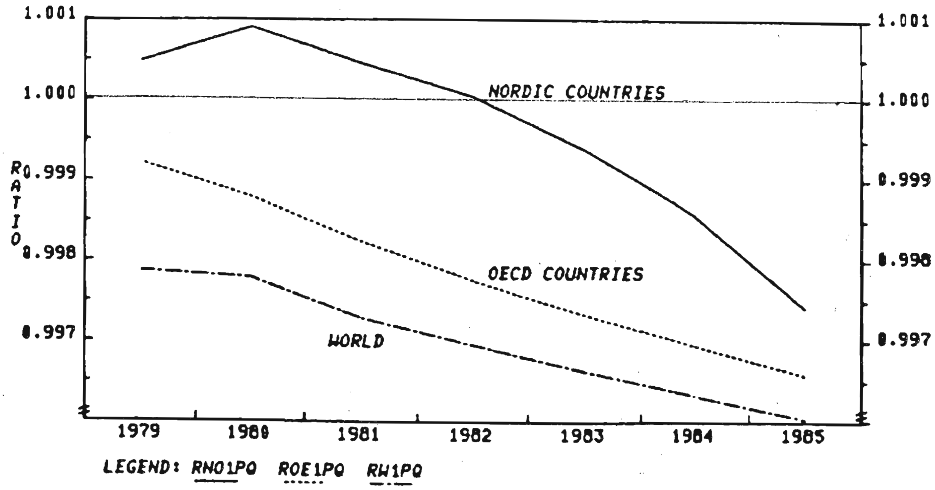


Diagram 2/II Indices of response: GDP deflator
(Alternative II)

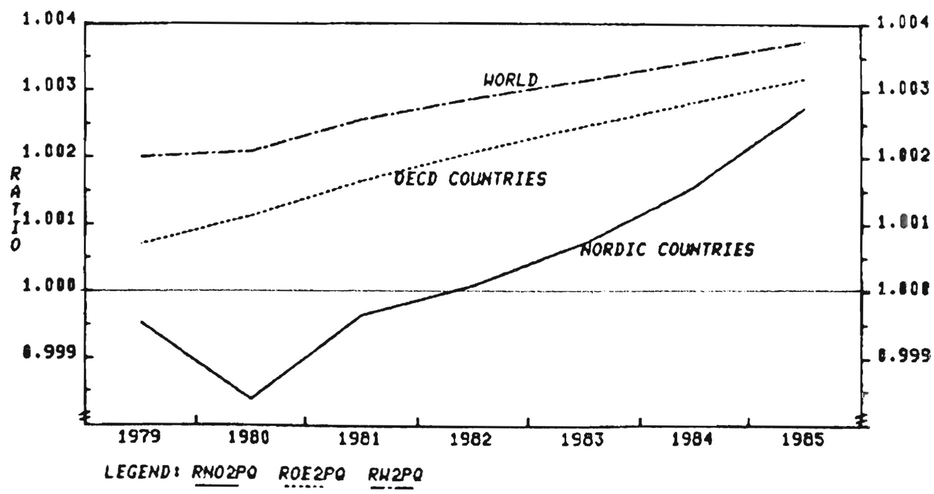
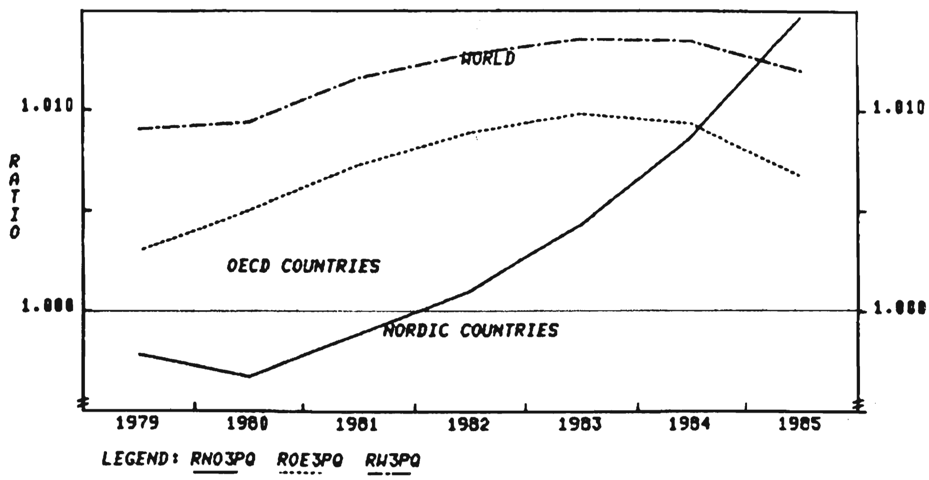


Diagram 2/III Indices of response: GDP deflator
(Alternative III)



C Manufactured Goods Exports Deflator (PX)

Diagrams 3/I, 3/II and 3/III show the effect of changes in fuel prices on manufactured goods export deflators.

A 10 percent change in fuel prices (Alternatives I and II) does not produce any significant changes in the export prices of manufactured goods (Diagrams 3/I and 3/II). The impact of a 50 percent rise in fuel prices on the world price of manufactured exports reaches its peak by 1983.

However, there are wide variations in the impact of a 50 percent rise in fuel prices on the price of exports among various countries. These variations are shown in Diagram 3A. Diagram 3A shows the percentage increase in Px under Alternative III compared to the base case for a selected number of countries. For example, the response of Swedish export prices to an increase in fuel prices is relatively slow. As a result, Sweden enjoys a slight competitive edge in its exports over other countries under Alternative III.

Diagram 3A Manufacture export prices
(Alternative III)

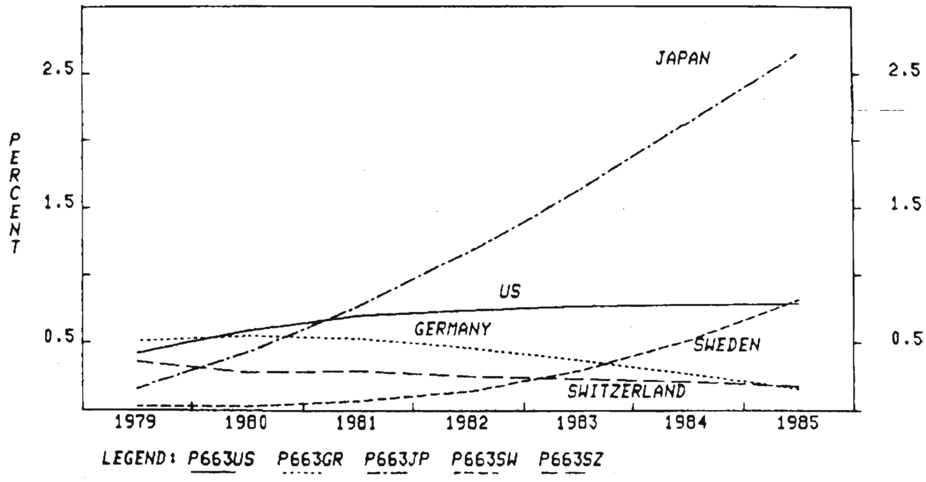


Diagram 3/I Indices of response: MNF. Exports deflator
(Alternative I)

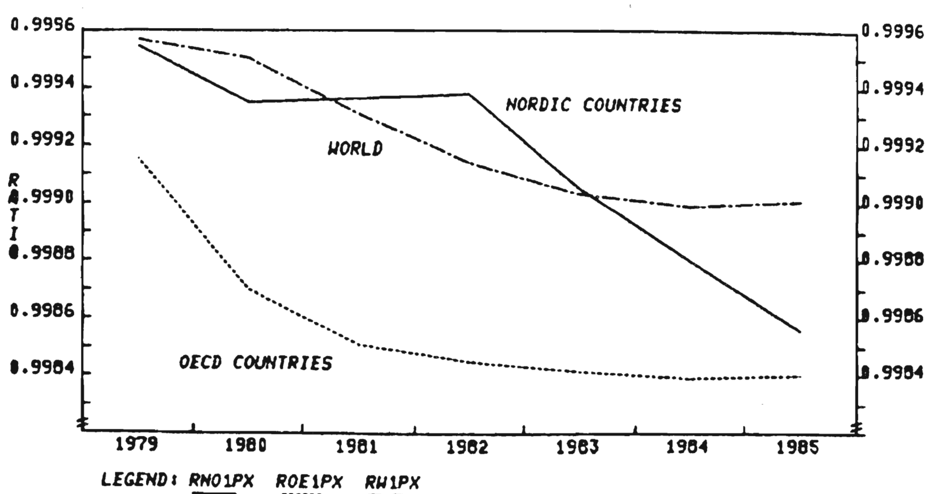


Diagram 3/II Indices of response: MNF Exports deflator (Alternative II)

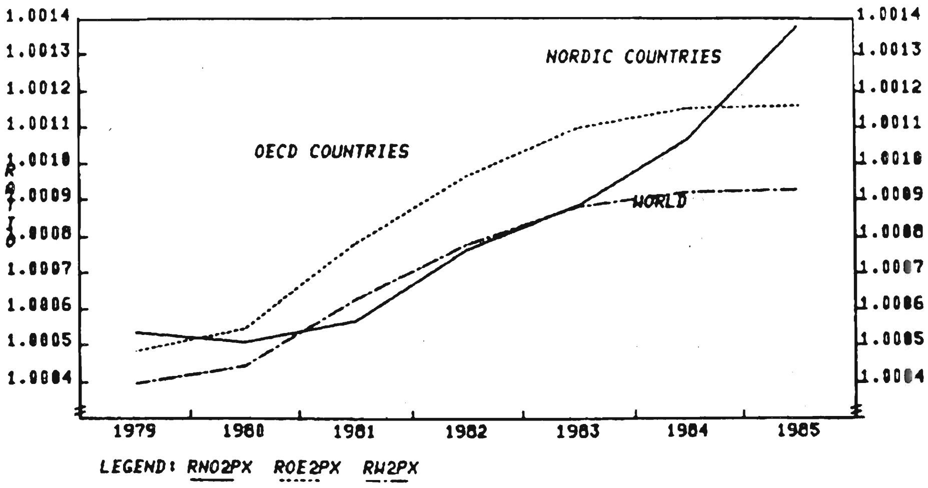
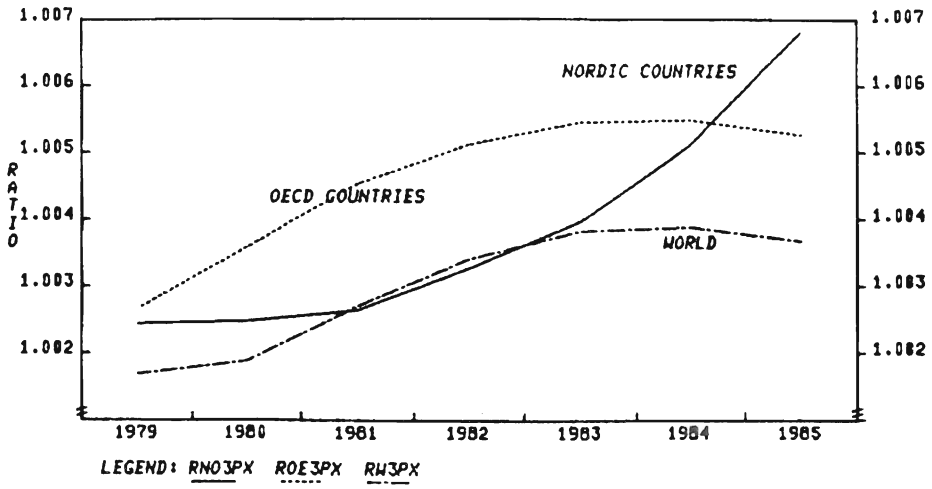


Diagram 3/III Indices of response: MNF. Exports deflator (Alternative III)



NOTES

1 Standard Industrial Trade Classification, categories 5 through 9. These categories cover the processed goods in contrast to primary goods (SITC 0-4) which are by and large in their raw form.

2 Among the ten are the prices of fuels and metals used in this study.

3 See the papers by O. Eckstein and D. Wyss, L.R. Klein, and R.J. Ball and M. Duffy in Board of Governors of the Federal Reserve System "The Econometrics of Price Determination", 1970.

4 Relative price of fuels = Price Index of fuels over world price index of primary commodities. Fuels include crude petroleum, natural gas, coal and electricity. Primary commodities cover SITC 0-4. The indexes are based on 1970 = 1.

ON THE OPTIMAL RATE OF STRUCTURAL ADJUSTMENT*

by Gunnar Eliasson

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ABSTRACT

The first concern of this paper is the time dimension of the adjustment process in an economic system characterized by various forms of monopolistic competition. We attempt to define notions, and measures, of stability that capture the macroeconomic consequences of shocks and disturbed price signalling in markets. We want to know if, when, where and how an economy settles down on a "steady" growth path and to what extent the answer depends upon the nature of the adjustment process itself.

It appears that a bounded space that is a subset of another bounded space is a more useful concept to deal with our problem than the conventional equilibrium and stability definitions. The bounds should be considered as welfare determining and as such they will be entirely arbitrary until we have determined how national welfare depends on the variation in and the predictive uncertainty associated with a chosen set of welfare variables. Optimal adjustment in our sense involves both (a) the time it takes to get back to a steady growth path and (b) the loss (or gain) in long-term growth due to the adjustment process itself.

The second concern of this paper is to demonstrate through micro simulation experiments how stability in that sense depends on the structural diversity of the economy. The paper is mainly exploratory, aiming at hypothesis formulation. Only a few of the experiments used in this study have been properly designed to allow strong empirical or theoretical conclusions in this context. We have found tentatively:

(a) that the less structural diversity (productivity or profitability) across micro units (firms) in the initial state of the economy, the less stable the macro economy vis à vis externally administered price shocks.

(b) <u>that</u> a certain level and distribution across firms of unused capacity (cyclical slack) is needed to maintain a stable relative price structure during a growth process.

(c) <u>that</u> the "Le Chatelier-Brown principle" is significantly at work in the micro-to-macro model economy. Reversal speeds depend importantly on the state as described by (a) and (b) and shocks of various kinds can "prematurely" trigger reversals. More particularly, the model economy can be made to perform excellently by short-term criteria (high utilization rates, currently and efficiently allocated labor, etc) for extended periods of time, only to develop eventually a more shock sensitive supply structure.

(d) <u>that</u> the simulation experiments imply a basic, underlying tradeoff between macroeconomic and microeconomic stability. The closer to steady state output growth at the macro (industry) level, the more the "Brownian motion" over time in the growth rates among firms.

(e) <u>that</u> different (size, time, sign) price shocks require different market regimes for optimal adjustment.

(f) <u>that</u> it was virtually impossible to settle the micro-to-macro model economy used for simulation experiments down on a "steady" long-run macro state -- strictly defined -- for more than a couple of decades, except at the expense of a not negligible reduction of the growth rate. The reason seems to be the absence of sufficient micro "instability". The model features an endogenous <u>exit</u> of firms, but no <u>entry</u>. Hence the model is afflicted with gradual "structural decay" in the very long term, meaning less structural variation and more market concentration. The diminishing vitality in the competitive market process that followed appears to have been detrimental to steady growth in the very long term. This sensitivity may diminish when we have introduced market entry as a standard feature of the model.

(g) that output growth along an endogenously determined trend cannot be sustained if not associated with significant short and long cycles in economic activity around that trend.

This list of properties of the micro-to-macro economic model of Sweden (called MOSES) indicates our area of interest, namely the interaction of economic agents in a cyclically unstable growth process - an old Schumpeterian notion.

The model used is very complex, and the design and running of experiments is a costly procedure. Experiments have been carried out at different times and on somewhat different model specifications. Hence, at this stage we refer to our results as suggestions and hypotheses for further testing. If some or all of these hypotheses hold up, they will call for policies quite different from the conventional macropolicies.

1 THE NOTION OF STABILITY - THE PROBLEM

What Do We Want?

Superficial comparison of the behavior of macro time series for any industrial nation during the steady 60s and the volatile 70s suggests the following two questions:

1) What kind of price system (p) will support a steady -- or stable -- macroeconomic growth trajectory over a period of several decades?

2) What kind of (supply) structure (q) and behavioral response pattern of an economic system will support that price system?

We have tried to analyze these problems experimentally within a micro-to-macro simulation model of the Swedish economy. This model endogenizes price and quantity determination across firms and over time -- and hence economic growth -- in a way described below. We try to formulate a theoretical concept of stability corresponding to the common-sense notion of stability that we need. We need a concept where time (durability) is part of the stability problem. The instability domain may occur soon, before the system has exploded or collapsed. We do not care very much if a disturbed system, because of the disturbance, does not return to the same point from where it began to move. (Equilibrium points, steady states and similar concepts appear to be of limited value in this context.)

What Does Economic Literature Offer?

A superficial glance at the literature of economic theory shows that stability problems have been treated in the following fashion. On the one hand we have the stability analysis of static competitive equilibrium situations associated with names like Arrow, Hurwicz etc. The problem has been to define the conditions under which the economy, when brought -- by exogenous forces -- more or less away from the equilibrium point, returns to the -- or sufficiently close to the -- same point; the fixed-point rubber-band analysis so to speak. Such analysis by definition is restricted to a limited set of models -- and corresponding problems -- with static fixed-point characteristics (Lindahl (1938), Arrow-Hahn (1973), Arrow-Hurwicz (1977) etc). Time has no empirical content in those models: it is just a scalar parameterizing the (fictitious) evolution of the system. Debreu's (1959) treatment is the ultimate in this respect; dates are attributes of commodities, leaving very little economic meaning in the time concept (cf Smale, 1976). A recent development along similar lines has been phrased in terms of so-called search equilibria, where no single price, but rather a dispersion of prices (due to imperfect information) in a timeless world signifies an equilibrium and perhaps a stable cluster (see Sharefkin's paper in this volume). We also have the large body of theoretical literature on monopolistic competiton. It is, however, partial in nature and cannot easily be applied and generalized to micro-to-macro analysis except in the way we have done it below.

The concept of practical stability suggested by LaSalle-Lefschetz (1961) in a sense recognizes time. Practical stability[1] means that a process eventually returns tolerably close to a point of equilibrium that has been disturbed, without necessarily approaching that point monotonically. A flying areoplane is a case in point. Its flight path is practically stable, whatever happens to it during flight as long as it eventually lands safely, tolerably close to its point of destination.

Hence, practical stability is defined by LaSalle-Lefschetz in terms of a point residing in a bounded region of a normed space (bounded orbit), a notion supported by Berlinski (1976) who argues that the notion of "stability makes sense only relative to some measure of distance" and that the same norm notion is sufficient.

The Distance and the Time

But there is a very different family of stability concepts that have originated in physical and engineering sciencies. They represent changing structural forms mathematically. Questions posed in this literature concern what circumstances make such forms stable and under what conditions they collapse. For instance, when inputs (causes, prices etc) pass slowly through a well defined domain, under which structural circumstances do various forms (systems) exhibit abrupt changes (discontinuities, cathastrophes etc) in the corresponding state spaces? The mathematics is often borrowed from natural science models (meteorology (Lorentz 1976), stress analysis, under which configurations does the bridge collapse, etc). Much of this discussion has been associated with Zeeman and Thom. There is, however, a variety of half-built bridges that connect these notions with the economist's preoccupation with the price characteristics of competitive equilibria -- even though the various authors reside in different academic and linguistic worlds and do not normally honor each other with cross references. The distinction between the short and the long run are cases in point. The short term presupposes a fixed structure. If the system is disturbed it returns to equilibrium without disrupting the structure. In the long run, somehow, structure changes. In Smale (1967), Thom (1972) and others the short and the long terms are submerged in the same structure and it becomes interesting -- as we will see in our later quantitative model analysis -- to talk about "structural stability" (Smale (1967), see also Ysander (1981)).

Recent theoretical work based on Lorentz (1963) has demonstrated that, with sufficient nonlinearities and tendencies to overshooting, random-looking system behavior can be deterministically generated. Such systems could very well be unstable even though they possess an equilibrium. Trajectories would be very sensitive to initial conditions and would move away from any periodic cycle that can be represented. Such behavior has been termed <u>chaotic</u> (Day, 1982, 1982b). In such systems both structural change, economic growth and "unpredictable" (by any forecasting method) events could be generated. As will be seen below, the micro-to-macro simulation model we use for illustrative purposes exhibits all these features.

When a system is inherently unstable or chaotic and remains far enough from any established steady state for sufficiently long periods of time, the distance suggested by Berlinski (1976), rather than the steady state or the equilibrium point, becomes the important criterion for evaluating the stability properties of the system. A disturbing degree of arbitrariness as to the choice of reference for measuring the distance[2] then enters the scene. Among other things, the analysis now requires an entirely new tool-box compared to the one that economists normally carry. Economists generally worry about the return of the system, at some future time, to a reference point called the equilibrium point or trajectory, not about when and how far away the process will be during the adjustment period. But during a deep depression or a run-away inflation, policy makers and individuals will worry about how fast they can get the economic system back into a tolerable operating domain, and not about the systems operating characteristics 10 years from now. Suppose we introduce a bounded domain, called the stability domain. It is bad for the system (an aeroplane, an economy etc) to be outside that domain. It represents danger, unpleasant social conditions etc. As soon as the system gets outside that stability domain, time becomes important, namely the time needed to get back.

Looked at through the new pair of glasses suggested in engineering literature, the important thing is that a perturbed process moves in a bounded orbit (say a band around a growth path) and stays there, and how long that readjustment takes. Quality and safety controls applied to engineering production systems offer a host of examples. Even though an explosion in the output flow of a chemical plant would eventually stabilize, the point is that explosions should not be allowed to occur at all. It is obvious that some practical stability problems of economics resemble this one.

Arbitrariness here also refers to the possibility that we don't know our system (model). We may be thinking in terms of a macroeconomic model that describes the 60s well, to figure out what to do in the late 70s. Then, of course, we don't know the location of, or about the existence of a point of equilibrium very well.

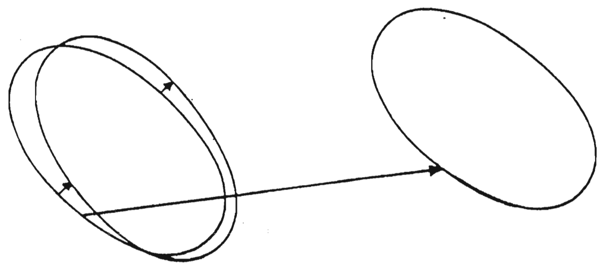
Second, the new pair of analytical glasses allows a host of interesting and natural notions of distance. The introductory questions suggest some historic benchmark. For instance, instability could be said to prevail if the amplitude of the business cycle passes outside some preset limits -- if the level of output drops or falls significantly below an established growth trend or if the unemployment rate reaches 6 percent or more. By such standards the so-called high market response experiment in Figure 5 would be in an instability region most of the time after year 30. The economic circumstances then prevailing would certainly warrant the label unstable, crisis, depression or collapse in common language. The concept of an equilibrium in the economists' sense then does not offer much help as a reference for measuring distance and especially in the general class of models that we consider, where it often does not exist. Third, the equilibrium point may be a very erratic object, especially if the system (the process) normally operates at some distance from that point, calculated by some method. The stability of an aircraft in flight is again a case in point. Even if an equilibrium flight path could be calculated, during flight the distance from the ground is really what matters.

Boundedness and Response Strategies of Actors

Boundedness thus appears to be the interesting concept to use in defining a notion of stability. What can we draw upon in defining that notion?

Resilience, originating in the biological sciences (Holling 1973, May 1973 and Grumm 1976), is a concept we can try. Resilience obtains when an external shock does not move the operating characteristics of the system more than marginally (small rightward movement to the left in Figure 1).

Figure 1



Suppose you shock the system with external signals like those of the 60s and the 70s. The oil shock of the 70s would not have brought the system down as it did with the real economy, if the system would have been resilient. An economic model, a real life economy or the Northeast U.S. power grid (that collapsed in the middle 60s) can be designed to be more or less resilient vis-à-vis events like the oil shocks of the 70s. One does not want to build infinitely resilient (or stable) systems. One would, however, like systems designed to be resilient vis-à-vis shocks that are likely to occur. In that sense, it is interesting to discuss the resilience of various systems (say the three models described in this conference volume and the real economy) in the context of price developments of the kind described in Josefsson's-Örtengren's paper.

Suppose now that we have an economic model the state of which is currently and endogenously updated through the dynamics of the ongoing economic process. The micro-to-macro model described below exhibits exactly those properties. One clear conclusion then follows. The state of the economic system will depend critically on the actual path the economic process has taken. In policy terms this means that if the economic process is set in motion at some point in time, one could, in principle, move the system differently up to a later point in time (everything else the same), and the breakdown characteristics (the resilience) vis-à-vis particular shocks would differ accordingly. One feels inclined to demand such properties from any theory claiming, to explain the events of the 70s.

Controllability is a key notion for macropolicies. Most macroeconometric models up to the middle 70s were resilient to even extreme price shocks by assumption (cf the simulation runs in Sarma's paper) or any departure from desired activity paths could be easily corrected by the informed policy maker in charge. On the other hand, the micro-to-macro model economy to be discussed later in this paper appears not to be resilient if shocks are sufficiently large and resilience appears to depend significantly on the micro characteristics of the state of the economy. Resilience can, however, be enhanced by improving behavioral strategies by the various actors in the economy. In macro models the only real agents are the macro policy makers, and in this setting the concept of controllability of the system naturally arises. Arrow-Kurz (1970) discuss controllability from a centralized point of view, and this is the notion applicable to most macro models of a Keynesian type.

In dynamic, micro-based models the controllability concept becomes much more complex. Both firms and individuals act in response to price signals that they interprete individually, and may act both in accordance with policies and against policies. In the noncooperative game situation that follows, inconsistent behavior develops easily and normally at the micro level. Actors in an economy (firms, individuals, governments etc) are equipped with rules designed to help correct locally bad situations within the normal operating domain of the system. Such was also the case for the operators of the Northeast U.S. power grid in the 60s and at the Three Mile Island nuclear reactor in 1979.

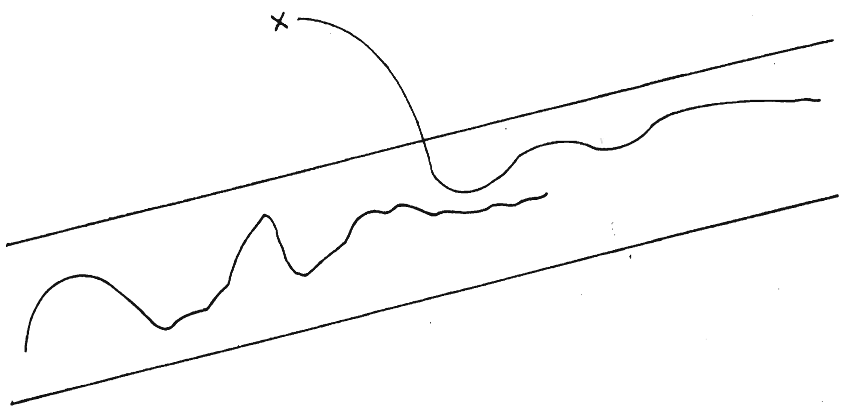
A system can also be equipped with rules to improve rules of behavior, emergency operating rules, learning by doing, information gathering and so forth. To some extent this is the case in the micro-to-macro model economy used for illustration in this paper. It is very much the case in the real world. There are, however, limits to what can be in implemented in the form of such safety devices. Time -- to observe, to learn, to understand and to act -- is a very practical constraint in designing and implementing good behavioral strategies.

The complexity of most real-world systems makes improvements in operating rules an individual, iterative procedure that may even be destabilizing, in the sense of lowering the resilience of the system. Firms or households in the micro-to-macro economy respond to mistakes by being more cautious, thus causing trouble for the system as a whole in the form of rising unemployment. Micro units are also equipped with expectational devices that are rational for them as individual actors. Combined with quantity responses in the economy and secondary price adjustments, prices of the economy sometimes "overshoot" significantly, occasionally causing serious collapses of parts of the economy (Eliasson, 1978a, pp 105 ff). In this perspective, governments trying to correct the course of the economic process in the seventies on the basis of experience from the 60s may, in fact, have been the cause of the economic distress experienced (direct intervention in markets, legislation, subsidies etc), because they did not understand or predict the response of the economic system.

Stability as a Welfare Notion?

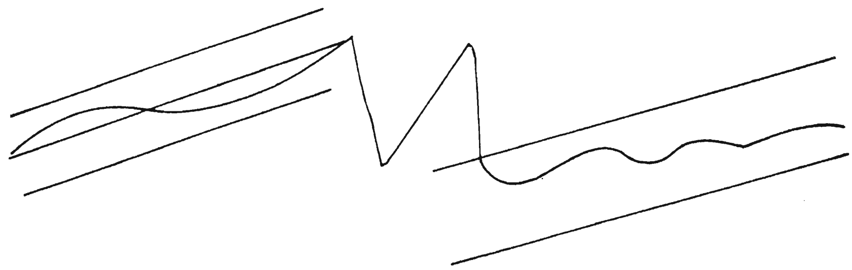
No one of the stability notions described above appears to be sufficient for our purposes. An economically relevant notion of stability must have some welfare content. We are looking for a bounded region in the space of goal variables of an economic system. Some of those variables (say unemployment) must stay within the same bounded domain indefinitely if the system is to be considered stable. Mathematically the process would be uniformly convergent. Whenever outside the band or the tube the process has to return to be called stable (cf Figure 2).

Figure 2



For other variables (like output) the "domain of stability" can change over time as the system evolves. Dramatic departures from some normal range, say normal cyclical variations, are called instabilities. If such a departure occurs, the important point for stability is not that the variables return to earlier stability regions, but that all goal variables return to regions that are called stable. Rather than comparing two equilibrium situations we would prefer to study the systems in two stability regions (the two tubes in Figure 3).

Figure 3



One would expect normal economic systems to contain several such, possible "stability rated" regions to return to.

Thus, even though the Swedish economy was thrown into a "destabilized phase" after the 1973/74 oil shock, there is a range of choices of future stability regions (including growth bands) within which to stabilize eventually. Swedish policy makers could take their pick from the international, experimental policy theater of the 70s, and their choice would determine which stability region would be the ultimate outcome and how long it would take to get there. A normative (or ethical) welfare function for the nation, or at least its policy makers, is needed to make this choice. With such a welfare function, a unique growth band can be chosen.

2 STRUCTURAL COMPARABILITY

The man in the street might say that the performance of the Swedish economy was "stable" during the 60s and "unstable" in the 70s. The implicit notion would be that the two developments g(60) and g(70) had been generated by the same underlying economic structure ψ. Do we understand, and know how to characterize, the nature of ψ in sufficient detail? Suppose we do; then

- at what "distance" from the empirically known (and measured) g(60)(= g(70)-g(60)) does development become "unstable", and

- what causes that departure?

Alternatively, one could ask whether the talk about a growing structural instability in the Swedish economy during the 70s rather refers to a change in the underlying structure? To an economist that last possibility must be very disconcerting. He must replace his earlier concept of the general economic structure with a new concept h. We then cannot give meaningful answers to the two introductory questions. Comparability requires that g and h be subsets of a general class of structures ψ that can generate both g(60) and g(70) or any g(i) that would be of interest to compare with or to explain g(70). A general class of structures ψ that is capable of generating both a business cycle and a variety of structural developments is required for, e.g., a good growth model. Obviously such a model has to be based on very extensive information. Is it possible to formulate and estimate a model with such powerful explanatory capacity? We must if we want to understand (and be able to recognize) such turbulent economic behavior at that of the 70s. The only informational basis for such early recognition would have been data generated during the 60s and earlier.

Prices

In the standard theory of competitive economic equilibrium, both sides of the market take prices as given. This theory can be extended by introducing expected prices, also taken as given from the Walrasian auctioneer. But what happens if expectations are mistaken?

Suppose mistaken expectations have moved the actual price p to a point arbitrarily distant from the market clearing point $\bar{p}$. We assume that this can happen without disrupting the process or the system, i.e., the structure of the system (g) remains unchanged. Standard competitive analysis is concerned with the conditions under which p returns to $\bar{p}$ again without changing g. First, only a limited set of structures g allow p to vary around $\bar{p}$ without changing g. Second, even if variability in p is allowed in some neighborhood of $\bar{p}$, $|p-\bar{p}| < \varepsilon$, additional restrictions apply to g if return of p to $\bar{p}$ is to be guaranteed. If not, we have a basic inconsistency between economic structure and price dynamics. Or rather: are structures g with nonconverging prices economically interesting, and of practical importance? Traditionally, structures g for which an equilibrium point does not exist and for which convergence of p to $\bar{p}$ is extremely slow, have been considered theoretically uninteresting and of no practical importance. Expressed differently, if the existence of an equilibrium in the conventional sense cannot be proven, we should reject the theory or the model! One could argue, however, that such rejected structures would be the relevant ones if we want to take up Schumpeter's challenge, and try to explain business cycles as an integral part of an endogenous growth process.

There are two important reasons for attempting that task. First, instability in the traditional sense of non-convergence to p may be the normal characteristic of economic systems when sufficiently disturbed. If, for instance, decision makers repeatedly traverse the same "cobweb" cycle, they will eventually learn and change their decision strategies. If the situation is very complex they may stick to their old rules of thumb as long as the variation in outcomes are acceptable ("stable"). If not, a complex situation with many actors offers a very large number of possible strategy choices, meaning a structure g(70) very different from g(60). Perhaps this is the normal tendency of an economic system. (See Sharefkin's paper in this volume.)

Second, convergence to $\bar{p}$, or to an entirely new $\bar{\bar{p}}$ may not occur within this new system or within any typical economic structure. Instead, structures g and prices p may keep oscillating in a mutually dependent fashion. $(g, p) \in \psi$. This is one way to describe the behavior of the micro-to-macro model that we use for illustrative purposes below. As long as g stays within a bounded region, we call the system stable. The second objection is the more important one. It covers the first and, if valid, it rules out the above theoretical procedure as unsound, because it excludes many important economic phenomena.

An extensive literature on systems stability exists in which no explicit price system parameterizes the response surface of the model. The economist should merge the two approaches. The engineering model, with no explicit prices or market clearing, and the economist's model that responds to God-given prices should be merged into a new model, where both structure g and prices p are endogenized. At least three aspects of economic reality can then be recognized in the model. First, decision makers have to recognize that prevailing prices may be non-clearing prices and unreliable predictors of future prices. Second, market interdependencies have to be allowed; a disturbance in one market may spread to other markets. Third, the speed of market responses may be such that disturbances keep growing, at least for some time ("overshooting", see Eliasson (1978a, pp 105 ff), and Genberg's paper in this volume). To accommodate these features, the model or theory must meet at least three requirements. Disequilibria or instabilities will have to be normal, endogenous parts of the economic growth process, that is also endogenous. The endogenization of supply and capacity growth requires a micro representation at the level where supply decisions are taken (establishments, firms). These three requirements summarize Schumpeter's view of "Business Cycles and Economic Growth" as a process in which entrepreneurs figure importantly as agents of innovative change and creative destruction. The micro-to-macro model used below in this paper builds in these three features. Under certain circumstances such models are not "structurally stable", and part of our analysis is devoted to this particular property.

Such modifications of our world concept, however, make for much more complicated mathematical formulations. Since prices depend on quantities, stable aggregation functions no longer exist, except in unusual or peculiar circumstances (Fisher 1965, 1969, 1982). Assume that agents in the market respond to a perceived price signal by adjusting quantities at different rates. Then those agents will not act in an identical fashion over time, and any cross section in time would find different actors striving to adjust their positions to different prices. Inconsistent behavior, more or less, is the normal state of affairs. There is no way of obtaining stable aggregates, and we must resort to explicit micro-to-macro process analysis; supply must be modeled at the micro level. The only remaining question is whether we should try to restore mathematical tractability by a stochastic device (see Sharefkin's paper) or be satisfied with a cumbersome numerical analysis. It appears as if simulation will be the most efficient, and perhaps the only possible analytical technique to perform interesting economic modeling.

How Should We Go about Modeling the Dynamic Properties of an Economic System?

One has to introduce

(1) the time (t) it takes for prices to respond to the response of actors to perceived prices, and

(2) the magnitude of response it takes to move prices (p) within the chosen period of time, and

(3) the magnitude of quantity response initiated by a particular price signal (= q).

Time can be modeled as continuous or discrete; the discrete version involves the choice of proper time unit. A particular requirement to note is that only a restricted set of response patterns on the part of decision makers are compatible with a stable system ψ. There must always exist some classes of response speeds and response steps that will confront the system with an even larger, needed adjustment the next moment or period and so on. (The non-explosive or non-collapsible class may not include optimizing behavior on the part of the individual decision makers in response to perceived prices.)

A second aspect is that such a system deals with actors (decision makers). To be "aggregable" it must exist in a state resembling static equilibrium. The system can collapse to a static equilibrium in certain special cases. But are those special cases of any interest?

Any other state would involve quantities (q) changing at different and changing rates.

Does there exist, within the system

$$\psi \quad (t, \dot{p}, \dot{q}, \ldots)$$

defined in some space, a state where all quantities move at the same, stable rate? What would the trajectories of p be in the corresponding space?

Does the system tend to remain in the domain defined by these trajectories, and do those trajectories remain roughly in place if the system is disturbed by some outside shock?

The conventional presumption is that the p vector stays put if all quantities change at a constant rate. Stability of quantity aggregates and of the price vector are then guaranteed, and aggregate quantities will change at the same rate as its component quantities. I conjecture that if the parameters regulating adjustments of type (1), (2) and (3) above differ across micro units, then a system that has been pushed out of a (q, p) micro steady state (strictly defined) will never return to such a state.

Initial Structures

A common procedure for studying the stability properties of an economic model is to position the system in equilibrium and then to shock it. That procedure is believed to isolate the effects of the shock from other features of the dynamics of the system.

This procedure assumes two things. First, it assumes that the system's response does not depend upon the initial position in relation to the perceived equilibrium position. Suppose, for example, that the system moves to very different equilibria which depend critically on the initial departure from equilibrium; or that the time it takes for the system to return to some common equilibrium depends critically on its initial state. Second, such an analytical procedure assumes that an equilibrium position exists from which to depart when shocked. If we have a dynamic systems representation of our economy, it may be difficult to find an initial equilibrium. Exogenous price signals driving the system may be incompatible with its initial and updated structure for a very long time. Once started on a particular, initial structure, that structure may for ever drive the (q, p) $\varepsilon\psi$ system in a fashion that now and then takes it out of the bounded orbit, and into an unbounded orbit that passes outside the stable region.

Say that we define "economic stability" to mean that GNP moves within a predetermined maximum amplitude around a smooth growth path. If the economic system cannot be manipulated, by varying initial structures and/or policy parameters, to maintain such a smooth growth path, then the system would be called unstable or uncontrollable. One question that we must ask after having performed the simulation experiments to follow is whether such an instability should not be considered normal, or unavoidable, behavior of any economy. It is easy to demonstrate that a large class of models with dynamic features (feedbacks) exhibit cyclical properties. Why should models be restricted to the class that generates periodicity? Should not a good economic model generate (endogenously) a real depression occasionally? (Cf Day, 1982, 1982b. Also see simulation experiments below.)

A special case of the initial structure problem is the cyclical problem of capacity utilization. Capacity utilization is part of the initial state that determines the production and investment decisions of firms each quarter. Capacity utilization is also part of the actual as seen against the potential productivity specification of each firm. Local scarcities -- insufficient labor or machinery, for example -- may generate local price and wage escalation. If more widespread, those price and wage escalations may destabilize the relative price structure in a cumulative way. If this is a valid hypothesis[3], then there is a tradeoff between the overall degree of capacity utilization and the long-run growth rate. A certain level and distribution (across firms) of slack is needed to maintain a stable relative price structure, which in turn is needed for a stable growth rate. Thus there may be a conflict between trying to stabilize quantities q (like business cycles) and prices p. The more stable q the more erratic the p structure. The more stable the p structure, the more prone to erratic adjustments the quantities q. Ill-timed expansionary policies, and perhaps stabilization policies in general, would then be undesired events from a long-term point of view. They may reduce long-term growth rather than increase it (as conventionally believed), because they affect the dynamic (across micro units and over time) allocation process negatively. Perhaps the policies of the 60s had something to do with the limited ability of the economy of the 70s to absorb the exogenous shocks then delivered.

Micro Versus Macro Stability

Thus far we have talked vaguely about structures. Stability has been defined in terms of one particular dimension (variable) of that structure. Choose a simple structure, say a very simple macroeconomic model. Any chosen macroeconomic model can be disaggregated further into substructures. We have many sector models and a few micro models based on decision units (firms, households).

Suppose we have a time trajectory of aggregate industrial output and its components in terms of individual firm outputs. To what extent should one expect compatibility between component stability and aggregate stability? Is stable and uniform microeconomic growth supportive of macroeconomic stability or is there a conflict?

Nobody really knows, since neither a micro stable nor a macro stable system in the above senses have ever been modeled simultaneously (cf Sharefkin's paper. Burton Klein (1983) has also addressed this problem.). We argued above that variation across micro agents (firms) in the dynamic specification of the model would make attainment of a steady state (q, p) situation infeasible. The problem can, however, be studied "experimentally" within a micro-based macro model. We can try to obtain macro stability and study what that state looks like at the micro level, and vice versa. We will do some of this in what follows.

In such a context, however, it becomes important to represent <u>aggregation</u> exactly. Even if the behavior of individual firms can be modeled, the number of units change through <u>exit</u> and <u>entry</u>, and surviving units change in size. Macroeconomic models are based -- explicitly or implicitly -- on the "static" equilibrium assumption because such an assumption is required for stable aggregates. Departures from that assumption require that very peculiar additional assumptions be imposed if stability in aggregate relationships is to be preserved. This is, of course, a very unsatisfactory state of affairs.

The dynamics of a market pricing system can be expected to depend upon concentration tendencies. This becomes more important the longer the time period we study. The evolvement of micro structures over time must therefore be a part of our inquiry. In each time (decision) period a new micro structure represents the initial structure for the next period. Structural stability then becomes important. Structural stability as here defined captures a particular type of micro stability in the growth process, namely how initial structures evolve over time.

As an introduction to the next section, suppose we have two systems g(60) and g(70) that both belong to ψ. Their properties differ in the sense that g(60) describes a choosen period (the 60s) well and similarly for g(70). We can think of g as a dated, macro model, g(60) being estimated on macro data for the 60s and similarly for g(70). The shift from g(60) to g(70) is what we call "structural change". It can be "quantified" in terms of the changes in the matrix of estimated coefficients. To explain the shift, however, we must understand the underlying common structure ψ, which includes a micro representation of the supply process.

3 EXPERIMENTS AND NUMERICAL ILLUSTRATIONS

We have argued that, when demand and supply relationships are interdependent, at the micro level the concept of an equilibrium gets blurred and mingles with the concept of stability (also see Sharefkin's paper). We asked whether the notion of a stable equilibrium carried any useful information at all in an analysis of a market economy with an endogenized price system subject to shocks. One particular aspect of this problem is under which circumstances <u>structural (q) adjustment</u> driven by induced price change ($\dot{p} = F(g)$) is a stable process in our particular meaning of uniform convergence, namely when it takes place within a bound-region in the space of particular target variables. In what follows this problem will be investigated and illustrated through experimentation with a micro-to-macro model of the Swedish economy, called MOSES. (This model economy endogenizes both relative price change and structural responses.) Economic growth is endogenous under an upper technology constraint on individual firm investment. Firms consistently strive for higher profits on the basis of adaptive price expectations ($\dot{p} = E(\dot{p}(t-1), p(t-1)..)$. This will lead to maximum profits if and only if price expectations are realized over the indefinite future.

Our analysis is carried out in three stages. Two versions of the model are used: one initialized in 1968, using predominantly synthetic firms with unrealistically equal labor productivity, profitability, and capacity utilization characteristics across the firm population, and one initialized in 1976, with 150 real firm units covering some 80 percent of value added in Swedish manufacturing industry. In the latter case, the micro performance distributions are very accurately represented across the firm population in the initial year 1976.

In <u>step one</u> we run an extensive series of experiments on "one shot" price shock experiences on the 1968 firm distribution, using a variable market and individual firm parameter design to mimic different market regimes. This set of experiments, reported in some detail in the appendix, also gives us some familiarity with this, still unconventional model economy. The firms in the model economy are subjected to the 1969 through 1973/74 price experience associated with the "oil crisis". From 1976 on, foreign relative prices (exogenous) are returned to the earlier, stable trends of the years 1963 through 1972. Some of the experiments are then rerun with identical parameter specification on the more realistically structured 1976 data base and results are compared.

Step two contains a series of relative-price induced structural adjustments (price pivoting) under variously specified market regimes on the 1968 data base. This time, the relative price trends that began with the oil crisis are either continued through 1987 or accelerated.

Step three, finally, reports on attempts to move the realistic 1976 model economy onto a steady-state macro-level time path by enforcing a set of internally consistent exogenous assumptions on inter alia foreign prices, the interest rate and technical change embodied in new investment vintages. Those exogenous assumptions are imposed in a fashion that should not disturb the system unduly. It should be observed, however, that the Swedish economy in 1976 (the initial year) represented a substantially disturbed economy.[4] Hence, the initial state from which simulations began underimposed, external (foreign prices etc.) steady state conditions, means a significant initial disturbance.

The purpose of these "historical" and very long (50 years) experiments is to investigate the long-run stability and convergence properties of the micro-to-macro model. We want illustrative answers to the question: do we want stability and convergence, and if so, exactly in what sense?

The Optimal Rate of Structural Change

Price Shocks

In the first set of experiments we found:

I:1. For the 1968 initial structural specification of the production sector (with little structural diversity between firms), and for trend projections of exogenous variables there seems to exist a firm and market behavior parameter region within which the economy adjusts to a long-run growth trend with fairly long swings in output and employment. The amplitude of those swings is within long-run historic experience; this is our definition of stability. (Also see Figure 5 and the accompanying text.) The market and firm behavior parameters determine whether the generated trend can be supported in the very long "historic" term.

I:2. The ability of the economy to stay within the stability region for a particular shock and a particular parameter specification depends very much on the initial efficiency distribution of production units. Generally speaking, the more equal the firms, the more likely that large chunks of the population of firms will collapse in response to a large relative price change. The economy will then be thrown outside the boundaries of the "stability" region, and will be thrown further the speedier firm and labor responses to price impulses. (Cf Eliasson 1978a, pp 105 ff, Eliasson 1978a, pp 72 ff.)

I:3. The more unstable the relative price structure, the more erratic economic development and the lower the rate of trend growth generated.

I:4. We infer that for each initial, "structural" representation (state) of the micro units there exists a response parameter specification that ensures approximate stability (boundedness) and a higher growth rate (the optimal structural adjustment speed).

This set of experiments suggests that long-run stable growth at the macro level requires a rich variation in micro structures. Such an observation runs counter to the idea of generally stable growth patterns at lower micro levels. Two conclusions follow from this. First, growth models in which growth is endogenized, have to be rich in micro specification for a stable long-run growth trajectory to be generated. Second, that richness in micro-variation also has to be dynamically unstable. In such a model set, to which the MOSES model economy belongs, one should perhaps not be able to prove the existence of a competitive equilibrium, even as an ex ante state.

Price Pivoting

In the second set of experiments we change the competitive conditions affecting Swedish model firms in foreign markets. The experiments are carried out on three different initial structures;

(1) all synthetic firms with little between-firm diversity (1968 initial year),

(2) half of the sample of real firms, but with a data base that is incomplete in important respects. Somewhat more between-firm diversity (1968 initial year).

(3) Most firms (150) real. Complete micro data base. Very good quality representation of initial micro structures for initial year 1976.

In all three experiments, relative prices were pivoted in favor of engineering industries against raw material industries, or vice versa. The same aggregate manufacturing-industry price development was employed in all the experiments.

The experimental results support our earlier findings. Changes in competitive conditions in foreign markets require an adjustment of domestic supply structures; capital must be scrapped and new capital accumulated. There is an intermediate period of output losses and a slow-down in economic growth that persists, at the end of the experiment period (30 years), in all runs.[5] This loss is fairly small, in the long term, when foreign relative price change is slow. When "price pivoting" is rapid, on the other hand, the relative price structure of the economy is disrupted (see Josefsson's-Örtengren's and Genberg's papers in this volume). Under those circumstances, we must recognize and distinguish between two kinds of dynamic, allocative losses. First, there is an "allocation loss" due to faster scrapping of output capacity (remember that no subsidies etc were introduced in these experiments) than the compensatory accumulation of new, competitive capacity. Second, the market price disturbance generates errors in both employment, production and investment decisions at the micro level. The effects of those errors on prices and capacity linger on for many years.

Historic Experiments

The third set of experiments on the new 1976 real firm data base was designed to investigate the feasibility of moving a "real-life model economy" onto something that resembles a steady state macroeconomic growth path. That path should stay close to some exponential growth path, given a set of internally consistent input "signals". The initial 1976 state was a state of disrupted supply conditions ("disequilibrium"). Forcing long-term, consistent external steady state conditions on the firms of the model economy (different from those that had prevailed on the average for the 20 or so years preceding 1976 and definitely at variance with the 1976 supply structure) amounts to an additional shock to the firms. The experiments were carried on for 50 years by quarter, and the reader should note carefully that these experiments were only for analytical purposes. We do not pretend to have made any kind of forecast.

We were also interested in the behavior of individual firms in the macroeconomy when positioned on that sort of steady path.

III:1. We were only partly successful in obtaining a steady state representation of the economy. It appeared as if both cyclical and very long macro fluctuations are needed for sustained economic growth to occur. If an extended boom without cycles was engineered for a long period an equally extended collapse or period of stagnation tended to follow. Such long boom periods forced "equality" and more parallel growth pattern on the firm population -- and vice versa -- by forcing the low performers to exit. More concentration followed.

III:2. The model has endogenous exit. But there is no "entry of firms device" in the current version of the model. In experiments of 50 years (200 quarters) or more the model is effectively subjected to a gradual, structural decay in the sense of diminishing micro (structural) variation. After 30 years between 78 and 97 of the 150 initial firms shut down. We conjecture that this may be the reason for the apparent macroeconomic collapse in some of our experiments. With steady entry of new firms, some of them more innovative and competitive than the best existing firms, industry structure would be updated. We hypothesize that this would have made the model economy more robust against external shocks. Such long-run experiments are very costly and we did not have the opportunity to rerun the model with an entry feature (see Eliasson 1978a, pp 52-55).

III:3 If the market regime is very responsive to external market changes a medium term allocative ("static") efficiency improvement can be obtained. In the longer term, however, competitive fall-out and "structural equalization" (due to such "forced short-term optimization") makes the whole industry very sensitive to small disturbances. If too much feasible efficiency is squeezed out of the economy in the short and medium term, the economy becomes more vulnerable to disturbances of various kinds.

One concluding hypothesis (not yet satisfactorily demonstrated through simulation experiments) is that competitive equilibrium conditions may be a non-attainable state in a dynamic micro-to-macro model economy. As model economic performance approaches this state the competitive process weeds out low performers and diversity decreases. The entire economy grows increasingly unstable (collapse prone). If you manage to steady the price structure you destabilize quantitites and vice versa.

Our conclusion is that long-term stable economic growth at the micro level in the micro-to-macro economy that we are investigating requires a wide and constantly changing performance dispersion among the participating micro units. Wide but realistic dispersion was assured initially (in 1976) through the real firm data base. Continued and changing dispersion, however, requires that no structure g of ψ be a proper subset of g(t-1). Since model structures at various points in time are proper subsets g(t-1) ε g(t), the model structure is gradually losing structural content during the 50 year (quarterly) runs reported on in the next section, and the whole model gradually converges to a very simple one-sector, one-firm model (concentration tendencies) where the whole price mechanism becomes unsettled and finally breaks down, generating strong cyclical fluctuations at the macro level. We have not had the time and resources needed to activate the entry module (see Eliasson 1978, pp 52-55) of the economy to test the interesting hypothesis that persistent structural dispersion (as opposed to convergence upon simpler and simpler structures) is a prerequisite for steady, long-term macroeconomic growth.

4 POSTSCRIPT ON OUTPUT COLLAPSES, CONTROLLABILITY AND THE NON-ATTAINABILITY OF AN EQUILIBRIUM STATE

If designed properly, the MOSES economy can be made to stay fairly close to a steady-growth trajectory for a few decades. During that period, productivity and other performance measures improve at a steady rate. But then some endogenous disturbance causes the system to "collapse" -- to fall far below the previously steady growth trajectory. In those cases where we have identified the cause of the collapse, either some large production unit has gone bankrupt or a sudden scarcity has developed in some market. The labor market and local or global wage formation is particularly critical in this respect. Sudden scarcity makes prices and/or wages rise rapidly, creating a chain reaction of output reductions in other markets. That collapse is, however, always endogenously slowed. Prices increase due to scarcities, investment and output slowly recover. The economy eventually returns to its previous steady-growth path or a new growth path and the reason has been a realignment of factor and product prices. Normally steady growth then persists for several years. If the experiment is allowed to continue, however, prices and quantities will eventually be incompatible and again the situation may be resolved by another collapse.

We call such collapses "instabilities" even though they are of limited duration and even though the economy -- the goal variables -- recover and resume their steady growth. In some simulations on some market specifications ("regimes") they appear only as short and long cycles around an endogenously determined trend.

This account of the MOSES simulations suggests an explanation of the disorderly economic behavior in the world economy after 1973. The late 50s and the 60s saw a gradual smoothing of the business cycle, and a gradual increase in capacity utilization rates throughout the production system of the industrialized world. The maintenance of countercyclical and slowly-increasing excess-demand pressure through Keynes inspired demand policies was undoubtedly at least partly responsible. The production efficiency of the industrialized world increased. This was manifested in higher total-factor productivity growth rates. We know from our simulation experiments that such a development breeds inconsistencies between quantity and price structures and is usually accompanied by an increasing sensitivity of the (real) economy to both external and internal (endogenous) price disturbances. Such inconsistencies ("tensions") may be gradually released if both the price system and quantity structures are flexible and align in the right proportions to produce long and moderated swings around a steady (endogenously determined) growth path. Flexibility can, however, be both too slow -- creating rigidities -- or too fast -- creating erroneous adjustments (overshooting etc). The conjecture would be that 10 to 20 years of successful demand management in western economies coupled by institutional and legal change that fixed both prices and quantities in past structures had eventually fostered a fragile, inflation- and collapse-prone global economic system. That system was thrown into a state of disorder by various disturbances, the most important being the 1973/74 oil price hike. On top of this came the apparent inability of policy authorities and their advicers to understand what was going on.

Analogies from much simpler physical systems may be useful here. The Northeast (U.S.) electricity blackout in 1965 is a case in point. Let us describe that collapse in terms suggestive of the economic mechanisms at work in MOSES.

The electrical power grid of the Northeastern U.S. is (and was at the time) automatically interconnected. A failure in part of the system was automatically compensated for by supplies from elsewhere or by the activation of reserve generating capacity. Two general properties of such systems are relevant here. First, the more efficiently tuned (the less spare capacity, or slack), the less the ability of such systems to cope with component failures.

Complex systems of the kind we are discussing are not well understood in all their details, and that was even more the case in 1965. They can usually be controlled only in some normal operating domain. Simplified, operating rules then apply and can control the system. The entire system (our ψ above), however, requires such a large number of combinations of rules to cope with all conceivable incidents that a listing of rules for all contingencies is infeasible. Not even extensive computer simulation studies of the entire system can identify event sequences that may be catastrophic. Such an unlikely sequence led to the 1965 blackout.

An economy is vastly more complex than a large, modern power grid. Economic blackouts are even more likely for the national economy; only their timing can be surprising.

One might then argue by analogy, that the extensive political manipulation with the Western industrial economies during the rise of their welfare state systems has carried those economies out of their normal operating domains and into inflation- and collapse-prone domains. Contemporary economic science has only a rudimentary understanding of those domains.

Within large, complex systems, the distinction between exogenous and endogenos triggering mechanisms becomes blurred. An oil price shock, or the failure of a power generator in a complex grid, would normally be called exogenous; but the consequences, which arise in ill-understood ways, arise from intrinsic features of the system.

Returning to the MOSES economy, one might say that even though the Swedish economy is vastly more complex than the 1965 Northeast power grid, the MOSES representation of it is not. Still, the MOSES economy exhibits instabilities of a similar, structural kind.

SUPPLEMENT

EXPERIMENTAL DESIGN AND RESULTS

a) The Micro-to-Macro Model (MOSES)

This article does not allow a satisfactory description of the micro-to-macro model used as analytical instrument.

The principal idea behind the model design, however, is that long term investment financing decisions within each firm are organizationally separated from short term production and employment decisions according to what we call the additive targeting theorem (Eliasson 1976a, p 291ff). A stylized version of the production and employment machinery with a stochastic interpretation added can be found in Sharefkin's paper in this volume.

Investment spending follows a rate of return dependent cash flow that is held back by an acceleration (capacity utilization) regulator as described in Eliasson-Lindberg (1981).

The most important exogenous variables are:

- The domestic interest rate (in these experiments),
- foreign market (relative) prices (see Eliasson (1978)),
- technical change in new investment vintages at the firm level (see Eliasson (1980)) and
- the labor force.

The economy is driven forward in time by these exogenous inputs only. Technical change in best practice vintages is projected forward from estimates made in Carlsson-Olavi (1978) and Carlsson (1980). Technical change is transformed into productivity growth through the individual firm investment decision each period and the current (endogenously determined) operating status of that additional capacity. Hence, economic growth is endogenously determined under an upper, unattainable technical constraint. In the short term this constraint is determined by the best alternative allocation of labor over existing vintages of capital in firms. In the long term the upper constraint is defined by the best of all possible allocations of investment resources in the model over some chosen "long-term period".

The macro household consumption system builds on modified estimates from Dahlman-Klevmarken (1971) and the income tax system is based on marginal macro tax rates estimated in Jakobsson-Normann (1974) with indexation from 1975 and onwards. This closes the demand and supply sides of the MOSES economy.

A principal presentation and overview of the model is found in Eliasson (1978a and 1983). Bergholm (1983) presents the current operational status of the model and Albrecht-Lindberg (1983) the micro data base used for initializing the model runs.

b) The 1973/74 Oil Price Shock Accomodation under Various Market Assumptions - Step 1

In the first experimental round we designed a set of experiments on a real firm data base, but with incompletely specified initial, structural conditions. Most importantly, the spread in production efficiency - measured by labor productivity - under normal capacity utilization across firms was unrealistically small.

As exhibited in some detail in Tables 1 through 3 we had four different experiments set against a reference run and reality; high, semi-high, slow and very slow response. To get familiar with these "market regimes" the reader should first consult Table 3. The market response parameters are explained in Table 2. In Table 3 they have been varied, one at a time, and the macroeconomic outcome has been compared with a chosen reference run. The results are commented upon in a separate text accompanying the table. Each of the four market regimes in Table 1 represents a certain combination of response parameters in Tables 2 and 3.

We ran the real foreign relative price scenario through these four economies for the years 1968-1975. Relative prices then took on a continued stable trend together with all other exogenous variables from 1976 through 1988. Tables 1 and 3 show simulation results for the first 8 years only.

This meant that relative price experience, interpreted by firms in the data base from 1963, was a fairly reliable predictor of future price change through 1970. There is a brief recession experienced by all in 1971, followed by a dramatic disruption of past price experiences, both relatively and absolutely, especially for basic industries through part of 1974, followed again by a complete and unexpected reversal. Price expectations in firms are formed in an adaptive, error correcting ("learning") fashion. If price development follows a stable cyclical pattern, firms are gradually learning to predict with some reliability. When this pattern in price behavior disappears -- as it did after 1974 -- firms first projected past patterns and made production and investment mistakes. When the error learning mechanism failed to predict well they became confused and adopted a cautious stance, in the sense that prices were underestimated and wages overestimated compared to what the same price signals would otherwise suggest.

High or fast market response means that a firm puts heavy weight on recent experience and responds very rapidly with quantity adjustments. Slow is the reversed situation. High (fast) response would guarantee rapid approach to a steady equilibrium point, if it exists. All actors in the market would learn the signalling code and expectations would appear to be rational. If the equilibrium is not stable because firms are adjusting too rapidly according to erroneously perceived future prices, the price system that determines the "equilibrium position" is disrupted again. The same expectational assumptions at the micro level would generate price expectations that, for instance, would not approximate -- within a meaningful time horizon -- what a rational expectations hypothesis would predict.

Macroeconomic behavior of the model is illustrated in the table. Over the "real time" period the normal and the semi-high market response patterns generate the highest growth rates that are also reasonably close to reality, as shown in the left hand column. The fast and the slow response patterns are not so good. The industrial sector loses almost half of its growth momentum during the 8 year period ending in 1975. Hence, extreme market regimes (very speedy or very slow) do not seem to be conductive to growth in this experimental setting of the model economy.

However, when the exogenous environment is allowed to stabilize on past trends from 1976, things are reversed again under some market regimes. Firms gradually learn to interprete price signals and to predict. Under other regimes a destabilized economy never gives domestic prices a chance to stabilize even though foreign (exogenous) relative prices are forced back (exogenously) on a steady state development.

The high response economy (called 822 in Table 1) is in a bad shape, exhibiting rapidly adjusting investment and production decisions along tangential expectations, that turn out to be all wrong. The economy collapses over the next 10-15 years, registering a steady decline in industrial production of 7 % per year.

However, the very cautiously-responding decision makers of experiment 831 that have not adjusted their structure very much and that have remained faithful to historic, pre-crisis price experience, of course benefit from the return to past price trends. Their old assets suddenly became profitable again. They win out substantially in the overall 20 year run.

To judge from Josefsson's-Örtengren's (see their paper in this volume) historic price study, relative domestic prices on manufactured goods, in fact, more or less returned to pre 1973/74 positions by the end of the decade. When that relative price structure is imposed in the experiment on foreign prices towards the end of the 80s, the results mentioned above were obtained. In reality, on the other side, a new OPEC price shock occurred in 1979, and threw the economic system into turmoil again.

Table 1 **Shock accommodation under different market regimes. Eight year experiments beginning 1968 (endogenous variables)**
Percentage change per annum, when not otherwise indicated in variable list

	REAL	REF 800	LOW LOW 831	LOW 821	SEMI HIGH 832	HIGH 822	1000	REF 1035
Q	6.4	5.0	3.7	4.5	3.1	-7.1	5.9	5.6
L	-1.3	+0.8	-0.2	-0.5	+1.8	-10.3	0.8	-0.2
PROD	5.5	4.8	4.4	5.5	3.0	11.0	5.9	5.8
PDOM	6.1	7.0	5.8	7.0	8.5	9.1	7.0	7.7
W	12.7	13.0	2.8	16.7	13.7	28.1	14.0	15.7
M	31.5	40.9	47.4	37.9	43.5	29.5	40.8	33.0
A21	7.8	4.4	8.6		4.7		4.1	3.8
A22	6.4	14.1	15.0		15.1		14.5	13.2
RU	(2.0)	6.3	8.9		6.7		5.9	3.3
CON	2.7	-0.2	-1.7		-1.5		-	6.0
GNP	3.1	3.7	2.2		3.2		4.6	5.7
CPI	6.4	6.7	6.0		7.7		6.5	7.2
DI	11.1	6.9	4.4		6.5		7.2	13.1
SAVR	3.0	3.3	2.0		3.1		5.0	8.3
RI	7.3		-		-		2.6	6.3
X	31.6	33.3			-		33.4	29.0
IMP	28.6	24.5			-		25.0	27.4
BW	13.5	14.4	11.2		13.8		19.1	17.7
NW	10.4		5.9		8.6		-	5.4
X(vol)	6.2		7.5		7.5		10.1	8.8
M(vol)	(6.2)		2.6		2.0		6.8	9.8
Production by subindustry								
(1) RAW	6.5	6.4	5.4				7.3	7.1
(2) IMED	3.2	5.5	4.7				6.6	4.8
(3) INV	6.8	4.1	3.0				5.1	4.9
(4) CON	2.5	4.6	2.9				5.5	5.7

Note: Symbols are explained on next page. Numbers in headings are identification numbers for experiments. We have kept them for easy reference both in text and back to sources.
A reference case (REF) is a carefully calibrated model specification that reasonably well tracks the trends of the real national accounts variables (see Eliasson, 1978a, pp.32-51). The main difference between REF 800 and REF 1035 is that experiments with numbers above 1000 have a monetary sector with an endogenized domestic interest rate turned on -- the foreign interest rate is exogenous. Note, however, from Table 2 that some other parameters also had to be changed to obtain satisfactory tracking performance.
Since experiments in tables 1, 2 and 3 were run a couple of years ago -- partly for other purposes -- all data have not been com-

Table 2 Parameter specification

	800	821 (Low)	822 (High)	832 (Semi-high)	831 (Low Low)	823	824	825	826	827	828	829	830	1000	1035	1036
NITER	9	9	18	12	5	12								9	9	
KSI	0.15	0.15	0.5	0.3	0.1		0.3							0.15	0.25	
IOTA	0.5	0.5	0.9	0.6	0.3			0.6						0.5	0.5	
SKREPA	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	
MAXD	0.06	0.06	0.18	0.18	0.03				0.18					0.06	0.06	
MARKETITER	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GAMMA	0.1	0.3	0.1	0.1	0.3					0.1				0.1	0.1	
THETA	0.01	0.01	0.05	0.03	0.005						0.03			0.01	0.01	
TMX	5	5	1	3	7							3		5	3	
TMIMP	5	5	1	3	7								3	5	3	

Variable list

Q; industrial output
PROD; labor productivity
M; profit margin (percent of value added)
A22; unused machinery capacity
GNP; Gross national product, constant prices
DI; disposable income, current prices
RI; rate of interest on industrial loans, (exogenous in all experiments except 1000 and 1035)
BW; borrowing in manufacturing sector
X(vol); export volume

L; industrial employment
W; industrial wage cost level
A21; labor hoarding (percent of employed, measured in hours)
RU; unemployment (percent)
CPI; consumer price index
SAVR; household savings ratio (percent of DI)
X; export ratio (percent of gross output)
IMP import ratio
NN; net worth (nominal) in manufacturing sector
M(vol); import volume

Table 3 **Sensitivity analysis, single parameters**
Trends 1968-75 for manufacturing (8 years)

	REAL	REF 800	831 Low Low REF	823	824	825	826	827	828	829	830
DQ	6.4	5.0	3.7	3.8	3.8	4.4	3.8	3.7	3.7	4.7	4.3
DL	-1.3	+0.8	-0.2	0.3	-0.1	0.4	+1.3	-0.2	0.4	0.4	0.3
DPROD	-	4.8	4.4	4.1	4.5	4.6	2.8	4.4	3.8	4.8	4.6
DPDOM	6.1	7.0	5.8	5.8	5.8	5.8	7.6	5.8	5.8	6.6	5.8
DW	12.7	13.0	2.8	4.4	4.9	6.3	4.3	2.8	3.2	8.8	4.4
M	31.1	40.9	47.4	46.6	46.6	43.9	49.1	47.4	46.8	46.0	46.8

Explanation to Table 3

The reference for the single parameter sensitivity analysis is the low-low market response case in Tables 1 and 2. Note that the table only exhibits 8 year runs. In the longer term some of the effects may not be sustainable, for instance, the positive output effect in experiment 825. For such experiments see Historic experiments below.

First (823) we more then double the number of searches each firm is allowed in the labor market each quarter (from 5 to 12 = NITER, see Table 2). Obviously most labor is being reallocated and industrial employment increased compared to the reference case. A substantial increase in wages over the reference case is observed, but only a very small, positive output effect. Profits suffer.

Second (824) the propensity of (the extent to which) a firm in search of labor to upgrade its own wage level when it meets another firm with a higher wage level is increased from 10 percent to 30 percent (=KSI). Again, only an extra wage escalation that eats into profits can be observed.

Third (825) we double the fraction of the expected next year wage increase that the firm uses as its initial offering bid when entering the labor market (from 30 to 60 percent = IOTA). This time wage escalation is even higher and the profit margin decrease larger, but a stronger positive output effect from the reallocation of labor can also be observed. Total manufacturing output grows .7 percent faster per annum 1968-75 than in the reference case. The reader should note here that model specifications are such that firms needing more labor for profitable expansion enter the labor market first.

Fourth (826) the imposed restriction on product price dispersion (fraction by which price increases are allowed to differ from expected values during one year = MAXDP) is lifted from 3 percent to 18 percent. The result is higher product prices, higher profit margins and more employment, but no more output. Labor productivity growth is almost halved.

Fifth (827), the reservation wage of the worker is lowered. He now moves in response to a wage offer only 10 percent (=GAMMA) above his correct wage, rather than 30 percent as in the low-low response reference case for these experiments. Everything else being the same, there is very little macroeconomic change to observe in the table.

Sixth (828), we raise the proportion of a firm's labor force that is allowed to quit in response to a generous wage offer from one raiding firm from 1/2 percent to 3 percent (=THETA). The macroeconomic response is higher wages, smaller profit margins, more employment and less productivity growth, but no positive output effect.

Seventh (829). Export price elasticities are raised. Firms aim at adjusting their export ratios to levels motivated by foreign domestic price differentials in 3 years rather than in 7 years (=TMX). This time a strong output expansion propelled by export growth sets in. It is, however, inflationary in both domestic prices and wages, and the cost for firms is somewhat lower profit margins (a higher wages share).

Eight (830). The same variation is now imposed on import price elasticities. The effect on output and domestic employment is the same. Increased foreign price competition, however, leads to no extra domestic price increases.

c) Price Pivoting - Step 2

In this set of experiments the structural adjustment of the economy to post 1973/74 (oil shock) relative price signalling is studied under three initial structural specifications. External conditions ("price pivoting") are imposed by pivoting relative foreign prices against, or in favor of, certain markets, while preserving the time development of the aggregate industrial export price index.

In the first simulation round - shown in Figures 4 - structural variation across the initial firm population is small. The micro firm data base is all synthetic. The productivity spread across the firm data base is very narrow. In the second round of experiments we used the new real firm data base with half the number of firms being real and with more across-firm diversity in terms of initial productivity. A more elaborate set of experiments, with both differing tax and market regimes, on exactly this second experimental set up has already been reported in Eliasson-Lindberg (1981). The two sets of experiments were initialized on the 1968 data base. 1968 was a fairly normal recession year of the 60s.

A third set of experiments (not reported on) has been run on the new 1976 data base with 150 real firms. Practical reasons and costs prevented an identical experimental design. Nevertheless, the results from the third set of experiments emphasize the differences observed between the two first experiments, namely that structural variability is imperative for economic systems stability when the economy is subjected to exogenous disturbances. If this is a normal property of an economy it indeed warrants further empirical inquiry. This same 1976 initial data base will be used in the historic experiments to be reported on in the next section. It was also used to analyze the shock-like interference in the Swedish economy of an extreme industrial subsidy program and the imagined (MOSES simulated) withdrawal of these subsidies (Bergholm-Carlsson-Lindberg, 1981). The 1976 real firm data base is described in Albrecht-Lindberg (1983).

From this also follows as a supplementary suggestion that, if you do not properly specify and measure your initial conditions, you cannot say very much about the results of any policies or parameter variations. Initial conditions dominate the dynamic nature of the effects. Comparing two equilibrium situations does not appear to be a very interesting or fruitful exercise at all after this inquiry.

Some results from the first set of experiments on all synthetic firms are shown in Figures 4. The second set is reported on in much detail in Eliasson-Lindberg (1981. To get the exact meaning of price pivoting, see Figure 2, page 402.) Because of that we only report briefly on the results. In both cases relative prices are pivoted slowly (5 years) and rapidly (one year) against and in favor of basic industries respectively. After pivoting, the realized relative price spectrum is preserved throughout the 20 year period studied. It appears that rapid relative price pivoting

Figure 4 Sector outputs, profit margins and labor productivity developments in price pivoting experiments
Index 100 = Reference Run

Figure 4A Output (Q) with relative foreign price pivoting in favor of raw material industries (RAW)

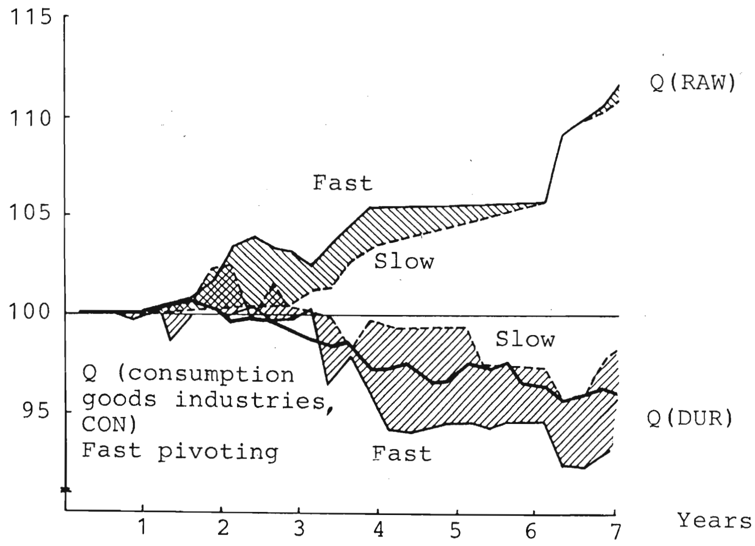


Figure 4B Ditto, pivoting in favor of durable goods industries (DUR)

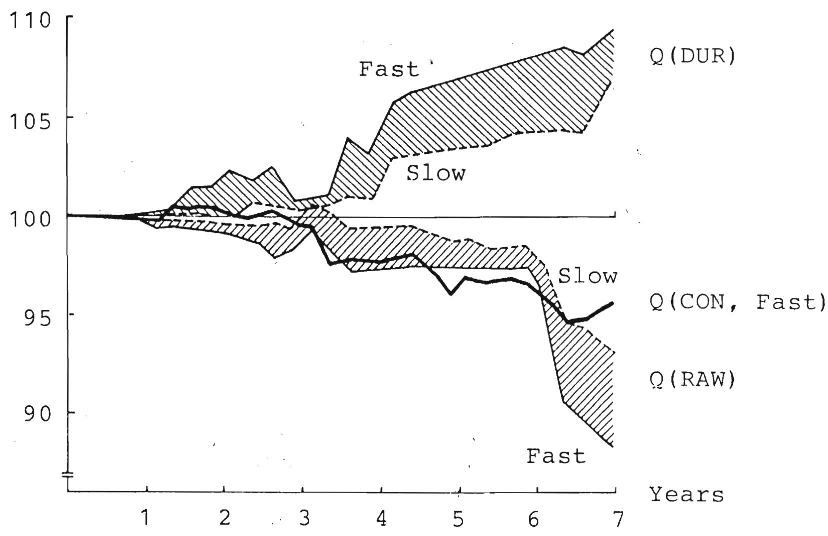


Figure 4C Profit margins in fast and slow pivoting experiments

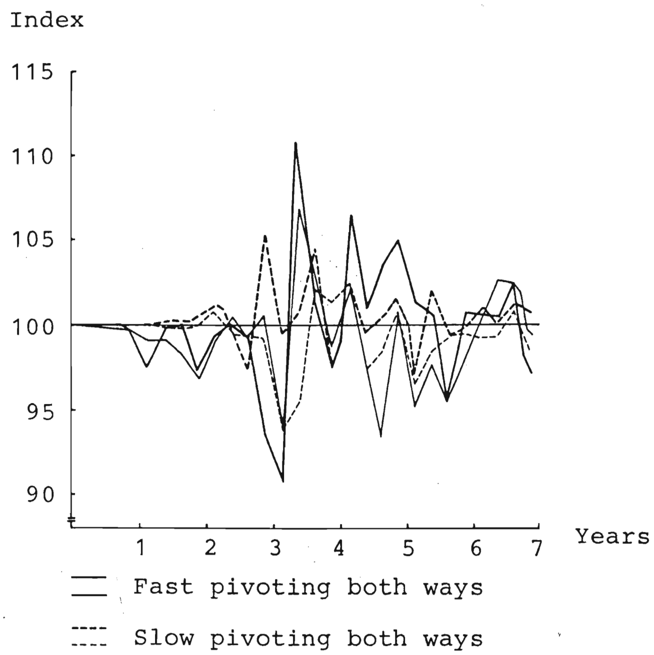
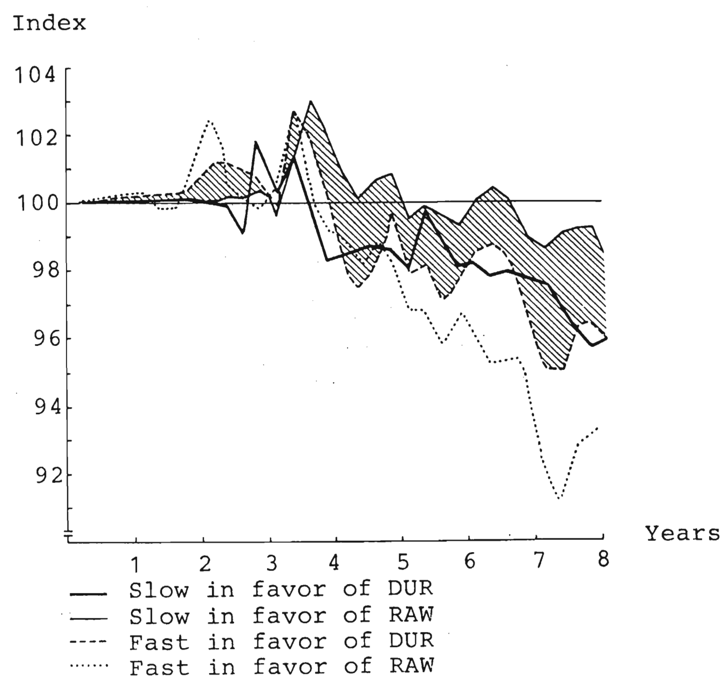


Figure 4D Labor productivity developments, all manufacturing



under a fast market response regime is an unstable combination that makes the economic structure prone to collapse. Total output decreases.

One expected result is clearly exhibited. The price-favored sector gains in output growth and vice versa. Overall manufacturing output growth decreases for all of the 20 years of the experiments, but more so the faster the pivot. The decrease appears larger when pivoting is in favor of raw material producers, probably because raw material producers were relatively less efficient in the initial 1976 state.

Average manufacturing productivity declines in all experiments relative to the reference case (Figure 4D). Profit margins, however, stabilize in all experiments around the level of the reference case, even though the ups and downs are larger in the fast pivoting experiments (Figure 4C).

The less across-firm variability in productivity performance, the more likely that a large fraction of output capacity in the sector that is hurt by the market development will be forced to exit at an early stage, generating a sudden supply vacuum in that market. A temporary increase in the domestic price level much above the foreign price level, and an excessively rapid expansion in the remaining firms, are consequences. Then follows a sudden influx of imports that takes the domestic price level down below the foreign price level. This instability keeps repeating itself and spreads to other sectors.

The more initial, structural variation and the smaller (slower) the quantity responses of the system per unit of time, the smaller the total output loss over the entire experiment.

d) Historic Experiments - Step 3

The goal of this experiment was to define a set of consistent external assumptions for the model and then attempt to engineer a steady growth path of output determined by the underlying technology assumptions on productivity change in best-practice, new investments. The external assumptions were set up as follows:

		Annual change (percent)
(1)	Foreign price (each sector DPFOR)	5
(2)	Labor productivity in new investment (each firm, DMTEC)	2.5
(3)	Credit market loan rate	7.5
(4)	Labor force (net)	0
(5)	Public sector employment	1

These exogenous assumptions were imposed "for ever" after an initial adjustment period from "real" data 1976 of 2 years. No relative price change was assumed, and all firms drew upon a pool of equally specified investment objects.

Initial conditions end of 1976 are as observed in the IUI-Federation planning survey. Hence, as introduced in this set of historic runs, they are far from any kind of "equilibrium" state. Any change in external market conditions back to normal or back to a consistent and steady long-term input of exogenous variables would mean something like a shock for the firms residing in the initial state of the experiment.

Furthermore, the period preceding 1976 is one of abnormal change, due to the oil price disturbance. This shows up in the data base that defines the last 5 years of experience of the firms. Hence, the market environment of the firms at the end of 1976 has a very different interpretation and appears -- to them -- very difficult to predict. Generally speaking, firms' expectations (learning) functions would not generally predict well.

Wages are endogenously determined within each firm under a constraint: that firms try to maintain a profit margin determined from a long run profitability target as long as this does not mean that they plan to lower profits below a level that they expect is feasible. This means that firms allowing wage change to exceed

DPFOR + DMTEC = 7.5 percent

for many years will experience cash flow problems. If they continue they either have to shut down or dwindle away, since they cannot finance continued investments.

The long-run profitability target is imposed through the credit market (exogenously here). Firms invest in the long run in proportion to their real rate of return, and they borrow to invest in excess of internal cash flows in proportion to their excess rate of return above the market loan rate.[6] Hence the exogenously applied loan rate will eventually dominate both the investment and the short term (quarterly) production decisions.

Since individual-firm profitability will eventually depend on the "equalitarian" productivity assumption in new investments, one would expect that very similar rates of return will eventually obtain across firms, namely when all pre 1976 vintages have been replaced by new investment. In the longer term a 7.5 percent nominal rate of return equal to the interest rate should prevail.

Thus, in the long-run all firms should be very similar, it appears.

Three differently-specified market regimes are sufficient to illustrate our arguments. In the low or slow market adjustment regime (specifications are identical to those in Table 2) firms are slow (KSI is low) to upgrade their own wage level when they learn about firms that have higher wage levels. Firms are slow in looking for new labor, when they need it (NITER is low). Even though firms expect a wage increase next year they offer only a small fraction of the expected increase when they enter the labor market to hire people (IOTA is low). Firms are slow to adjust prices above or below expected levels when the market is expansive or in recession (MAXDP is narrow). Workers have a high reservation wage: they require a fairly large increase above the current wage to move (GAMMA is high). Finally, only a very small fraction of a firm's labor force leaves each time the market (other firms) offers generous wage increases (THETA is small). In the high or fast market response case (822) all those parameters are changed in the opposite direction, as specified in Table 2. There is a normal market regime (REF = 800) identical to the low case except for the reservation wage. Workers leave for the same wage increase offer (more than 10 percent) as in the high response case.

What do the simulation experiments tell us? The story is very straightforward (see Figure 5).

The high market response case generates an initial period of fast output growth. For thirty years, output growth is close to what is feasible. (The upper line (MAX) defines maximum output growth with no additional labor input and all installed capacity replaced by new vintage capital each period.) Firms are very competitive, and each sector is restructuring very fast in response to the adjustment in foreign prices imposed by the experiment. A large number of firms are competed out of business, and the remaining firms (in each sector) are beginning to take on very similar performance characteristics. Laid off labor is not rehired because the achieved industrial organization is very efficient. The reason for this high performance up to the year 30 is essentially the high utilization rate of existing capital. Apparently this steady, fast growth situation is not very stable. A few large firms need more labor just after year 30. To get it, they increase their wage offers more than had been normal earlier, and other firms start losing workers (because of fast response assumptions). All other firms rapidly adjust their wage levels, and a whole range of similarly profitable and productive firms suddenly find themselves in a distressed situation. A wave of bankruptcies and exits follows, and the economy goes into a tail spin. 30 years of fast growth is replaced by an almost 15 year period of complete stagnation until the economy begins to recover. In the high-high market response case (not shown), the growth period is terminated even faster and the following depression is extreme.

In the low response and the normal cases there is no initial, fast growth period and no collapse. The low response case yields a long run 50 year terminal output level almost equal to that of the high response case after the collapse. The normal case (REF) yields a substantively (30 percent) higher terminal output level, corresponding to roughly 0.7 percent faster output growh per year.

One can note from the diagram that average profit margins are lower and more unstable in the high market response case, although the business sector manages to restore long-run profitability at the expense of less investment, less growth and higher unemployment.

Long-run manufacturing output growth is increased even more if the government abstains from drawing one percent extra from the labor force every year (REF 2). Manufacturing output now grows almost 0.9 percent faster per annum for 50 years than in the normal market case. More firms remain at the end of 50 years, and productivity growth is slightly slower (since the manufacturing sector now employs practically all people that went to the government sector in the earlier case). Unemployment was slightly higher in the beginning, then roughly the same (below 2 percent all years after 30 years). Profitability is the same as in the normal case but the output level is 50 percent higher, and 75 percent higher than in the low response and high response market regimes.

On the other hand, if the public sector pulls two percent, rather than one percent, extra from the labor market every year (i.e., if public employment increases exogenously by two percent every year) while the labor force does not increase at all, the industry sector collapses very soon, due to an extreme wage cost inflation that throws all firms, except the very best out of business (not shown).

A semi-high market regime (same as 832 in Table 2, simulation results not shown) produces expected results. The early, first 30 years' upswing and the following collapse are not as pronounced as in the high-response market regime. The economy has recovered substantially and much more than in the high market response case by the year 50.

An extreme low-low market response (same as 831 in Table 2, results not shown) produces an asymmetric set of results, fully compatible with our idea of an optimal rate of structural adjustment. In the high- and semi-high market response settings, adjustments of structures were too fast, and generated instabilities in the model economic system. This time adjustment is too slow, and the "steady state resemblance" of the REF and low experiments (see Figure 5A) disappears. After 20 years of fairly slow expansion, 20 years of complete stagnation in industrial output follows. During the last 10 years of the experiment, the industrial structure has finally adjusted to the steady state conditions imposed exogenously and a rapid catching up effect in output can be seen. By year 50 output has reached the level of the REF case.

The reader should note that assumptions about initial conditions and technical change embodied in new investment have been identical in all historic experiments reported. Experimental designs differ only by market regime. This should be sufficient to demonstrate the extremely important role of the market regime in explaining long-term macroeconomic growth.

Figure 5 **Historic experiments 1977-2027 (50 years)**

Figure 5A **Industrial output**
Index 100 = 1976

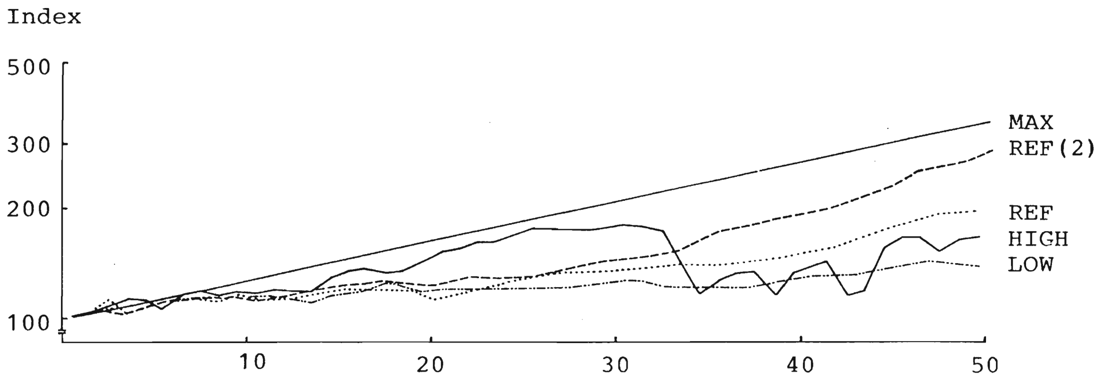
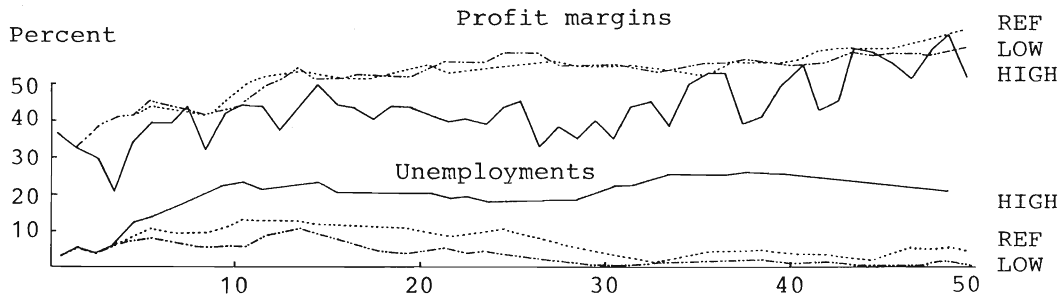


Figure 5B **Profit margins (percent of value added, upper part) and unemployment (percent, lower part)**



Two additional things should also be mentioned here. First, technical change at the plant level has been set roughly at the rate of growth that we have observed for best practice plants during the period 1955/75. Nevertheless, manufacturing output growth is only at about half the rate observed during that period or during the preceding 100 years. (If the rate of output growth in Swedish manufacturing had continued for the next 50 years along the 100 year trend established 1870-1970, output would have been more than four times larger -- and the index in Figure 5A at just above 1400 -- in the year 2027.) Two factors help explain this difference. This time best practice investment have identical characteristics throughout the manufacturing sector, and there is no growth in the labor force. Hence, there is much less potential for structural change than has normally been the case. When we introduce more diversity, larger long-term growth rates are normally obtained. But structural change, induced by different market regimes, nevertheless, manages to generate a growth difference of 1.5 percent per annum on the average for 50 years in the four cases reported on.

A second factor may, however, be an even more important explanation. The MOSES model as currently set up has an endogenous exit feature but no market entry. Lacking this innovative potential typical of a capitalistic market economy, the Swedish economy as described by the model is subjected to a gradual, structural decay. In short period (up to 20 years) runs this does not matter so much. In 50 year runs it matters a lot. Market competitive vitality is lost (as we have demonstrated in a few experiments with entry (Eliasson, 1978a, pp. 52ff)). Firms tend to become very similar, and grow in phase. The economy gets very sensitive to disturbances. The loss of diversity (to many exits) was what brought the MOSES economy down after 30 years in the high-market response case.

NOTES

1 Or a "generically stable process", as they are also called.

2 A similar kind of arbitrariness afflicts the choice of "lag length" in economic modeling.

3 This property has been observed frequently in the MOSES micro-to-macro economy, for instance when simulating exchange rate changes under variously composed initial conditions as to capacity utilization (Eliasson, 1977). Another example of this is that when an entry of firms module was added to a series of simulation experiments, relative prices stabilized compared to the case with no entry, because local bottlenecks disappeared at various points in time during the simulations. As a result of a more stable relative price development also economic growth was somewhat increased (Eliasson, 1978a, pp. 52-55).

4 For reasons of cost or time we have been unable to design the experiments in such a fashion that all results can be neatly exhibited and compared. There are several open ends, and practical considerations made impossible a revamping of the 1976 data base to a new base with more similar firms, which would have been the preferred experimental procedure. The results are, however, of such a nature as to warrant an exploratory presentation of this kind.

5 Note that we have later fed the model with the real price development 1973 through 1976 and simulated future development of the Swedish economy on the basis of real price development through 1980, on the 1976 real data base with and without the Swedish industrial subsidy program fitted in exact amounts to the actual firms that received subsidies. The results support the above conclusions. See Bergholm-Carlsson-Lindberg (1981).

6 The **profit targeting** and **investment** decisions can be briefly described as follows:

For the sake of simplicity, assume no dividends.

Goal variable = value growth of firm $=\Delta NW/NW$

NW = net worth (replacement valuation of assets).

$$\frac{\Delta NW}{NW} + \frac{DIVIDENS}{NW} = RNW = M * \alpha - (\rho + \frac{\Delta p}{p}) * \beta + (RRN - i) * \Phi \quad (1)$$

$\alpha = \frac{sales}{assets}$

β = fraction of depreciable assets in total assets.

ρ = depreciation factor

Φ = ratio of debts to net worth (NW)

RRN = Nominal return to total assets

i = nominal loan rate.

$$\text{Profit margin} = M = 1 - \frac{W}{P} * \frac{1}{Q/L} \tag{2}$$

Targeting applies to M.

A target on M can be determined by the help of (1) from a target on RRN (the rate of return). This target in turn can be derived from the nominal rate of return on net worth (RNW).

Given expectations on W (wages) and p (product prices) and a target on M, a labor productivity requirement follows from (2). This is the way the production decision in a firm is taken.

The decision to acquire further debt is linked to the difference (RRN - i) in (1). When new borrowing is determined also total available finance for investment is given from the production-profit plan. The investment - financing plan is realized if not held back by the existence of unused machinery capacity in the firm (endogenous variable).

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PART IV

POLICY MAKING AND DECISION THEORY

STABILIZATION AND GROWTH POLICY WITH UNCERTAIN OIL PRICES: SOME RULES OF THUMB

by Mark Sharefkin

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1 INTRODUCTION

The 1980s and 1990s promise to be a difficult period for stabilization and growth policy. One of the lessons of the 1970s--that our economies are vulnerable to oil import price risk--must be put to use. The question is how.

In trying to answer that question, we proceed by constructing several highly simplified abstract models. Each model aims at capturing some essential feature (or features) of the problems of macropolicy in the new, supply-troubled international environment of the 1980s. Policy instruments are identified and rules for deriving optimal policies are stated.

This paper has been written with macromodeling for Swedish macroeconomic policy very much in mind, but the author is relatively ignorant of Swedish conditions. Where there are suggestions for experiments with realistic macro models, the models in question are existing models of the Swedish economy. While it would be nice to have a new class of models built from the start with the new environment in mind, many crucial choices must be made long before a new model generation can emerge.

1.1 The Two (or Three) Energy Problems

There is a tendency to talk about "the" energy problem, but we all know better. At least two energy-related problems are worth distinguishing.

There is one looming reality: uncertain energy supplies and prices in the world markets of the 1980s and the 1990s. In a way, this is nothing new: import commodity price instabilities are familiar to every trading country. But oil is not just another commodity. It is the premier commodity traded internationally, and has few short-term substitutes. Because oil prices have since 1973 been set by OPEC, "forecasts" of future world-market oil prices rest in part on forecasts of the stability of the OPEC coalition, and thus upon the relative power of OPEC member states and world demand for OPEC oil.

Forecasting an oil price future is thus akin to forecasting, to the penny, what a compulsive gambler will be worth after a month in the casino of Monte Carlo. The oil-importing countries face an energy price lottery over that period, and what should be "forecast" is the lottery: the spread of future energy prices which must be taken seriously. Identification of the large and noninsurable price risks of oil import dependence as "the" energy problem is our point of departure.

To go further, we need ways of connecting that oil price lottery, and our devices for dealing with the problem, with our objectives. In jargon, we need models tying together the lottery on oil prices, our policy instruments, and our policy objectives. Since the set of policy instruments at our disposal changes with the time horizon over which they can be deployed, we distinguish two kinds of energy planning periods: a short or middle term of about 2 to 5 years, and a longer term of about 10 to 20 years.

1.2 Energy Policy in the Short-Term

The 1970s have been, and the 1980s and 1990s promise to be, periods in which stabilization policy is destabilized. Prescriptions and decision rules accumulated during the steady expansions of the 1950s and 1960s will be challenged. The oil-import price-risk problem will command careful examination.

What went wrong with conventional stabilization policy in the 1970s? There will never be a decisive answer; we are still far from agreement about the causes of the worldwide depression of the 1930s. But the macroeconomic disappointments of the 1970s have forced macroeconomists to regroup in two camps. In the first camp there is insistence that years and perhaps decades will pass before we have a "good" macroeconomics. Meanwhile, current-generation macroeconomics is judged adequate to the task of explaining what went wrong--and what might have been done. The second camp, after a long hard look at the "foundations" of current generation macroeconomics, despairs of building anything on them, and seeks to rebuild those foundations anew.

I am too unprincipled to choose between these camps; both have something to offer. Begin with the first approach, and in particular with Alan

Blinder's recent book.[1] In Blinder's view "what went wrong" in the 1970s is quite simple: the American economy was repeatedly shocked from the supply side--by food and energy price increases and by devaluation of the dollar. But both policy-makers and some economists clung to the belief that all macroeconomic disturbances are aggregate demand disturbances, and demand restraint the appropriate response. The result at the time was the recession of 1974-75, the worst American recession since the depression of the 1930s. One legacy is enduring controversy over what current-generation macroeconomics can contribute to macroeconomic policy.

If we accept this view, then we can continue to use the currently-available tools of macroeconomic analysis--either large macroeconomic models or small, "summary" versions of those models consisting of equations defining the relationships among wages, prices and unemployment. True, several novel macropolicy instruments must be added to the traditional demand-side instruments. Whereas fiscal and monetary policies once were sufficient for dealing with demand-side disturbances, we now need a roster of complementary supply-side instruments, including one-shot cost-reducing policies like tax reductions. Optimal policy mixes of demand and supply-side instruments can be devised: though the tradeoffs between inflation and unemployment are less appealing than they were for traditional demand-management policy in a slack economy, those tradeoffs are no less real for being less attractive. They can be explored either by large-scale macrosimulation or by systems of wage-price equations. Either method can be used to design optimal policy responses to supply-shocks and disturbances.

This program is appealing: it is after all both practical and labor-saving. But it would be a mistake to dismiss attempts to go further. For there is a real, and possibly a serious, problem inherent in the program. The high inflation rates of the 1970s have disrupted the relationships upon which estimates of the structural coefficients of the parameters of a full macroeconomic model, and all the coefficients of a much smaller wage-price equation system, rest. Because the program suggests that we base the design of optimal policies against stagflation on those estimates, the derived policies may be quite wrong, given the new values of the structural coefficients. But our knowledge of those new values is severely limited by the limited number of observations available on the new structure.

There is a way to avoid this difficulty: the relevant structural coefficients can be endogenized, so that we know (for example) how they shift in a period of rapid inflation. That in turn will require both a rethinking of macroeconomics and new kinds of macromodels. We are well into that period of rethinking[2], and some of the early-generation models are up and running. Using those models to design optimal macropolicies against stagflation is premature, but the stakes are so high that not using them may be much more costly.

Rather than choose between the two macroeconomic camps, I have instead temporized. I sketch two general analytical methods for designing optimal stabilization policies against oil-price shocks in particular, and against supply-shock induced stagflation more generally. The first method builds on conventional wage-price equations, is relatively routine, but may give misleading results. The second method builds upon some of the newer work in macroeconomics and macromodeling. It is comparatively incomplete and tentative, but promising. In both cases, the objective is the same: to design optimal macroeconomic policies against supply-shock stagflation.

1.3 Energy Policy in the Long-Term

Over the long term of 10 to 20 years, the economies of the developed countries must undergo substantial structural change and adjustment to the new international economic environment. Uncertain oil import prices are only one feature of that new international environment, but they are arguably the least predictable, and least controllable, feature.

OPEC may be able to set the price of energy in the world market over the next twenty years. Individual firms and enterprises cannot be expected to insure themselves against oil-import price risk efficiently. Left to themselves, firms will bear that collective risk individually, by diversifying over activities varying in energy intensity--and therefore in vulnerability to energy price increases. While rational for each individual firm, individual firm decisions, taken together, will be inefficient. Too much insurance against the collective oil-import price risk will be purchased.

There is an alternative to the market-determined allocation of energy price-related risk: a deliberate policy aimed at <u>encouraging</u> "flexibility" in structural adaption. Though formalization and precision seem disproportionately difficult, the commonsense notion of flexibility is simple enough. Consider the example of a firm planning to invest in capacity with which to meet demand for output over a ten-year planning horizon. Say that the firm is a large multi-product firm with significant market power in several product markets, that demand for the firm's products may fluctuate over the ten-year planning horizon, and that the firm must choose between two kinds of new plant. The first plant type permits a large cost reduction per unit of composite output for the (current-period) output mix; the second makes possible a smaller cost reduction per unit (composite) output for the current output mix, but also permits cost reductions for other output mixes that may be better matched to future demand conditions. Under these assumptions, the best choice for the firm may be the second kind of plant; that choice gives the firm more "flexibility" in facing uncertain future output demand.

This story is easily recast as a parable for an oil import-dependent economy facing uncertain oil import prices. The uncertainty is on the input, not the demand side, but the idea is the same. Distinct kinds of domestic capital equipment are characterized by differential factor-input intensities: inputs are disaggregated at least far enough to distinguish capital goods of various energy intensities, labor, and energy. If oil imports are important, and oil import prices uncertain, policies pushing firms (and hence the country) toward investment in less energy-intensive capital equipment may make sense. Such policies increase the "flexibility" of the economy in adapting to an international energy market in which supplies and prices are uncertain.

To make this general idea more precise we need a model. The vintage capital models of growth,[3] developed during the debates of the 1950s over the role of technical change in economic growth, are in fact exactly what we need. In those models capital equipment is tagged by the date at which it is purchased. Past investments, embodied in physical capital, can no longer be changed in response to changing input prices, but current-period investments can be chosen with current-period and expected future period prices in mind.

Section 3 below specifies and explores a vintage capital model of an economy facing uncertain future prices. A definition of the "right amount" of flexibility is proposed, and rules for "buying" that amount of flexibility with a tax on imported oil are derived.

2 SHORT-TERM ENERGY PROBLEMS

Here, as elsewhere in this paper, the source of all energy problems is taken to be the uncertain price of imported oil. The focus in this section is on what macropolicy can do after the economy has been shocked by a sudden oil price increase. Thus, we regard short-term energy problems as simply one species of the genus of problems posed for traditional stabilization policy by supply-side shocks to the economy.

Supply-side shocks were a distinguishing feature of the macroeconomic history of the American economy in the 1970s. In the wake of that decade, the impression that macroeconomic theory could not explain what had happened gained currency. The assertion that macropolicy "failed" because macrotheory was, and is still, inadequate seemed too obviously true to be questioned seriously.

But the truth is somewhat more complicated. "Current" macroeconomic theory can easily "explain" stagflationary episodes such as those of the 1970s.[4] That it was not used to do so at the time is unfortunate but understandable. And that it can do so after the fact does not prove that current theory is "valid". Still, seeing how far current theory can go towards an explanation is instructive.

It is easy to see that supply-side shocks can cause stagflationary episodes; the analysis is about as trivial as such things can be. Shift aggregate supply upwards against unchanging aggregate demand: the result, for at least some portion of the (real) time period of adjustment, is simultaneous inflation and contraction of real economic activity--the definition of stagflation.

Whether this genre of macroeconomic analysis, and policies derived from such analyses, are adequate is another question, one which will be open for some time. For the purposes of section 2.1 we assume that the answer to this question is yes. In section 2.2 we throw caution and current macroeconomic theory to the winds. The results are some guidelines for exploring the limitations of current macroeconomic analysis in dealing with supply side shocks--and some sobering insights into the difficulties inherent in that exploration.

2.1 Standard Macroeconomic and Supply-shock Policy Design

Consider first the case in which the government sets macropolicy instruments to insure that real economic activity does not fall in the wake of a supply-side shock. In the jargon that has grown up around this issue, we say that the government "fully accomodates" the shock. Under that full-accomodation assumption, what will be the impact of the shock on the rate of inflation?[5] If we can answer this question, we will be able to design one particular anti-shock policy--a one-time reduction in some cost-increasing tax or program.

Under the assumption that the government fully accomodates the shock by fiscal and monetary policy, the usual price-wage equation systems simplify considerably, since all nonprice and nonwage influences can be isolated in the constant terms of these equations. In a general formulation in which the rate of price change (respectively nominal wage change) depends only upon lagged values of the rate of wage changes (respectively the rate of price changes), two equations describe[6] the evolution of both price and wage inflation:

$$\dot{P}_t = a + \sum_{j=0}^{n} b_j \dot{w}_{t-j} \tag{2.1}$$

$$\dot{w}_t = \alpha + \sum_{i=0}^{m} \beta_i \dot{\rho}_{t-i} \tag{2.2}$$

These equations can easily be reduced to a single equation describing the evolution of price inflation alone:

$$\dot{P} = A + \sum_{k=1}^{n+m} \gamma_k \dot{\rho}_{t-k} \tag{2.3}$$

In terms of the constants of the original system, the constants appearing in the single-price inflation equation are given by:

$$A = \frac{a + \alpha\Sigma b}{1-b_0\beta_0} \tag{2.4}$$

$$\gamma_k = \frac{\sum_{i+j=k} b_j\beta_i}{1-b_0\beta_0} \tag{2.5}$$

Estimation of this system on United States data gives results that are virtually "accelerationist": the sum of the coefficients in the pure price-level equation is slightly less than one. Thus an initial shock to the price level builds, over many periods, into a substantial increase in the price level.

Even this restrictive framework can help us in the design of policies for dealing with an exogenous shock to the price-level. Remember that this formulation is restrictive precisely because conventional macropolicy settings--fiscal and monetary policies--are assumed accomodationist: the level of real economic activity is held constant. Now consider the choice of one additional policy instrument--a one-time reduction in costs. Because price increases are cost-sensitive, that reduction translates rapidly into a reduction in the rate of price inflation. Devices for carrying out such a reduction are available in many countries: taxes on capital income, or payroll taxes, or both, can be reduced.

Assuming that the tax system was optimal prior to the shock, a one-time cost reduction imposes a social loss. We are willing to incur that loss because there is a benefit associated with reductions in the rate of inflation. Remember what the principal component of that benefit is: inflation causes a "crawl away from money", and a reduction in the efficiency of the transactions mechanism. Though the "transaction function" is conceptually and empirically elusive and the source of much disagreement, any macroeconomic policy choice implicitly rests upon some transactions function. For present purposes, simply assume that the loss from distorting the tax system by the cost reduction, and the transactions benefit of reduced inflation, can be summarized in a loss function[7] $L(c,p)$. Now we have come far enough to promulgate rule S1.

Rule S1: To estimate the optimal cost-reducing post supply-shock policy to be superimposed on accomodation, proceed as follows. Estimate, or guess at, a loss function expressing the tradeoff between the impact of the cost-reducing policy and the inflation that policy is intended to slow. Then estimate the above price-wage system, and use it, together with the loss function, to derive the optimal cost-reducing policy.

Some technical comments are inevitable here: they can easily be verified by the reader. The single equation 2.3 describes the evolution of the price level under an accomodationist policy, and translates a reduction in the current-period price level into a reduction in the rate of inflation in every period thereafter. Technically, we should define the loss function L over the rate of inflation in the period in which the cost-reducing policy is implemented and in all successive periods. But in practice something much less ambitious should do: for example, a separable quadratic loss function defined on the cost-reducing policy and on the rate of inflation in a few future periods might be chosen. With a positive-definite quadratic form chosen for L, it is easy to show that the optimal cost-reducing policy is always well-defined (by loss minimization), and that it has sensible properties. In particular, it is always positive, and vanishes in the limit in which zero social cost is assigned to the rate of inflation.

Rule S1 has the virtue of simplicity. It also has one glaring defect: the presumption that post supply-shock government policies are policies of strict accomodation, with the level of real economic activity maintained in the wake of the shock. That is a very special constraint on the kinds of policy responses to exogenous price shocks that can be considered.

It would be helpful to have a similar framework susceptible of broader interpretation. One particular extension is straightforward: write down an expanded system of wage and price equations in which measures of real economic activity affecting wage and price inflation appear explicitly. Then construct a loss function over both supply-shock response policies and those measures of real activity. Finally, compute optimal policies by minimizing the loss over the feasible combinations implied by the expanded wage-price system.

Here, in the context of a particular system of expanded wage-price equations, is the proposal. Begin from the following standard equations:

$$\dot{w}_t = A + \sum_{j=0}^{n} P_t \dot{\rho}_{t-j} + \sum_{j=0}^{m} C_j \log U_{t-j} \qquad (2.6)$$

$$\dot{\rho}_t = D + \sum_{j=0}^{\ell} E_j \dot{w}_{t-j} \qquad (2.7)$$

Assume that policy can control the unemployment rate--for example, that fiscal and monetary policy are set to maintain unemployment at some constant level. Assume further that some cost-reducing policy is available: that by choosing an instrument c, we can achieve a one-time slowing of the rate of increase of the price level. Then with a loss function[8] L(U,p,c), we can use the above system of equations to choose an optimal c, an optimal constant level of unemployment U, and an optimal rate of inflation p. In particular, we have Rule S2:

<u>Rule S2</u>: To estimate the optimal combination of cost-reducing and conventional (fiscal and monetary) stabilization policy instruments following a supply shock, proceed as follows. Estimate, or guess at, a loss function expressing the tradeoffs between the impact of the cost-reducing policy, the inflation rate, and the constant rate of unemployment. Then estimate the "full" wage-price system. Use it, together with the loss function, to derive the optimal fiscal, monetary and cost-reducing policy settings.

Note that in this case, both aggregate demand-management and cost-reducing policies are simultaneously optimized.

Rules like S1 and S2 are about all we can expect from "conventional" macroeconomic formulations that fall short of simulations with full macroeconomic models. The cost and difficulty of such simulations suggest exploiting whatever information is embodied in simple wage price equation systems like (2.6) and (2.7).

But there is a price to be paid for that simplicity. The structural coefficients in wage-price systems may shift rapidly during a period in which many important economic relationships are being redefined or renegotiated. Because the 1970s clearly were such a period, we must be cautious both using rules S1 and S2 as guides to policy in similar periods in the future.

But what are the alternatives? One is easy to pose: try to endogenize the structural coefficients.

2.2 Alternative Approaches to Supply-shock Policy Design

2.2.1 Motivation

The previous section stated rules for constructing supply-shock optimal policies from the estimated coefficients of wage-price equations. But those derived policies will be open to question if the estimated coefficients are changed by the shock to which we are responding.

Significant shocks to the economy may change the behavioral relationships these coefficients summarize, and hence the coefficients themselves. Faced with this situation, we can do either of two things. We can try to reestimate wage and price equations from post-shock data, or we can try to endogenize the changes in those coefficients. Reestimation will be most difficult when we need it most. For in the months immediately following a shock, when compensatory policies can be most effective, there will be relatively little data from which to estimate the new structural coefficients.

But we have argued that there is an alternative: "endogenize" the structural coefficients appearing in the wage-price equations. For if we know how those coefficients are changed by the shock, we can simply apply rules like Rules S1 and S2 to wage-price equations with the new structural coefficients.

Endogenizing the changes in those coefficients is an ambitious program,[9] related in spirit to the effort to provide a microeconomic foundation for macroeconomics. It will be years before the returns from that effort are in; in the interim, about all we can do is examine the properties of simple models with endogenized structural coefficients. We hope to obtain a specific constructive procedure for the structural coefficients of wage-price equations--in our simplified construct and, by extension, in the full MOSES model[10] of the Swedish economy developed at the Industrial Institute for Economic and Social Research (IUI). The reader is forewarned that much of what follows in this section is speculative and incomplete, and that at least some of what follows is undoubtably wrong.

2.2.2 A Model with Endogenous Structure

Simulations analogous to those suggested at the end of this section may ultimately be run with the MOSES model of the Swedish economy. But MOSES is too complicated for the purposes of this section: the complexity of a large macroeconomic model quickly exhausts the intuition. For that reason we begin with a "reconstruction" of a minimal, and somewhat more tractable, model. The model described here shares certain features with MOSES, but the two should not be confused. It is entirely possible that the two models behave very differently in some important respects.

We want to preserve and mimic those features that distinguish MOSES from the more conventional macroeconomic models. Thus, we want firm behavior to be guided by a kind of satisficing planning process, and not by "profit maximization".[11] We want the allocation of labor across firms to be the outcome of a process of search by firms over a segmented labor market. And we want demand in product markets to be Keynesian effective demand, not Walrasian demand.[12]

We begin by formalizing our simplified version of the MOSES simulation model of the Swedish economy. Begin by introducing some notation. There is a finite number of firms $f=1,\ldots,/F/$ indexed by the set F. There is a single consumption and capital good: once embodied as capital, it cannot be consumed and does not depreciate. The commodity variables appearing in the model are

$Q(t/f)$	Firm f output (per year) in year t
$Q(t)$	Aggregate output
$L(t/f)$	Firm f labor input
$L(t)$	Total labor input
$K(t/f)$	Capital input to firm f
$K(t)$	Total capital input
$E(t/f)$	Energy input to firm f
$E(t)$	Total energy input.

The corresponding price, profit, and rate of return variables are

$P(t)$	Price of consumption/capital good
$P_E(t)$	Price of energy imports
$W(t/f)$	Firm f wage
$\Pi(t/f)$	Firm f profit
$m(t/f)$	Firm f target rate of return
$\hat{P}(t/f)$	Expected output price
$\hat{P}_E(t/f)$	Expected energy input price
$\hat{W}(t/f)$	Expected wage
$\Pi(t/f)$	Expected profit
$\hat{m}(t/f)$	Expected rate of return on capital.

Actual and expected variables are distinguished by placing a carat, or "hat", on the expected variables. Aggregate and firm-level variables are related by the identities

$$L(t) = \sum_{f\in F} L(t/f)$$

$$Q(t) = \sum_{f\in F} Q(t/f)$$

$$Q(t/f) = F^{f}\big(K(t/f),\ L(t/f),\ F(t/f)\big)$$

$$P(t)Q(t) = \sum_{f\in F} W(t/f)\,L(t/f) + P_F(t)\sum_{f\in F} F(t/f) + \sum_{f\in F} \Pi(t/f)$$

The ex post identity linking firm f costs, revenues and realized profit is:

$$P(t)Q(t/f) = W(t/f)L(t/f) + P_E(t)F(t/f) + \Pi(t/f) \quad (2.8)$$

The heart of the model is firm behavior: firms are the active agents in the labor markets. Each firm f in each period t plans for the next period t+1 in the following way. Beginning from the current-period realized rate of return $m(t/f)$, firm f constructs its next (t+1) period planned capital, labor and energy input vector. Given expected next-period prices, the firm constructs a rate-of-return-feasible region $X(t+1)$ defined by the requirement the expected rate of return will exceed the next-period target rate of return. That requirement is:

$$\frac{\hat{P}(t+1/f)\hat{Q}(t+1/f)-\hat{W}(t+1/f)L(t+1/f)-\hat{P}_E(t+1/f)E(t+1/f)}{\hat{P}(t/f)K(t/f)} > \hat{m}(t+1/f) \quad (2.9)$$

where

$$\hat{Q}(t+1/f) = F^{(f)}\big(\hat{K}(t+1/f),\ \hat{L}(t+1/f),\ \hat{E}(t+1/f)\big) \quad (2.10)$$

Thus feasibility is guaranteed. The condition (2.9) defines a set of rate-of-return feasible vectors of expected inputs

$$\{\hat{K}(t+1/f),\ \hat{L}(t+1/f),\ \hat{E}(t+1/f)\} \qquad (2.11)$$

Assume now that the firm chooses a vector at random from that domain. That assumption mimics[13] the "satisficing" behavior of firms in the full MOSES model, since each firm employs a rough satisficing criterion, rather than global optimization. The input vector chosen is of course a planned input vector. Plans may not be realized: to specify the dynamics of our model, we must specify a relationship between planned and realized quantities. Assume that planned energy requirements are always realized, so that

$$E(t+1/f) = \hat{E}(t+1/f) \qquad (2.12)$$

This is plausible because planned energy requirements are made firm by committed future purchases of oil imports. Assume next that planned investment is realized if consistent with realized profit; that if realized profit is positive but insufficient to allow realization of planned investment, realized investment equals realized profits; and that, if realized profit is negative, then realized investment is zero. Summarizing these assumptions, we have:

$$K(t+1/f) = \hat{K}(t+1/f) \text{ if } \Pi(t+1/f) \geq \hat{K}(t+1/f) - K(t/f)$$

$$K(t+1/f) = \Pi K(t+1/f) \text{ if } \hat{K}(t+1/f) - K(t/f) \geq \Pi(t+1/f) \geq 0$$

$$K(t+1/f) = K(t/f) \text{ otherwise.} \qquad (2.13)$$

The most striking departure from convention in the full MOSES model is the labor market determination of wages and labor allocation. In MOSES, firms enter the labor markets--actually interfirm raiding markets--armed with their planned labor input requirements $(L(t+1/f))$. Taken together with those plans, the MOSES labor-market search equilibrium concept chosen determines a realized labor input, and therefore determines the next-period production of individual firms. Typically the firm chooses a labor-market search concept s from a set S of feasible search concepts S at the market level. Some specifications of s will be decomposable to the firm level, so that s becomes an /F/-tuple of firm search concepts $(s_1, s_2, \ldots, s_{/F/})$. Later we will add this complication: for the time being suppose that s is specified at the market level. That specification leads to a relatively simple MOSES-type equilibrium concept.

We will need some definition like the following one: a MOSES1 equilibrium is a 3/F/+1 tuple

$$(s;\ g;\ (K(\cdot/f),\ L(\cdot/f),\ E(\cdot/f));\ P_E(t)), \qquad (2.14)$$

where we introduce (or reintroduce) the following notation:

s	Labor-market search algorithm ($s \in S$)
g	Trend growth rate (determined exogenously, e.g. by population growth rate)
$\hat{P}_E(t)$	Energy input price vector.
$K(\cdot/f)$	
$L(\cdot/f)$	Stationary stochastic processes (determined endogenously by the model).
$E(\cdot/f)$	
. . .	

Why is this MOSES1 equilibrium concept a sensible one? Remember that firm (satisficing) behavior is modelled as firm selection of a planned input vector from a (rate-of-return constraint) feasible set of planned input vectors. The random element in that selection makes the model inherently stochastic. Since the simplest stochastic process is a stationary stochastic process, the most natural outcome--and the simplest equilibrium concept to manipulate--is one in which the output processes generated by the model are also stationary stochastic.[14]

Suppose that we can prove (and not merely assert) that K,L, and E are stationary stochastic processes. Then there will be a relatively simple way in which to think about the way the model describes the economic impact of an abrupt change in the price of imported oil (an "oil price shock"). Before the shock, the economy will be described by one stationary stochastic process; after the shock, it will settle down into another. The effect of the shock can be summarized by listing the parameters of those pre- and post-shock stochastic processes.

In the MOSES1 equilibrium concept, the labor market search algorithm is specified for the market as a whole: s was given from the set S of possible labor market search. A more ambitious MOSES equilibrium concept,[15] which we call MOSES2, would allow firms independent choice of their own labor-market search algorithms, with each firm f choosing an algorithm s_f from a feasible set S_f. The point of this extension is to define an equilibrium concept in which all firms are doing "about the right amount" of searching. Each firm's chosen search concept s_f should in some sense be the "best" one for that firm, given the search concepts chosen by all other firms.

What can "best" mean here, since we have abandoned profit maximization as a rule for the determination of firm behavior? Since the searching is going on in the labor market, "best" might mean: the search concept that keeps realized labor closer to planned labor requirement than any other search concept available to firm f--given the search behavior of all other firms.

To close this simplified MOSES-like model we need two things: a demand side describing the product market, and an expectation-formation model describing how target rates of return and expected prices and wages are developed from their current-period analogs. For the demand side, take

$$\left.\begin{aligned}
C(t) &= cY_{DISP}(t) \\
Y_{DISP}(t) &= \sum_{f\in F} W(t/f)L(t/f) + \sum_{f\in F} d(t/f) \\
d(t/f) &= \Pi(t/f) - K(t/f) + K(t-1/f) \\
I(t) &= \sum_{f\in F} \left(\hat{K}(t/f) - K(t-1/f)\right) \\
M(t) &= P_F(t) \sum_f F(t/f) = P_F(t)F(t)
\end{aligned}\right\} \quad (2.15)$$

Then equality of demand and supply reads

$$C(t) + \hat{I}(t) + M(t) = P(t)Q(t) = \sum_f W(t/f)L(t/f) + \\ + P_E(t) \sum_{f\in F} F(t/f) + \sum_{f\in F} d(t/f). \quad (2.16)$$

Finally, target rates of return m(t/f) are revised proportionately to the discrepancy between realized and expected profits

$$\hat{m}(t+1/f) = \hat{m}(t/f) + \gamma_m \frac{\Pi(t/f)-\hat{\Pi}(t/f)}{P(t)K(t/f)} \qquad (2.17)$$

Similarly, expected (output) prices and expected wages are revised based upon changes in prices and wages over the last two periods

$$\left.\begin{aligned} \hat{P}(t+1) &= P(t) + \gamma_m(P(t) - P(t-1)) \\ \hat{W}(t+1/f) &= W(t/f) + \gamma_w(W(t/f) - W(t-1/f)). \end{aligned}\right\} \qquad (2.18)$$

Note that "the" labor market is not in "equilibrium": wages in any given period can differ between firms. With these equations we have completed the description of our simplified MOSES model. We summarize this section in Rule S4, a rule for designing optimal policies for shocks in MOSES-type models.

Rule S3: to design optimal policies for supply shocks in MOSES-type models, proceed as follows. Begin with a loss function describing the trade-offs between inflation, unemployment and the particular policy to be deployed against the shock. Construct the feasibility frontier from the underlying MOSES-type model by simulation: that frontier tells us how a shock of a specified type and given size shifts the parameters of the stochastic processes defined by the model. Pick an optimal policy by constraining the loss function with this frontier and the given shock, and then minimizing loss. The frontier can be constructed in either MOSES1 or MOSES2 equilibrium concept variants. Optimal policies can be constructed in either variant; and in MOSES2 the structural coefficients can actually be endogenized, since firms will alter their labor market search procedure in response to the oil price shock.

Let us close this section with some reflections on the MOSES1 and MOSES2 equilibrium concepts. There are two kinds of issues here: the general issue of which kinds of equilibrium concepts should be taken seriously, and the related issue of the corresponding notions of stability.

Equilibria like MOSES1 and MOSES2 may not exist, or their existence may be hard to prove: this is because the driving process, the selection of a random feasible input vector from a set of feasible vectors, may not have any nice properties of stationarity. Typically, only stationary input processes give rise to stationary output processes, and then only under highly restrictive conditions. But we would argue that the general notion of this kind of "equilibrium", rather than the existence of a special kind of equilibrium with particularly simple properties like stationarity, may be the important thing. Remember what we mean when we talk about "stabilizing" the economy, or about the successes and/or failures of stabilization policy. One picture, often shown to illustrate the success of postwar Keynesian "stabilization" policies, shows that quarterly percentage fluctuations in gross domestic product were noticeably smaller in the post-war years 1946-75. Pretend that such a picture really tells us something about the behavior of a dynamical system we both understand and can, to some extent, control. What are we saying about that dynamical system when we claim that post-war stabilization policies have been effective? Possibly that we have been able to steer the system to a (balanced growth) equilibrium. But another, and perhaps a more plausible interpretation, is that we have been able to "bound the orbit" of the dynamical system within a small neighborhood of some balanced growth path. If there are such system orbits which do not coincide with balanced growth paths--either indefinitely or over some time interval--refusing to look at anything but balanced growth paths may be unduly restrictive. We may be throwing away the most interesting system trajectories, and perhaps even those system trajectories with some descriptive realism.[16]

In going beyond the simplest equilibrium concepts we do surrender something important: the possibility of a simply-described, or simply-parameterized, equilibria. A balanced-growth equilibrium is completely described by a few parameters: that is why (economic) growth theory has emphasized balanced growth paths. And a stationary stochastic process can also be characterized by a "relatively small" number of parameters. Simple descriptions of equilibria permit simple characterization of the results of a change in exogenous parameters: comparative statics, comparative balanced growth, and the analogs for stationary stochastic equilibria all build on this truism.

Now let us turn to the second kind of issue--stability. Whatever the equilibrium concept, only stable equilibria are of any real interest or importance. Remember the reasons: real-world systems will spend little (real) time in, or in the neighborhood of, unstable equilibria. How, then, should we define stability for the stochastic equilibrium concept introduced in our simplified MOSES model? Remember how stability notions are defined in standard general equilibrium theory. First we embrace the Walrasian tatonnement model of price adjustment. Then an equilibrium is called stable if there is an open, unit-price-simplex neighborhood of the equilibrium price point, from any point of which the Walrasian tatonnement moves us toward the equilibrium point. Within that open neighborhood, small initial price displacements away from equilibrium are followed by a return to equilibrium. Remember, however, that the initial equilibrium prices depend parametrically upon the initial endowments of the individual agents and upon their preferences. Thus even in the deterministic pure exchange economy, a second kind of stability is of interest: stability with respect to the parameters of the model endowments and preferences. Again, an isolated equilibrium point is stable in this second sense if small changes in the parameters produce only small changes in the position of the equilibrium in the unit price simplex. In the jargon increasingly fashionable in economic theory, equilibria passing the first test are called "stable", and equilibria passing the second test are called "generic".

We have distinguished between these two notions because we want to examine their natural analogs, for stochastic equilibria, as candidate stability concepts for our simplified MOSES model. It is neither necessary nor desirable to choose between them. Each generalizes to the stochastic case, and each provides a concept useful in examining the stochastic equilibria of our heuristic model.

First consider stability against local price displacement. In a stochastic equilibrium model the initial conditions generally determine stochastic processes-distributions of endogenous variables in future periods. If for small changes in initial conditions the determined distributions converge, for times far enough in the future, to the same distribution, then we say that the equilibrium from which we started is "stochastically stable". Formalization requires some notion of when two probability distributions are "close".

Now consider to the second stability concept, the one we have called genericity of the equilibrium with respect to the model parameters. In our case, the most interesting model parameters are the parameters of the stochastic input processes that drive our model; the parameters of the stochastic firm planning process are examples. Then genericity means that a shock leads to only small changes in the input and output stochastic process. To put some teeth into these heuristics, we need a notion of closeness for stochastic processes. Remember that a stochastic process is a sequence of random variables, and that two such sequences are close when the joint distributions of the random variables are close. For the simple case--a serially uncorrelated process, with single-period distributions being generated by a finite parameter distribution--a natural definition of the distance between two stochastic processes is the Euclidean distance between the parameters of the two processes.

The general idea goes through for more complicated processes. Suppose, for example, that the processes are covariance-stationary: that is covariances depend only on lag length. Then those stochastic processes are completely determined by a vector with either a finite number, or a countable infinity, of components. Given weak conditions on the rate at which serial correlation vanishes with lag length, those vectors will be square-summable and thus lie in the space l^2. Since l^2 is a normed space, the l^2 norm defines a distance between any two stochastic processes.

Thus we have defined concepts of stochastic stability and stochastic genericity for our simplified MOSES model. That simple model embodies many of the difficulties involved in defining such concepts in the full MOSES model. How might one do experiments with our simplified model and, by implication, how should one do experiments with the full MOSES model? We are interested in the response of the model to oil import price shocks, which enter the calculations of the model's economic agents through the oil-price expectation function. In each case, we want to know whether the system returns to the pre-shock long-term growth path or settles into some new long-term growth path. And we want some idea of how long it will be before the oscillations about that new path fall within some predetermined fraction of the initial displacement from the long-term growth path. That some long-term growth path will be defined, in some sufficiently long run, is guaranteed by the trended-growth exogenous variable used in MOSES model runs.

Very generally, stability and rapid convergence are assured by capital flexibility and by price expectations which do not depend "too much" on the current price system. Thus, we want to "estimate", by simulation, two kinds of magnitudes. For a given oil price shock, we want to estimate the amplitude and duration of the resulting disturbance as functions of the capital flexibility and price-expectation function parameters. And we want to "estimate", by simulation, the largest oil price shock for which convergence, within some prespecified time interval, is to the original growth path.

3 ENERGY PROBLEMS IN THE LONG-TERM

3.1 The Optimal Vintage Capital Structure: A Simple Model[17]

Here we want an answer to a simple question. Suppose that the government has in its possession excellent information on oil-import price risk, and has at its disposal one policy instrument--a tax on imported oil. How should the government set that instrument so as to push the private sector to a level of energy intensity that is optimal given the import price risk? We begin with a formal model. Introduce the following variables and notation:

S	States of nature; $s \in S$
V	Capital vintages; $v \in V$
$p_F(s)$	Firm (or private-sector) probabilities of future oil prices
$p_G(s)$	Government probabilities of future oil prices
$r(v)$	Capital rentals
$e(s)$	Energy prices in state s
$C(0)$	Initial capital-goods endowment
$C(1)$, $C(2,s)$	Consumption program
$K(v)$	Total second-period vintage v capital
$E(v,s)$	Energy inputs complementary to $K(v)$
$W(C)$	Social welfare functional on consumption programs
Π	Firm (or private-sector) profit
$f^{(v)}(K(v), E(v,s))$	Vintage v production function.

The states of nature index future oil-import prices: knowledge of the state of nature amounts to knowledge of the future oil import price. There are two periods, and firms can invest in any of several vintages of capital goods. Capital goods of vintage v bear capital-market rentals r(v). Output runs in terms of a single good, with output from each capital vintage being produced with complementary energy (oil) inputs E(v,s). There are two time periods, and an initial endowment C(0) of the single consumption good must be allocated between current consumption and investment in the various vintages of capital goods. Firms and the government differ in their views of the likelihood of future oil price increases. Under the special assumption that the government has full confidence in its view of oil import price risk, what should be done?

Uncertainty is the heart of the matter, but let us first get the notation right in the "certainty case", where things are simpler.[18] Assume that the government has some well-specified objective called social welfare, and write it as

$$W(C) = U_1(C(1)) + U_2(C(2)) \tag{3.1}$$

The government's problem is to max (W(C)) subject to resources (or initial endowments) and technical constraints.

$$C(0) = C(1) + \sum_{v \in V} (K(v)) \tag{3.2}$$

$$C(2) = \sum_{v \in V} f^{(v)}(K(v),\ E(v)) - e \sum_{v \in V} E(v) \tag{3.3}$$

$$\left.\begin{array}{r} C(1),\ C(2) \geq 0 \\ E(v) \geq 0 \\ K(v) \geq 0 \end{array}\right\} \qquad (3.4)$$

But the private sector tries to maximize profit, not social welfare. Profit Π is given by

$$\Pi(K(v),\ E(v)) = \sum_{v \in V} f^{(v)}(K(v),\ F(v)) - e \sum_{v \in V} E(v) - \sum_{v \in V} r(v)K(v) \qquad (3.5)$$

In the certainty case, there is only one (present and future) energy price, e. Profit is written as three sums for easier comparison with the uncertainty case below. The firm's problem is to max $\Pi(K(v),E(v)$ by choosing second-period capital and energy inputs.

Now let us turn to the more interesting and realistic uncertainty case. The government tries to maximize expected social welfare,

$$E(W(C)) = U_1(C(1)) + \sum_{s \in S} P_G(s)U_2(C(2,s)) \qquad (3.6)$$

Note that it is the government's subjective probability $P_G(s)$ for future oil prices that enters here. The problem is to max $E(W(C))$ subject to resource (or endowment) and technical constraints:

$$C(0) = C(1) + \sum_{v \in V} K(v) \qquad (3.7)$$

$$C(2,s) = \sum_{v \in V} f^{(v)}(K(v),\ E(v,s)) - e(s) \sum_{v \in V} E(v,s) \qquad (3.8)$$

$$\left.\begin{array}{r} C(1),\ C(2,s) \geq 0 \\ E(v,s) \geq 0 \\ K(v) \geq 0 \end{array}\right\} \qquad (3.9)$$

Firm (or private sector) behavior is again given by profit maximization. But now profit $(K(v), E(v,.))$ is given by:

$$\max_{K(v)} \sum_{s \in S} P_F(s) \left(\max_{E(v,s)} \left(\sum_{v \in V} f^{(v)}(K(v), E(v,s)) - e(s) \sum_{v \in V} E(v,s) - \sum_{v \in V} r(v)K(v) \right)\right) \qquad (3.10)$$

Note that two maximizations are required to construct the firm's production plan. In the first (inner bracketed) maximization, the energy inputs $E(v,s)$ to be used with each vintage v of capital are computed, for each state of nature s and for any given capital stock $K(v)$, $v \in V$. In the second (outer bracketed) maximization, the optimal capital stock is computed. The relevant (probalistic) future oil price assessment is $P_F(s)$, the firm's. Once chosen, the capital stock is fixed over both periods, but complementary energy inputs $E(v,s)$ can be chosen after the state of nature s is revealed.

Now let us see how we can use this apparatus to compute the "best" level of one familiar policy recommendation, a tax on second-period imported oil. Social welfare is again given by (3.6). Again, the problem is to max $E(W(C))$ subject to resource and endowment constraints. The intervention in question is a single, second-period tax on oil imports, with the per-barrel tax q independent of second-period prices. Assume that the tax schedule is announced before period one begins, and assume that all tax revenues are distributed as second-period consumption. Then the implied constraints are

$$C(0) = C(1) + \sum_{v \in V} K(v) \tag{3.11}$$

$$C(2,s) = \sum_{v \in V} f^{(v)}\big(K(v),\ E(v,s)\big) - e(s) \sum_{v \in V} F(v,s) + q \sum_{v \in V} F(v,s) \tag{3.12}$$

$$\left.\begin{aligned} C(1),\ C(2,s) &\geq 0 \\ E(v,s) &\geq 0 \\ K(v) &\geq 0 \end{aligned}\right\} \tag{3.13}$$

Extension to the case of an oil-import tax dependent on import price is immediate: simply replace $e(s)$ by $(e(s) + q(s))$. The latter expression is the (state of nature s) price, to domestic producers, of a barrel of oil.

3.2 Optimality: Some Remarks

For the case set out above, conventional restrictions on social welfare and production functions guarantee the existence and uniqueness of an optimum consumption plan. In the certainty case, this is $(C^*(1),\ C^*(2))$, and in the uncertainty cases $(C^*(1),\ (C^*(2,\ s),\ s \in S))$. Moreover, the certainty case can be "decentralized" in the following sense. There are prices $e,\ r(v);\ v \in V)$ for which private-sector decisions, described in (3.5), guide the economy to the social optimum, defined by the problem (3.1). Note that a discount rate for future consumption can be introduced by introducing a coefficient $p_C(2)$ of the production function term in (3.5).

But for the uncertainty cases, there is an obstacle to "decentralization" of this kind. Because oilimport price risks are noninsurable, we have assumed that there are no contingent (on future oil prices) future consumption-goods markets. Thus in (3.10), which describes firm behavior, there are no coefficients $p_C(2,s)$ of the production function terms (though we might introduce a state-independent coefficient $p_C(2)$). Because there are "too few" prices, in general there will be no hope of using our tax instruments q(s) to guide the private sector to a social welfare-maximizing set of choices.

But we can still pose the following question. If we insist that government interventions operate through a tax instrument q, how well can we do with that tax instrument? To find the answer, proceed as follows. From equations (3.6), (3.8)-(3.9), we find the global optimum. From (3.10), with e(s) replaced by (e(s) + q), find the tax instrument q which gives us the "closest" private sector optimum. In other words: (3.10), with e(s) replaced by (e(s) + q), becomes another constraint. Social welfare is maximized subject to this constraint, and then the q(s) giving the best constrained social welfare optimum is determined.

We summarize the results and conclusions of this section in the following rule:

Rule L: To compute an optimal oil import tax proceed as follows. Choose a probability distribution on future oil prices, a discount rate for future consumption, and crude technological estimates of the energy-intensity of the various capital vintages. Then compute the optimal oil import tax as indicated in equations (3.6) through (3.10).

4 SUMMARY OF RULES

We summarize the paper by bringing together, in one place, the rules and recommendations put forward in the text. The reader must return to the text for exposition and qualification.

Rule S1: For a rough estimate of the optimal cost-reducing supply-shock policy to be superimposed on accomodation, proceed as follows. Estimate, or guess at, a loss function expressing the tradeoff between the impact of the cost-reducing policy c and the inflation that policy is intended to slow. Then estimate the above price-wage system, and use it, together with the loss function, to derive the optimal costreducing policy.

Rule S2: For rough estimates of the optimal combination of cost-reducing and conventional (fiscal and monetary) stabilization policy instruments following a supply shock, proceed as follows. Estimate, or guess at, a loss function expressing the tradeoffs between the impact of the cost-reducing policy, the inflation rate, and the constant rate of unemployment. Then estimate the "full" wage-price system. Use it, together with the loss function, to derive the optimal fiscal, monetary and cost-reducing policy settings.

Rule S3: To design optimal policies for supply shocks in MOSES-type models, proceed as follows. Begin with the loss function describing the tradeoffs between inflation, unemployment and the particular policy to be deployed against the shock. Construct the feasibility frontier from the underlying MOSES-type model by simulation: that frontier tells us how a shock of a specified type and given size shifts the parameters of the stochastic processes defined by the model. Pick an optimal policy by constraining the loss function with this frontier and the given shock, and then minimize the loss. The frontier can be constructed in either MOSES1 or MOSES2 equilibrium concept variants. Optimal policies can be constructed in either variant; and in MOSES2 the structural coefficients can actually be endogenized, since firms will alter their labor market search procedure in response to the oil price shock.

Rule L: To compute an optimal oil import tax proceed as follows. Choose a probability distribution on future oil prices, a discount rate for future consumption, and crude technological estimates of the energy intensity of the various capital vintages. Then compute the optimal oil import tax as indicated in equations (3.6) through (3.10).

NOTES

1. See Blinder (1981). Somewhat similar in spirit are Blinder (1980), Fried and Schultze (1975), Gramlich (1979), Modigliani and Papademos (1978), and Pierce and Enzler (1974).

2. Among the major efforts at a reconstruction of macroeconomic theory are Malinvaud (1977), Hicks (1979) and Tobin (1980). About the "new classical macroeconomics" I have nothing to say: Tobin's argument and final judgement--that the world represented therein is intellectually intriguing but not the world we happen to live in--seem persuasive. See also Akerlof (1979).

3. See, for example, the fundamental theoretical papers of Arrow and Kurz (1970) and Calvo (1976). For a textbook exposition see Wan (1971).

4. For a notably clear example of such an exposition see Chapter 2 of Blinder (1981).

5. Here is a selective listing of the published literature in this vein: Ando and Palash (1976), Gramlich (1979), Meltzer and Brunner (1981), Modigliani and Steindal (1977), Modigliani and Papademos (1978), Pierce and Enzler (1974), and Wallich and Weintraub (1971).

6. Here we follow the setup used, for other purposes, in Blinder (1981); see pp. 80-82.

7. For an extended, but obviously incomplete discussion of the notion of a loss function for stabilization policy, see Okun (1981). Though the supporting discussion is scattered through the text, pp. 297-99 summarize Okun's principal arguments.

8. Again, see Okun (1981). Note that, in principle, the loss function cited here is simply a more general variant of the loss function cited in note 7 above. Why, then, do we bother with the more restrictive case at all? There is a reason; the reader will have to judge how compelling it is. If one looks carefully at the loss function concept used, for example, in Okun (1981), it is evident that a consensus version of the loss function--one acceptable to the major macroeconomic policy makers and actors--will be difficult to attain: Implicit in the loss function is the relative social cost of unemployment and inflation, a matter on which there is serious disagreement. Thus the real usefulness of the loss function notion may be as a guide to what the tradeoffs are

within some domain of policy choice demarcating the extent of consensus between macroeconomic policy actors and decision makers.

9. It is probably misleading to talk of a "program", since much of what is being done in modern disequilibrium theory is in principle relevant to the objective of endogenizing the structural coefficients of a wage-price equation system.

10. For MOdel of the Swedish Economic System. For documentation on the model, see for instance Eliasson (1978, 1980).

11. This is not the place to discuss the issue of "satisficing versus maximizing". But since we do use the notion of equilibrium, it may be worth saying that equilibria can of course be defined even when agents are "satisficing". Those equilibria may be more complex than the unique equilibria derived from optimization, but that is another issue. Economists who study actual firms have long recognized the impossibility of "profit maximizing" behavior by managers. And practical macroeconomists have come to recognize the significance of simple internal summary signals-like rates of return--in internal information transmission. The characteristic lag relationships between wages, prices and costs are unintelligible in the absence of such devices. See Eliasson (1978, pp 56-63 and pp 142 ff), and Okun (1981).

12. In any macroeconomics that is descriptive of actual macroeconomies, demand is of course "effective demand". That the effective demand concept "alone" has significant implications for economic dynamics has recently been shown by several authors, notably Varian (1975) and Eckalbar (1980). For an excellent survey, see Drazen (1980). Very roughly, in this line of work all agents are optimizing, but two changes in the usual Walrasian assumptions are made: demand is effective and not Walrasian demand, and the market tatonnement is on both quantities and prices. The novel result is the possibility of stable non-Walrasian equilibria.

The effort to find out how much we can explain about involuntary unemployment from such simple assumptions is intriguing. But the exclusion from such models of features of real macroeconomics that almost must matter in price and quantity determination leaves one to wonder about descriptive relevance. In particular, the non-Walrasian equilibria in those models are based upon assumptions of "two auctioneers"--one in quantities and one in prices--and full optimization by individual agents.

13. See Eliasson (1978, pp 73-75.) We say "mimics" to emphasize that this mechanism is not identical with the mechanism MOSES-model firms use to make their satisficing decisions. It is however useful for what we want to do here: to define a MOSES-like equilibrium concept. We repeat our caution that the "reduced" model described in this subsection is not identical with the full MOSES model.

14. This kind of "equilibrium in stochastic processes" is the hallmark of the so-called "new classical macroeconomics". See, for example, the equilibrium concepts defined in Lucas and Prescott (1974) and Prescott and Townsend (1980). Though introduced into economics by the proponents of one very particular kind of macroeconomics, this equilibrium concept should be a fruitful one in any rigorous macroeconomics.

15. The notion described here in words is similar to the Nash equilibrium concept of game theory. It is not necessarily identical with the Nash concept, since the noncooperative game is defined only in the labor market. The desirability of some Nash-like concept as a basis for a more plausible equilibrium concept in economics generally, and as a basis for a better macroeconomics, is discussed in Hahn (1977, 1978). A start towards understanding the dynamics such systems can generate is provided in Smale (1980).

16. For an introduction to modern stability theory, and to some of these possibilities, see Hirsch and Smale (1974).

17. This is a stylized version of the IUI dynamic sector model. See Ysander-Jansson-Nordström (1981).

18. The reader familiar with growth theory will quickly note that we are using a two-period model, and may reflect that an infinite-horizon model is more appropriate here. True; but we suspect that there is little to be gained from the added complexity of the general, infinite-horizon case. As a practical matter, political consensus on the weighting of consumption this decade versus consumption next decade will be hard enough to reach. To even talk of a consensus on the weighting of consumption into the indefinite future is, to say the least, optimistic.

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STABILITY IN ECONOMIC GROWTH UNDER UNCERTAINTY - Growth of Knowledge, Decision Processes and Contingency Contracts

by Karl-Olof Faxén

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INTRODUCTION

In this paper, the following problem will be discussed:

Is it possible to combine in one and the same model the analysis of

1. Stagflation - inflation and unemployment at the same time.

2. A productivity slow-down.

3. The effects of increased variability in the price structure such as the effects of the so called oil price shocks.

4. Increased uncertainty in business and consumers expectations on prices, volumes etc.

In the 1970s, at the same time as inflation increased and stayed high, actual price dispersion increased and began to behave erratically (see Josefsson-Örtengren in this volume). Predictability decreased. This was generally thought of as an inrease in uncertainty. Unemployment was high even in peak years with increasing rates of inflation. Capacity utilization was low and growth in manufacturing productivity was slower than before 1973 in almost all OECD countries.

In this paper the emphasis will be upon price uncertainty and not upon uncertainty in expectations of volumes demanded or supplied. This does not imply that volume uncertainty is unimportant. For the formulation of investment strategies in the energy field, for instance, volume uncertainty is probably more important than relative price uncertainty. If the present approach should appear fruitful, the analysis could be continued so as to include volume uncertainty.

Survey measures of expectations are now available both for EEC countries and for the USA. In empirical macroeconomic analysis, actual measures of both means and standard deviations of survey-measured expectations can now be used instead of "adaptive expectations" or "rational expectations".

As will be shown later in this paper, survey-measured standard deviations in price expectations contribute significantly to the explanation of unemployment and the degree of capacity utilization. Furthermore, the degree of capacity utilization contributes significantly to the explanation of the productivity slow-down after 1973.

Taken together, these empirical results indicate an underlying systematic relationship of importance for the understanding of stagflation. A theoretical analysis could be based upon three alternative classes of models: Risk models, subjective probability models and uncertainty models. It will be argued below that use of the concept of uncertainty in the sense of Knight (1921)[1] is essential. Variations in standard deviations in price (and volume) expectations should be interpreted as variations in uncertainty rather than in risk. The distinction between risk and uncertainty will be further elaborated below.

In Walras-type multi-period equilibrium models, stagflation cannot occur. The introduction of one or more stochastic disturbance terms with known probability distributions (risk), for instance stochastic productivity, does not change anything essential. Such probabilistic risk variables have "certainty equivalents" (means adjusted for effects from risk-aversion) and the Walras equation systems are solved as before. Expected unemployment is frictional.

Game theory, in the sense of von Neuman and Morgenstern, and uncertainty models appear more promising. The simultaneous and persistent existence of unemployment, inflation, slow productivity growth and low profits may be explained from the adoption of defensive business strategies, the effects of which cannot be compensated for by means of conventional monetary and fiscal policies.

In order to be able to use game theory and uncertainty to interpret the regression results presented in the Appendix to this chapter, a definition of an "increase in uncertainty" in the economy in general is required. Suppose such a definition is formulated, for instance as a measure of "uncertainty intervals" in general. The central hypothesis is then:

A general increase in uncertainty in the economy will lead to lower productivity growth, more unemployment and higher wage increases (more inflation). These effects are simultaneous and interdependent.

This hypothesis is supported by the regression results presented in the Appendix to this paper. An increase in uncertainty will increase "natural unemployment" in the sense of Milton Friedman and decrease capacity utilization. There is also a statistical relationship between capacity utilization and the productivity slowdown.

UNCERTAINTY REDUCTION POLICIES

The policy recommendation is uncertainty reduction both in government policies (monetary, fiscal and exchange rates) and in business itself. It is argued that the present stagflation cannot be overcome by means of conventional monetary and fiscal policies - at least not within a reasonably short period of time. The time needed to stabilize a disturbed price system and reduce uncertainty appears to be long and costly. (See papers by Genberg and Josefsson-Örtengren.)

Uncertainty reduction is not new. Business has always used a variety of methods to reduce uncertainty. Contingency contracts, futures markets, horizontal and vertical combinations within the same financial organization may be mentioned.

Uncertainty is not always bad. Innovation and creativity are essential for growth and both require and give rise to uncertainty. Without uncertainty, the economy would be inflexible.

It may be assumed that the relatively stable growth of the 1950s and the 1960s represented a balance between uncertainty and flexibility that was adjusted to conditions as they were at that time.

Then a change occurred around 1970. It might have been caused by endogenous factors related to a long period of stress upon the economy (cf. Eliassons contribution to this volume and also a study by Pehr Wissén[2]). Under these new conditions, a new balance between policies aiming at uncertainty reduction (future markets, contingency contracts etc.) and flexibility was required. This was, however, a slow adjustment. During the 1970s, because of that, actual price dispersions were higher, as were uncertainty measures in surveys of price expectations.

As inflation goes down after 1981, actual price dispersions as well as uncertainty measures in surveys of expectations will go down again. This does not necessarily reflect a return to the stability of the 1960s in underlying conditions. To a significant part, it may be traced to more use of uncertainty reducing strategies. For instance, conditions in oil markets may be more volatile, but futures markets are at the same time more developed. A new balance is struck between uncertainty reduction and flexibility.

Another example. In the labor market, collective agreements often contain provisions for adjusting wages according to the development of a consumer price index (price-wage links). This may be seen as a method to <u>reduce uncertainty</u> for both parties and make an agreement possible for a longer period of time than otherwise. The advantages in this must, however, be balanced against the <u>reduction of flexibility</u>. In case of a disturbance, for instance an unforeseen loss in terms-of-trade, price-wage links can be destabilizing (see simulation experiments in Eliassons paper).

Price-wage links in collective agreements have been forbidden by law in several countries, for instance at present in Germany and in the 70s in Finland. There has also been a discussion in the United States to introduce similar legislation. Thus, the general consequences of introducing price-wage links (as well as wage-wage-links) into systems of collective agreements in disorderly economies is a topical subject.

We argue that an analysis on the basis of a risk model, i.e., a model based upon conventional equilibrium theory (Walrasian equation systems) combined with stochastic disturbance terms, is inadequate to our purpose. The type of disturbances that actually pose a problem in relation to contingency clauses in collective agreements (price-wage links and/or wage-wage links) are of a non-stochastic nature.

The same applies to energy markets. For instance, in long-term coal contracts, price-price links are common. The same discussion applies as well to collective agreements on wages. The desire to reduce uncertainty and make long-run investments possible has to be balanced against the need for flexibility.

A major source of uncertainty are shifts in market regime (for instance when OPEC became an effective cartel in October 1973), in exchange rate regime (for instance the break-down of the Bretton Woods-system around 1970) and in monetary policy regime (for instance when the Federal Reserve in October 1979 declared strict adherence to monetary growth targets and disregard for interest rate consequences). Such events cannot be related to relative frequency statistics in any meaningful way. It is not that they occur seldom - it is rather that there is no natural way to classify them statistically. The importance of "Market regime uncertainty" is one major reason why uncertainty models are to be preferred over risk models.

"NATURAL UNEMPLOYMENT" AND INFLATION UNCERTAINTY

Survey based measurements of expectations give empirical evidence for a relationship between uncertainty, inflation and unemployment. The analysis is based upon the "Expectations Augmented Phillips Curve" as proposed by Milton Friedman and Edmund Phelps in the late 60s.[3]

As the variable upon the vertical axis, they substituted the difference between inflation *ex post* and *ex ante* for actual inflation in the original Phillips Curve.

An unexpected increase in total demand will simultaneously lead to unexpected increases in inflation and in employment. When expectations are fulfilled in the average, that is, actual inflation is equal to expected inflation, unemployment is said to be at its "natural level". There is neither an unexpected increase in total demand nor an unexpected decrease. The level of "natural unemployment" cannot be changed by means of monetary and fiscal policies. It is dependent on mobility in the labor market, demographic factors, structural imbalances etc.

According to the regressions presented in Appendix A, "natural unemployment" is also dependent upon uncertainty in inflationary expectations. Measurements of inflationary expectations among households have been made for the USA by the Survey Research Center at University of Michigan since 1948 and in the U.K. by the Gallup Poll since the beginning of the 60s. The distributions of qualitative answers from the surveys are first transformed to quantitative variables by means of a transformation function. Standard deviations of inflationary expectations across households are then computed.

Theoretically, it is intrapersonal uncertainty rather than interpersonal dispersions that is relevant. It may, however, be assumed that there is a close correlation between interpersonal and intrapersonal uncertainty.

Furthermore, it may be assumed that business uncertainty is correlated to households uncertainty. In other words the standard deviation of inflation uncertainty across households is taken as a measure of uncertainty in the economy in general.

SIGNIFICANCE OF UNCERTAINTY REDUCTION

The regressions for the USA and the U.K. indicate a significant influence of uncertainty upon unemployment. Of the 4-5 percent increase in "natural unemployment" in the USA from the 60s to the period 1973-82, 1 to 1 1/2 percent may be explained by increased inflation uncertainty among the U.S. households. A contribution of the same order of magnitude seems to follow from the U.K. regressions[4].

Thus, in both the USA and the U.K., the increase in uncertainty would account for between 1/3 and 1/2 of the total increase in "natural unemployment".

The regression results confirm the importance of uncertainty for an understanding of the stagflation problem. It seems to be a clue to a major part of the solution.

This does not mean that "natural unemployment" can be reduced by 1.5 percent from one year to the next by means of the adoption of "uncertainty reducing strategies" by governments and business corporations. Again, it is a balance between uncertainty reduction and flexibility.

On the other hand, uncertainty reduction is a method for business firms to survive and to avoid disaster in volatile surroundings. For governments, more credibility in medium-term monetary and fiscal policies may be attained by adapting uncertainty reducing strategies in this field. Thus, uncertainty reducing policies are desirable in themselves for those seeking to adapt such policies.

They are relevant even if it cannot be stated how much of reduction in uncertainty and in "natural unemployment" a new balance between uncertainty reduction and flexibility will mean.

UNCERTAINTY AND OTHER MACROECONOMIC VARIABLES

For a number of EEC countries, measures of inflation uncertainty are available for business 1965-79 and households for the years 1973-81[5]. The diagrams in Appendix C illustrate the development of households' inflationary expectations in the EEC and the USA. It must be remembered, however, that the concepts are different in the business surveys from those in the household's surveys. Consumers are asked about their expectations regarding average consumer prices, whereas businesses are asked for their expectations on their own particular prices. Thus, business is not asked about expectations of inflation in general.

EEC business expectations data have been analyzed by R.A. Batchelor[6]. In all four countries investigated, Belgium, France, Germany and Italy, Batchelor found significant, lagged relationships between business inflation uncertainty and capacity utilization. An increase in inflation uncertainty will cause a decrease in capacity utilization and, it might be added, at the same time cause an increase in unemployment. (See Appendix B). A similar, statistical relationship was found between inflation uncertainty and the lagged difference between actual and expected output.

Paul Wachtel has used Survey Research Center data for the period 1955-73, that is before the second shift (dummy D73 in the U.S. regressions, Appendix A) to study the effects of price uncertainty upon wages, prices and interest rates[7]. His regression results support the view that uncertainty is a significant factor explaining variations in those variables.

RISK AND UNCERTAINTY

The concept of risk is based upon relative frequencies. In probability theory, the relative frequency is the empirical counterpart to the probability as a theoretical concept. Events are classified according to some principle, statistics are collected and relative frequencies computed.

There are large and important classes of events for which this is an efficient approach. The existence of an insurance business may be taken as an example. Business can insure against fire, wreckage and so on. Without an efficient insurance system, predictability would be lower and profitable trade opportunities would go unexploited.

There is, however, no insurance available for the uncertainty that the copper price may be higher three months from now or the oil price lower six months from now. Instead, there are futures markets that make it possible for individual buyers or sellers to hedge against disadvantageous price developments. Uncertainty reduction takes place via markets - not via insurance companies.

The characteristic for uncertainty as a theoretical concept is that a number of "states-of-nature" are assumed to be admissible without there being any ground for assigning probabilities to those alternatives. For instance, price is conceived as lying between two limits. The "admissible set of states-of-nature" is just that price interval. The price just cannot be higher than the upper bound or lower than the lower bound. It is not that the probability is zero - it is just impossible. On the other hand, any price between the two limits is seen as feasible. It is not a rectangular probability distribution over the interval. In other words, there is no conceivable way of classifying events, collecting statistics and computing relative frequencies that would yield any information on the situation inside the interval.

The concept of an "uncertain prospect" should be distinguished from a probabilistic model using subjective probabilities. This issue is discussed further in the next section.

"Uncertain prospects" and probabilistic models are two classes of models, that can be used for different purposes. Each type has its own properties.

In probabilistic models, decision rules are of the type: Maximize expected values, often weighted by risk aversion.

Decision rules can also be designed for uncertain prospects. It is asked: Is it possible to find a strategy that will yield a higher pay-off than any alternative strategy over the entire interval? In this case such a strategy dominates all other strategies and constitutes the obvious decision. The decision-maker will follow that strategy and no other strategy, on the ground that it will yield the highest pay-off, whatever is the "true state-of-nature" inside the set of admissible "states-of-nature".

Obviously, there will often be no dominating strategy. For this case, many decision rules have been suggested, such as minimax, minimum regret and so on. It is an empirical question whether or not real-life decision makers follow this type of decision rules. It cannot be argued from normative grounds that any of them is better than any other. They just have more or less intiutive plausibility.

PROBABILISTIC SEARCH THEORY

In probabilistic search models, the essential element is a "stopping rule". When expected gains from continued search no longer exceed search costs, the rule says it is time to make a decision. Search theory developed in the beginning of the 1970s with the aim of explaining labor market search by workers. Search theory can, however, equally well be applied to any form of search in markets - whether markets for consumer goods, intermediate goods or raw materials, financial markets, markets for corporations etc.

The central idea is that search takes time and is costly. A buyer or a seller has to consider time and cost when deciding whether to accept an offer to sell or to buy something or to continue search. When search costs are high, it is better to make an early contract rather than to continue search. If expected price (or wage) dispersions are high, it pays to continue search rather than make an early contract. If more information makes it possible to make a better deal, it will pay to acquire more information at a cost in terms of time and/or money.

This means that high price (or wage) dispersions will lead to long search times and to high unemployment along with low capacity utilization.

In probabilistic search models, probability distributions of prices etc are known. In the real world, conditions may change during search in such a way as to affect those probability distributions. Such changes are best represented by means of uncertainty, not risk. The probability that a probability may change is itself a probability, and consequently search can from the beginning be guided by the second, composite probability distribution. Thus, modelling unexpected changes in conditions requires use of the concept of uncertainty. For instance, a parameter in a probability distribution is seen as uncertain. (Cf. the contribution by Eliasson in this volume.)

When probability distributions are not known and interpretations in terms of relative frequencies are not possible, probability concepts can be used subjectively. Behavior is explained as if assumed subjective probabilities were being used by decision-makers. This approach may be fruitful for situations like buying lottery tickets. Logical contradictions are, however, difficult to avoid in more complicated cases, such as investment and/or marketing strategies with sequential decision-making points distributed over time. Among other things, it is inherent in subjective probability that it depends upon the way it is presented and is not invariant when the presentation of the decision-making situation is transformed without change in its logical structure. Furthermore, it is difficult to combine subjective probabilities and risk aversion without getting into logical contradictions.

These limitations stated, search theory may offer a theoretical explanation for the empirical finding (from the regressions presented below) that increased dispersions in price expectations increase unemployment and decrease capacity utilization. However, it does not appear reasonable that of the increase in U.S. unemployment from the 1960s to the period after 1973, as much as 1 1/2 to 2 percentage units would be explained from a lengthening of search times among unemployed job-seekers because of increased dispersions in households' inflationary expectations.

Relationships between different markets as to dispersions in expectations have to be considered. Search theory is not yet very much developed on this point, it is true. Some work is going on in Stockholm at the Industrial Institute for Economic and Social Research (IUI). Bo Axell and Jim Albrecht, of Columbia University, have investigated search behavior in a two-market economy - one commodity and one kind of labor[8].

DECISION-PROCESSES MEAN MODIFICATION OF MODELS - NOT COLLECTION OF MORE FACTS

As was emphasized above, in many cases uncertainty decision models do not contain dominating strategies. Various intuitively plausible rules such as minimax, minimum regret have been suggested for those cases. Empirical research has, however, demonstrated that decision-makers often act differently. They try to modify their models until a dominating strategy can be found in the new modified model, rather than follow some minimax, minimum regret or similar decision rule.

In other words, search processes under uncertainty may be better modelled as search for new concepts, new frames of reference etc than search for additional information in the form of more observations within the same model. In this way, search under uncertainty may be differentiated from search under risk.

From the psychological point of view this corresponds to some recent empirical findings.[9] In the Montgomery-Svensson experiment, the stopping-rule for search in the Stockholm market for one-family houses was found to be the emergence of a model with a dominating strategy. Models were modified until such a result was obtained.

The sequence of scenario structures used by Shell to cope with the uncertainties of the 1970s as described by Jefferson is another example of the importance of search for new frames of reference and new concepts. The Shell decision rule is that a project must not lead to disaster under any scenario in the model and that search must continue until such projects are found. In the search process, models and projects are modified interdependently.

This approach would also have the advantage of connecting the analysis of disturbances and variations with the basic analysis of economic growth. If growth is seen essentially as growth of knowledge - not growth of capital in the form of machinery and equipment - the basic question may be asked: What is knowledge? Is knowledge the accumulation of more observations making confidence intervals shorter - as described in risk theory - or is more knowledge essentially shifts from one set of models to another, capable of explaining a wider set of phenomena without an increase in complexity?[10]

If the latter approach is used, growth of knowledge may be seen as the driving force in economic growth. The accumulation of capital in the form of machinery and equipment is a consequence of growth of technical knowledge, not an independent cause for economic growth. If technical knowledge did not increase, the economy would sooner or later reach a level of saturation with constant capital and constant productivity, in other words, a stationary state.

When seen in this way, the growth of knowledge is not a continuous process. It necessarily involves discontinuities, corresponding to shifts in models used. Such shifts constitute cources of uncertainty. It is important to observe that "market regime shifts" must be included here. Knowledge is not only technical knowledge in a narrow sense, it includes also knowledge about market organization etc.

It is characteristic of the process of growth of knowledge that periods of confusion and indecision occur from time to time. There are periods when the basic structure of knowledge within a certain field is relatively constant. Experiments and observations are made, elaborations are added and so on. Essentially, however, the situation is stable. Between such periods, there are periods when important but unexplainable empirical data make it difficult to integrate theoretical structures, periods when contradictions are prevalent.

Perhaps, the oil shock years can be interpreted as such an intermediate shift period. There was relative stability in energy markets before 1973 - not in the sense that relative prices were constant, but in the sense that the "market regime" was the same.

The model used by buyers and sellers was essentially the same. OPEC existed, but was not a determining force in world oil markets.

After October 1973, there was a period of confusion and shift. After some time, however, the new "market regime" was established and recognized by buyers and sellers in general. A new period began when oil market forecasts, business and government planning on coal, nuclear energy and so on were based upon the assumption that the oil market was cartelized by OPEC for the foreseeable future.

This changeover is not efficiently described as the accumulation of more observations within a risk model.

The same may be said on the history of contingency clauses in collective wage agreements[11]. The development from one form of contingency clause to another form is better described with the help of an uncertainty model, and with the basic assumption that the bargaining partners seek a consensus solution, characterized by dominating strategies.

The mathematical treatment of uncertainty models is extremely complicated. Basically, it is a question of game theory. There is very little known in general about games with an arbitrary number of players - n-person games[12]. On the other hand, such general treatment is perhaps not really needed.

Uncertainty in different markets is interrelated. Thus, the problem is not to analyze a single oligopolistic market, but a system of interdependent markets with varying degrees of latent possibilities for oligopoly. In ordinary price theory, it is taken for granted that the market structure is competitive, oligopolistic, monopolistic or whatever case is demonstrated. The basic problem, however, is: under what circumstances the market becomes competitive, oligopolistic or monopolistic?

This depends not only upon the situation in that particular market but also on related markets. For instance, there is a relationship between oligopoly on product markets and coverage of collective agreements in labor markets.

THE PRODUCTIVITY SLOW-DOWN AND THE DEGREE OF CAPACITY UTILIZATION

One important aspect of the stagflation problem is the productivity slow-down. In almost all OECD countries, the rate of manufacturing productivity increase was lower after 1973 than before.

According to regression estimates made by Yngve Åberg at the IUI, lower capacity utilization was a major causal factor behind the productivity slow-down. (See Appendix D)[13].

According to Batchelor, increased uncertainty was correlated with lower capacity utilization (Appendix B). If these observed relationships are combined, a relationship will emerge between increased uncertainty and the productivity slow-down. It may be that increased uncertainty is a basic cause for the productivity slow-down.

There is, however, no direct empirical evidence (in the form of regressions) that supports this relationship.

From a theoretical point of view, the existence of such a direct relationship does not appear implausible. For instance, both production planning and investment decisions should be more difficult, when uncertainty is higher. Such processes will then become more time consuming. More decisions will be postponed. Delays will mean slower productivity increases.

On the other hand, it is possible to explain the relationship between the degree of capacity utilization and the productivity slow-down from causal factors that are unrelated to uncertainty. For instance, a plant is normally designed for a certain level of production as optimum. If it has to operate at lower (or higher) levels organizational problems arise. A certain amount of slack in the organization is unavoidable at lower levels, and a certain amount of overcrowding is inevitable at higher levels. Balancing between different groups of machinery etc is no longer optimal when the degree of capacity utilization is too low.

UNCERTAINTY, PRODUCTIVITY, UNEMPLOYMENT AND WAGE FORMATION

Our basic hypothesis was:

A general increase in uncertainty in the economy will lead to lower productivity growth, more unemployment, higher wage increases and more inflation. These effects are simultaneous and interdependent.

Hence, relations between uncertainty, capacity utilization and productivity should be expected to exist theoretically as well as empirically. It is, however, more difficult to understand how enhanced uncertainty will also lead to higher rates of wage increase at the same levels of unemployment for wage and salary earners and vacancy times for employers.

If there is such a relationship it must be explained by reference to the lower ends of uncertainty intervals in models containing consensus dominating business strategies designed to secure survival, but not aiming at expansion and high profits. If these 'survival points' permit lower expansion, lower investment, lower growth rates, slower penetration of new markets etc than before - and consequently less aggressive price policies - will this also imply less sensitivity to wage increases?

According to product-cycle theory the importance of strict cost control will be largest during the mature product stage. Among other things the administrative tools for cost control will be more developed when business is mature, than during the expanding innovative period.

Perhaps the characteristic for the period of increased business uncertainty is the existence of a number of new expansive businesses like the North Sea oil fields, where wage formation is largely uncontrolled. If relative prices are more stable, those kinds of business opportunities do not arise with the same frequency. Consequently, wage formation is also less volatile. Even if these areas are relatively small, they can exercise a substantial disturbing influence upon wage formation in general, and industrialized structure as the Norwegian example demonstrates.[14] Wage-wage links exist in all kinds of labor markets, even when plant bargaining dominates as in the USA. Wage-wage links do not require a centralized wage bargaining system such as in the Scandinavian countries.

Thus, if higher volatility in the price structure and increased price uncertainty is combined with certain institutions in the labor market (that exist because they were efficient earlier, under more stable conditions), it follows that an increased uncertainty in the economy will lead to higher wage increases at the same rate of unemployment.

In the exploration of the increase in "natural unemployment", a wider frame-of-reference than just labor market search has to be applied. Only then will it be possible to explain why in many countries, especially in the USA, business corporations reacted to increased uncertainty by adopting defensive strategies that yield inflationary wage increases in spite of an abundant supply of labor.

CONCLUSION

We have argued in this chapter that to interpret the significance of variations in dispersions in price expectations as measured by survey methods, it is essential to use uncertainty models rather than risk models. Using game theory, it should be possible to define variations in uncertainty as a systematic part of a theoretical structure, containing also, among other variables, simultaneous unemployment and inflation (stagflation), productivity and growth. Empirical evidence (statistical regressions) has demonstrated the significance of relationships between those variables for a solution to the stagflation problem.

Uncertainty has to be reduced. Reduction of uncertainty can take place through futures markets, contingency clauses in long-term energy contracts and in collective wage agreements and by many other methods. The use of such methods to accomplish uncertainty reduction has, however, to be balanced against the need for flexibility.

Here, systematic theoretical analysis has a gap to fill. This analysis has to be based upon the theory of uncertainty, not risk. Under uncertainty, it is, for instance, possible to demonstrate that the use of contingency clauses may reduce flexibility in the macro-economic adjustment. If contingency clauses are too rigid, future disturbances can put the economy into a tailspin.

By contrast, risk models, built upon Walrasian equation systems, containing stochastic disturbance terms and maybe also probabilistic search and decision making processes, generally satisfy the Pareto principle that a contingency rule that is mutually advantageous to the parties (for instance, trade unions and employers' organizations) is no obstacle to welfare optimum. Only special assumptions on risk aversion (that would intuitively not appear as 'normal') lead to situations when this 'Pareto principle' does not hold.

Thus, risk models cannot logically produce many types of behavior that constitute basic political problems in a Disorderly Global Economic System. Relevant models are more complex and require more difficult analytical tools, for instance simulations. The concept of uncertainty is definitely needed to understand what has been going on in the 70s, even if it brings with it mathematical complications of an order that we cannot handle in the traditional fashion. Only uncertainty models can, for instance, provide a theoretical basis for a discussion of legislation concerning contingency clauses in collective agreements.

The same may be said regarding the analysis of interrelations between uncertainties in different markets. To study how uncertainty regarding expected oil prices (or coal prices) is diffused through the economy, many elements are crucial that are not present in risk models. It is not sufficient that new price observations are added as time passes. 'Market regime uncertainty' is essential for the diffusion process, and this cannot be represented in risk models. Economic growth itself is not a stochastic process within one and the same model. Growth of knowledge, as represented by model shifts, is an essential part of economic growth. Growth itself is uncertain, at the same time as it creates uncertainty, in Knight's sense, as distinguished from risk.

APPENDICES A-D: REGRESSION RELATIONSHIPS BETWEEN BASIC VARIABLES

Appendix A: Statistical estimates of the relationships between inflation uncertainty and unemployment

The regressions on the following page demonstrate three things.

First, inflation uncertainty among households, as measured by $S(P_E)$, is clearly significant in equations 1 and 3a. An increase in inflation uncertainty will increase unemployment. Of the total increase in U.S. unemployment from 3-4 per cent in the 1960s to 8-9 per cent in 1981-82, 1.5-2 per cent can be explained from increased inflation uncertainty. Even if this is less than half of the total increase, it is large enough to be interesting.

Second, the difference between actual (P_A) and expected (P_E) inflation is also significant. If actual inflation is one per cent higher than expected, unemployment is reduced around 1/3 of one per cent. The 'Expectations Augmented Phillips Curve' is confirmed.

Third, the dummy for the 'first oil price shock' gives better fit if located between 1972 and 1973 than between 1973 and 1974. Thus, the oil price increase in October 1973 cannot have been the only and major cause for this shift.

There was no shift in the second oil price shock but it was one between 1969 and 1970. According to the regressions, the breakdown of 'Bretton Woods' increased unemployment more than the 1972-73 shift did.

On page 3, R.A. Batchelor's regressions for the U.K. are quoted. The similarity to the U.S. data on page 2 is striking.

Appendix B: Effects of increased price uncertainty upon real output

In the main text, it is assumed on theoretical grounds that increased price uncertainty will decrease capacity utilization and real output. The table below gives empirical support to this assumption. There is a clear statistical relationship with one year lag from an increase in uncertainty in business price expectations to a decrease in capacity utilization and a reduction in actual output in relation to expected output.

Estimated regression coefficients 1965-77
Independent variable: Standard deviation in business price expectations.

	Belgium	France	Germany	Italy
Actual output				
Current	-0.21	0.57	-0.32	-0.32
Lagged 1-year	0.02	0.18	0.24	-0.00
Difference between expected and actual output				
Current	0.16	0.03	0.15	-0.28
Lagged 1 year	0.15	0.49	0.46	0.30
Degree of capacity utilization				
Current	0.34	-0.10	0.21	-0.32
Lagged 1-year	0.32	0.33	0.45	0.40

From R.A. Batchelor, 'Expectations, Output and Inflation', p. 19.

The estimated relationships between real output and price uncertainty are clearly significant when lagged capacity utilization is used as output variable. All coefficients are positive and of the same magnitude.

Next in significance and robustness is the relationship when the lagged difference between expected and actual output is used.

Lagged relationships are always better than current. Thus, causation is from price uncertainty to output, not vice versa.

Appendix C: Household's inflationary expectations mean values and variances

The following figures for EEC countries are based upon tables in Papadia-Basano: Survey based inflationary expectations (of households). Dispersions were supplied by authors. The U.S. figure is based upon Survey Research Center data.

Table 1 **USA. Households 1966–81**

Dependent variable = Unemployment U

Independent variables	Equation Number 1	2	2a	3	3a
Constant	0.67 (1.02)	3.50 (13.22)	3.49 (10.33)	2.08 (3.06)	1.64 (3.27)
$P_A - P_E$	-0.24 (2.07)	-0.36 (3.99)	-0.44 (3.50)	-0.33 (4.15)	-0.37 (4.46)
$S(P)_E$	0.75 (7.80)	- -	- -	0.31 (2.21)	0.41 (4.10)
D_{70}	- -	1.85 (4.92)	1.72 (3.32)	1.49 (4.10)	1.22 (3.38)
D_{74}	- -	1.99 (5.83)	- -	1.06 (2.05)	- -
D_{73}	- -	- -	2.07 (4.02)	- -	0.99 (2.29)
R^2	0.80	0.91	0.81	0.91	0,92
DW	1.24	1.87	1.69	2.18	2.12

P_A = actual increase in consumer prices

P_E = expected price increase 12 months earlier. Survey Research Center data.

$S(P_E)$ = standard deviation in price expectations among households

D_{70}, D_{73} and D_{74} = Dummies for years 1970-81, 1973-81 and 1974-81.

Figures in parenthesis are t-statistics.

DW = Durbin-Watson statistic.

Table 2 **U.K. Households 1962-81**

Dependent variable = Unemployment U

Independent variables	Equation Number 1	2
Constant	2.48 (1.89)	-1.37 (2.03)
RPW_{t-1}	0.07 (2.39)	'
OIL_{t-1}	0.02 (3.23)	'
RER_{t-1}	0.04 (2.34)	'
$(P_A - P^*_E)_{t-1}$	-0.24 (4.90)	-0.22 (5.29)
$S(P^*_E)_{t-1}$	0.66 (2.97)	0.70 (5.14)
D_{79}	'	5.35 (5.12)
D_{75}	'	2.95 (7.14)
R^2	0.94	0.95
DW	1.57	2.08

Figures in parenthesis are t-statistics.

Source: R.A. Batchelor: A Natural Interpretation of the Present Unemployment, pp 32 and 36.

For the U.K. P^*_E means current inflationary expectations.

Thus $(P_A-P^*_E)_{t-1}$ means that expectations one year earlier are compared to actual inflation one year earlier, not to current actual inflation as was done for the USA.

Note that P_A and P_E^* are defined for periods of 6 months not 12 months as in the USA.

For the U.K., lagged standard deviation of inflationary expectations gives better fit than unlagged, contrary to the USA.

RPW	= real product wage disequilibrium
OIL	= real oil price
RER	= real exchange rate

D_{75} and D_{79} = dummies for years 1975-82 and 1979-81.

The conclusion from this is that inflationary expectations among households are clearly significant both in the USA and in the U.K.

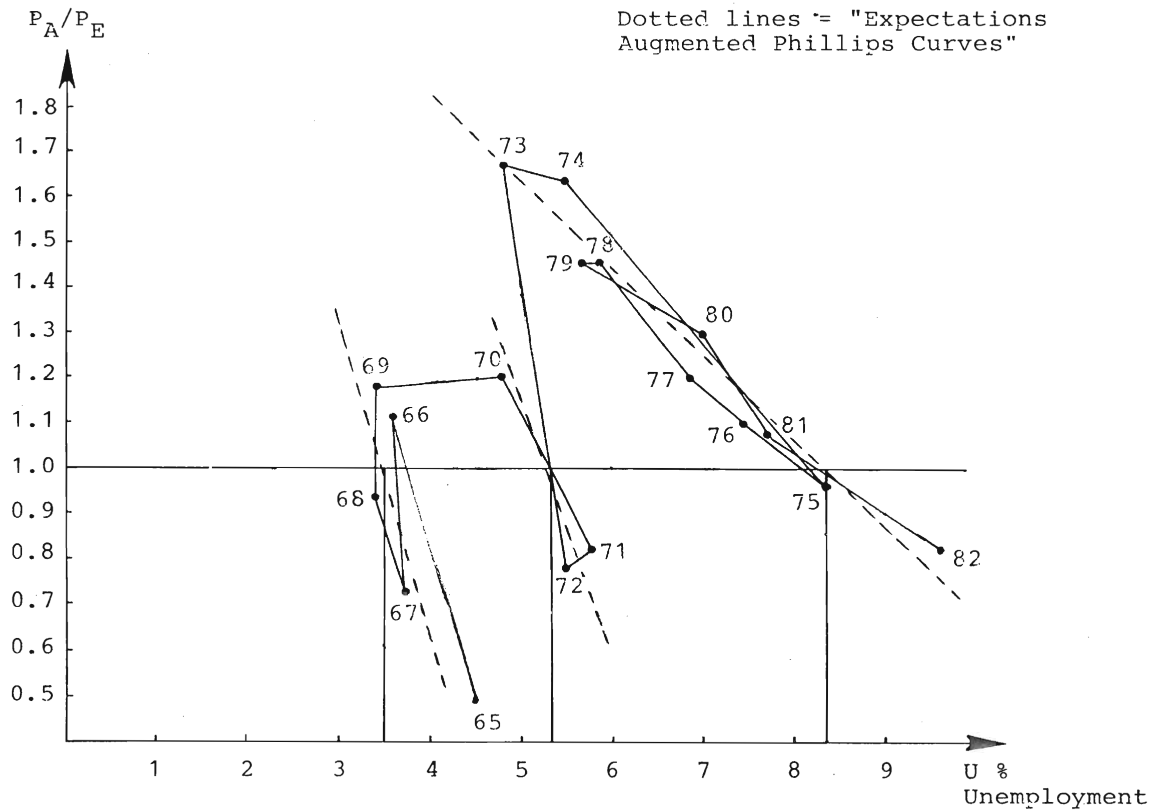
The increase in standard deviation of inflationary expectations from the 1960s to the late 70s was around 3 percentage points both in the U.K. and in the USA.

With a coefficient around 2/3, this would mean that increased inflation uncertainty contributed around 2 percentage points to the increase in unemployment between the 1960s and the late 70s.

If 'natural unemployment' in the USA was between 8 and 8.5 per cent 1973-81, compared to 3.5 per cent in the late 1960s, it would have been around 6 per cent if inflation uncertainty had been the same in the late 70s as in the late 60s.

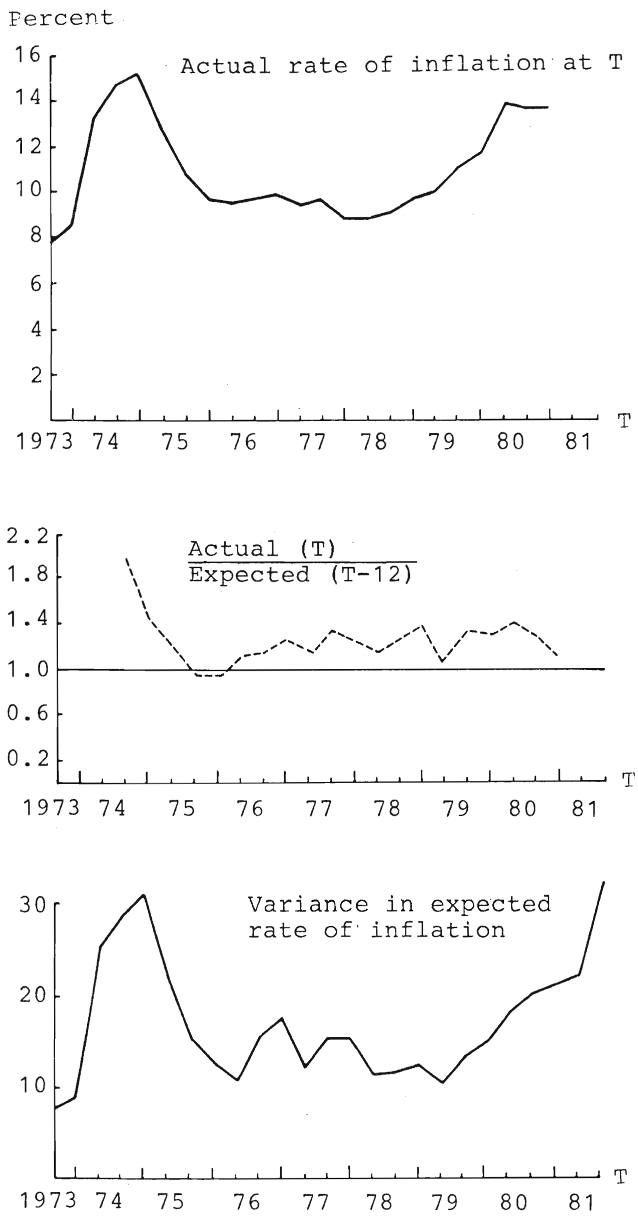
Figure 1

P_A = actual price increase
P_E = expected price increase



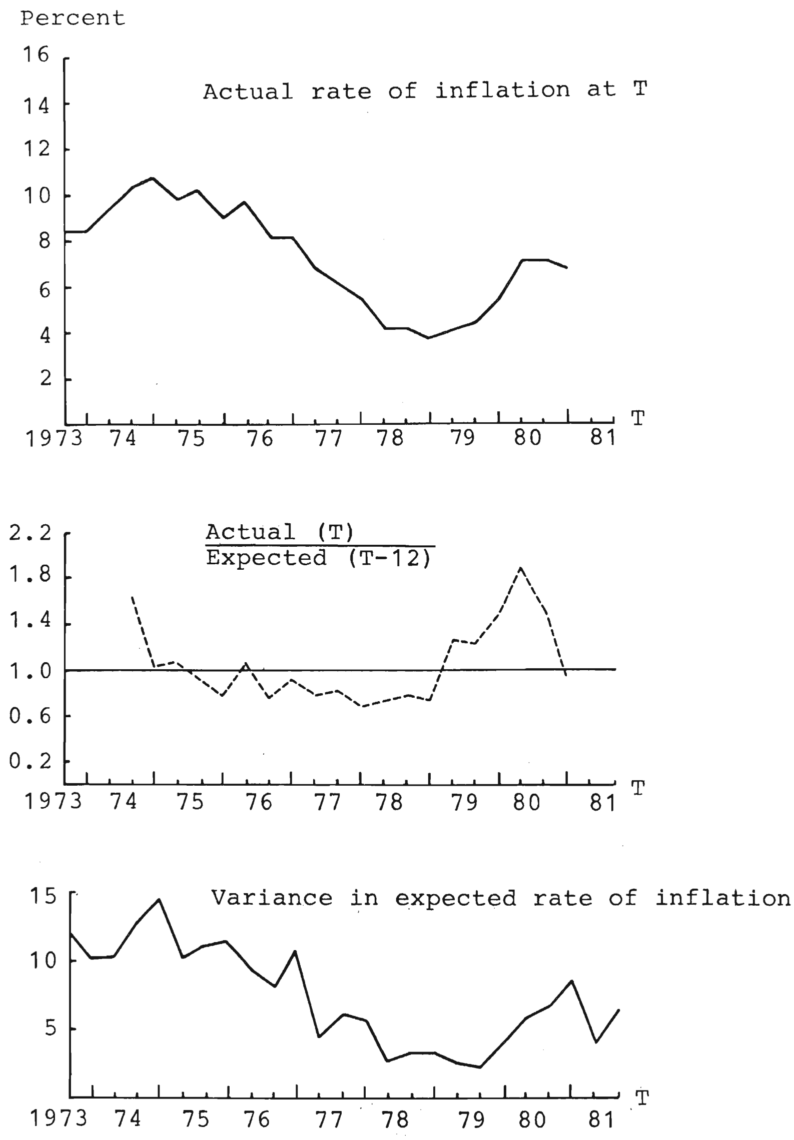
<u>Sources:</u> Actual inflation: OECD Statistics.
Expected inflation and variance in expected inflation: Table supplied by Richard Curtin, Surveys of Consumer Attitudes, Survey Research Center, University of Michigan

Figure 2 Households France



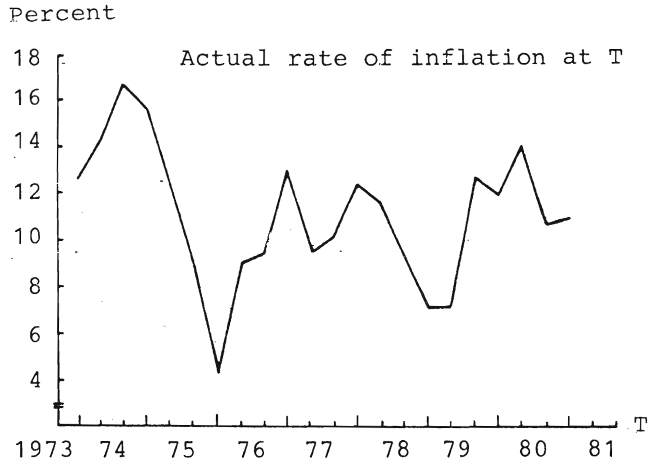
(T-12) indicates 12 months time lag

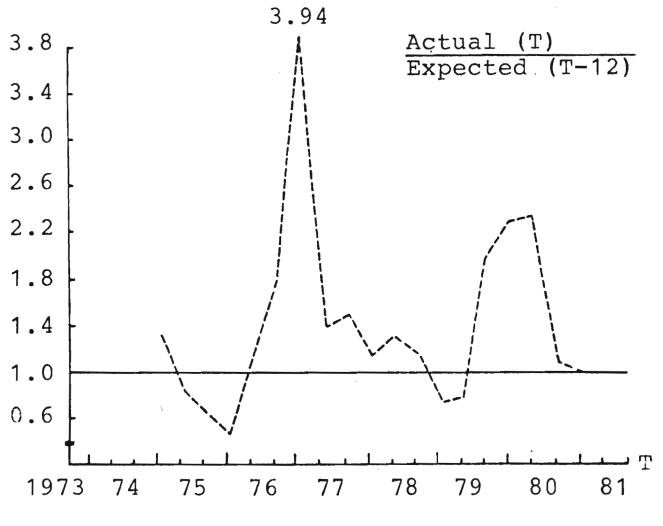
Households Netherlands

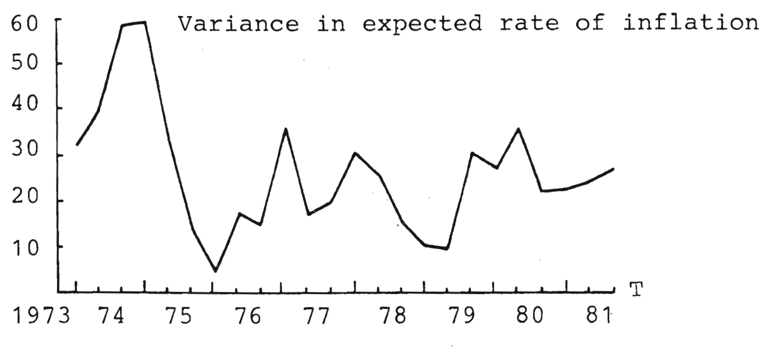


(T-12) indicates 12 months time lag

Households Denmark

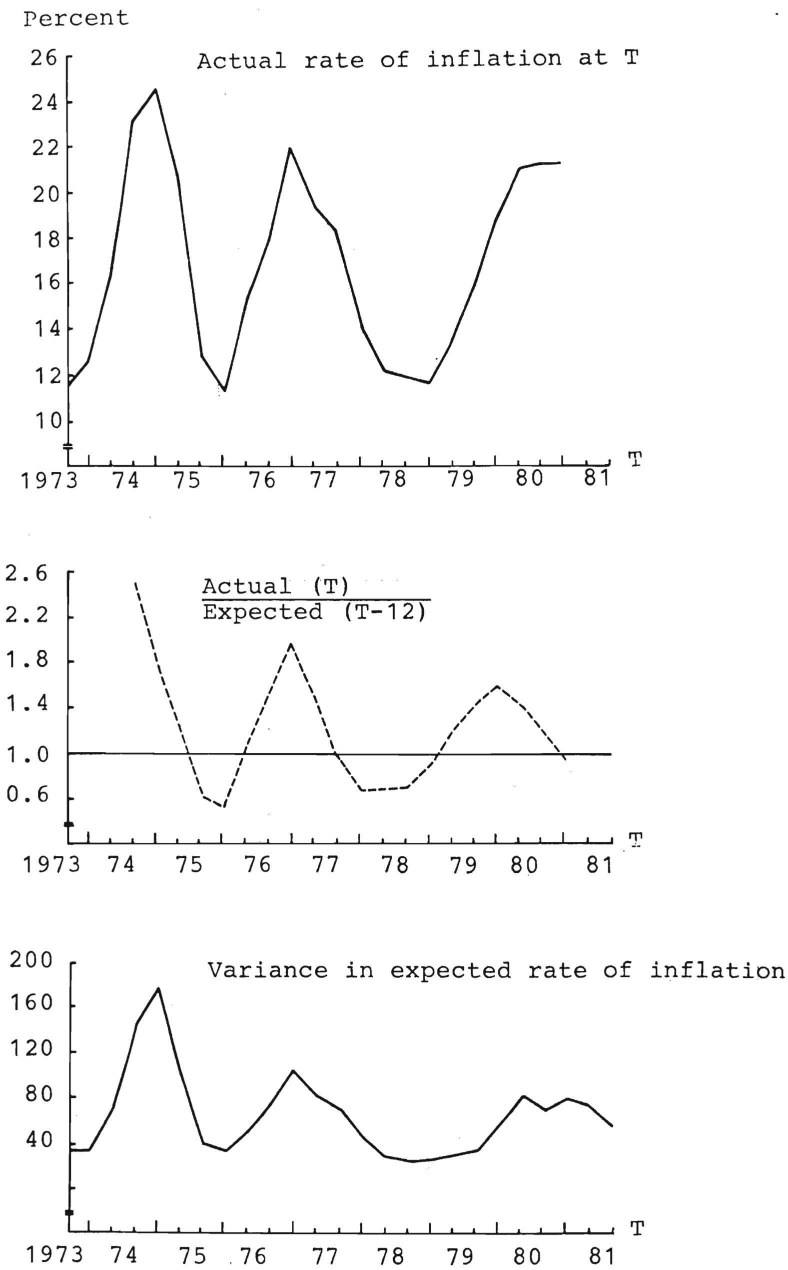






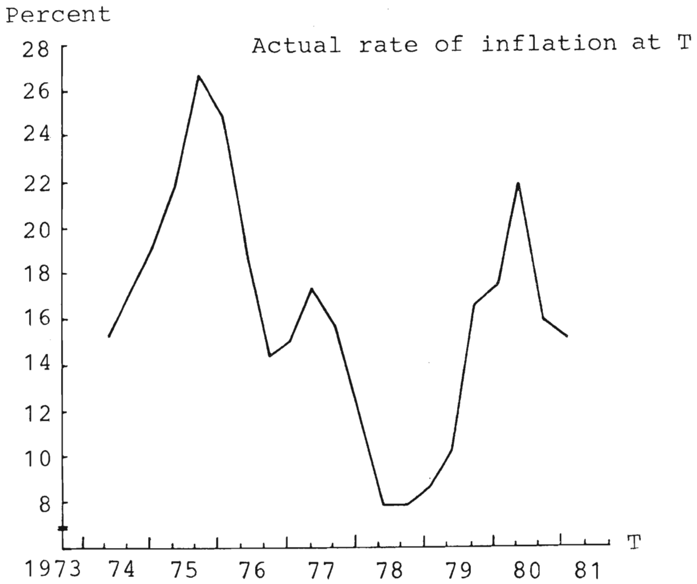
(T-12) indicates 12 months time lag

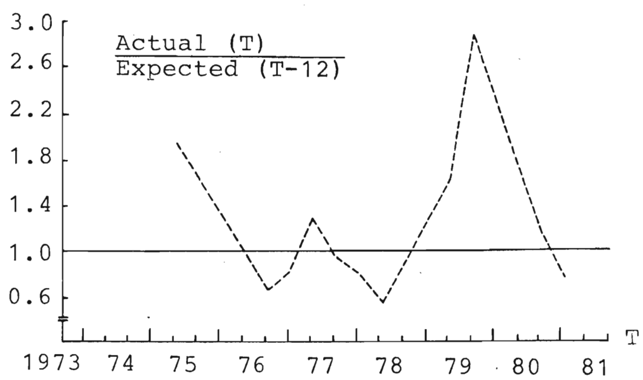
Households Italy

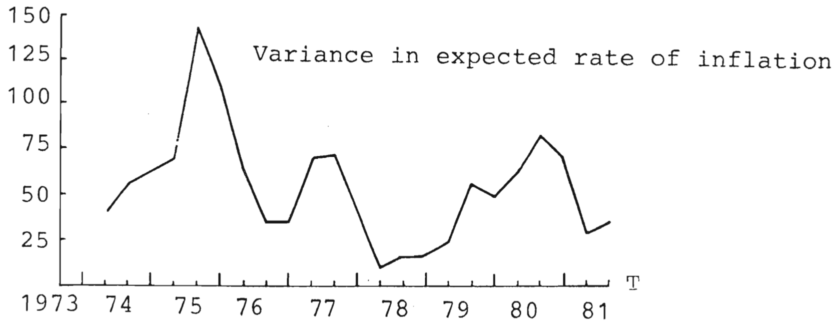


(T-12) indicates 12 months time lag

Households United Kingdom

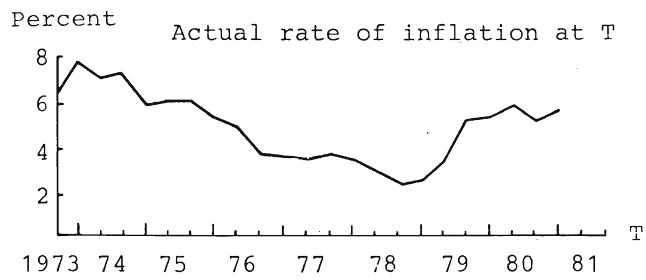


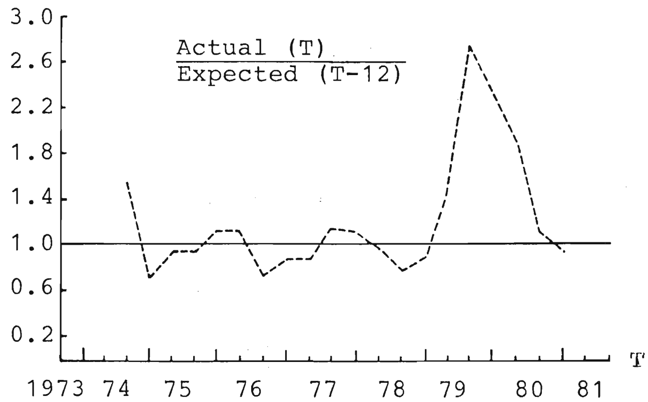


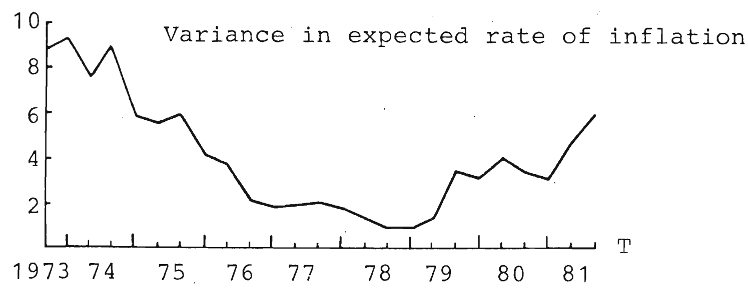


(T-12) indicates 12 months time lag

Households Germany

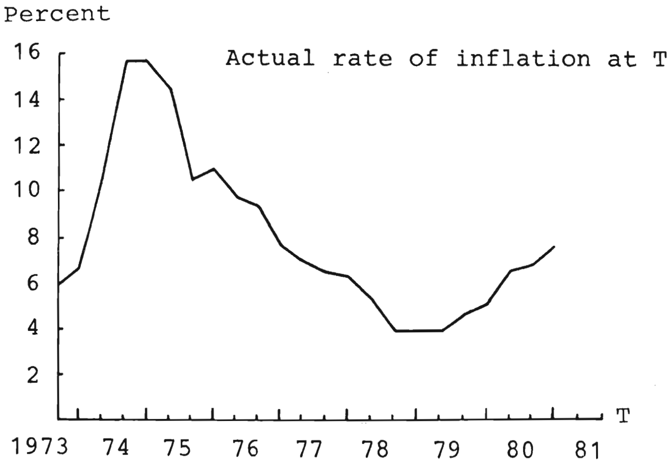


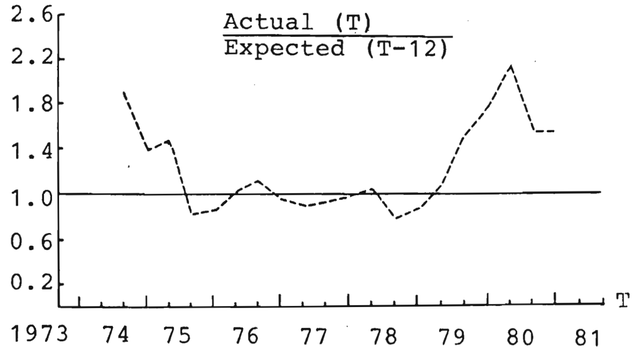


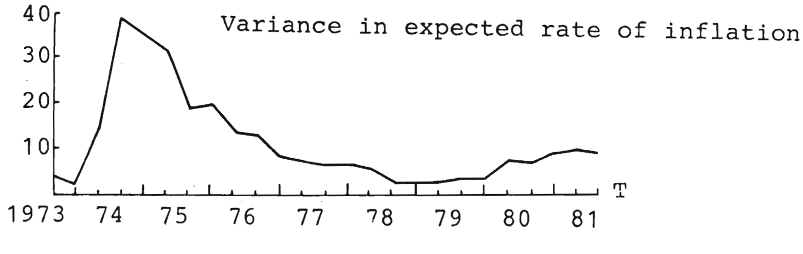


(T-12) indicates 12 months time lag

Households Belgium

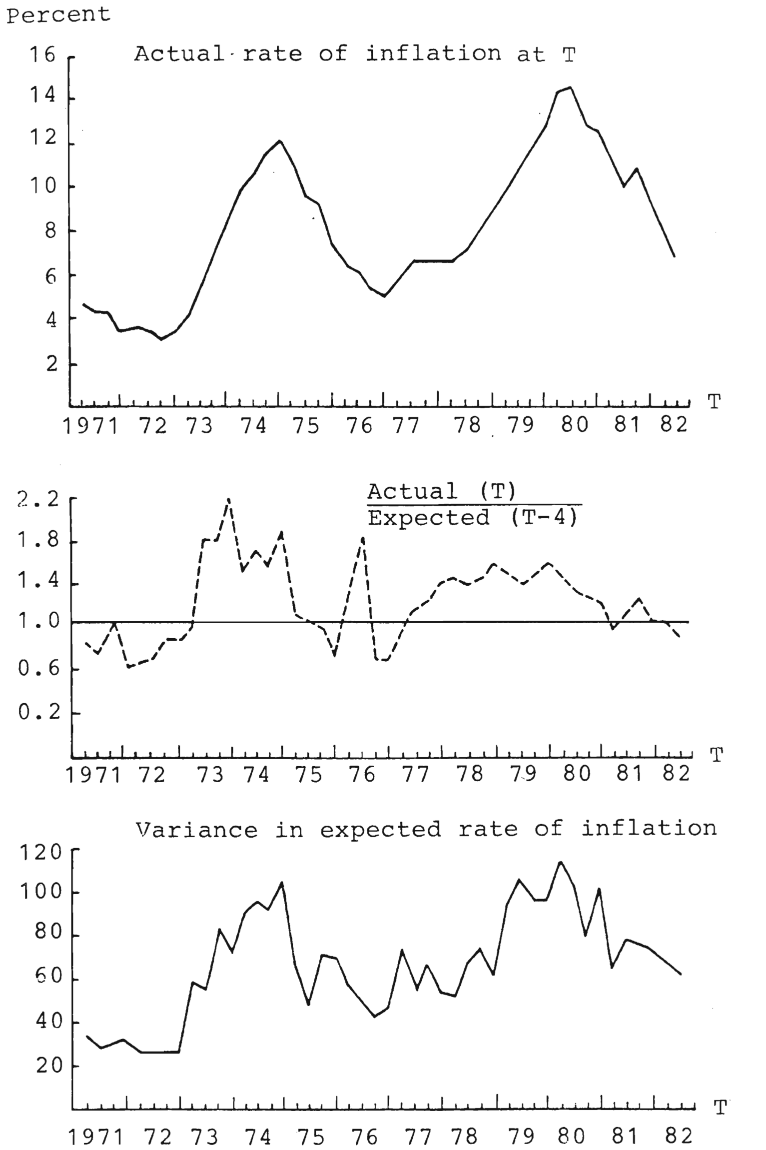






(T-12) indicates 12 months time lag

Households USA



(T-4) indicates 4 quarters time lag

Source: Actual inflation: OECD Statistics. Expected inflation and variance in expected inflation: Table supplied by Richard Curtin, Surveys of Consumer Attitudes, Survey Research Center, University of Michigan.

Appendix D: Statistical estimates of the relationships between capacity utilization and the productivity slow-down

Yngve Åberg distinguishes three sources of productivity increase: capital intensity, capacity utilization and technical progress.

The first is a physical measure, using OECD capital stock data. Capital is increased annually by investments in buildings and machinery minus depreciation. It is standard methodology.

For capacity utilization, however, Åberg uses his own measure. He defines "capital in use" economically, as price adjusted capital income. His definition is based upon the assumption that the real net return to "capital in use" does not have a time trend. In other words, "capital in use" is seen as a stream of services rather than a set of objects. The degree of capacity utilization is then defined as the ratio between "capital in use" (as measured by Åberg) and capital stock (as measured by OECD).

Manufacturing productivity increase and contributions from capital etc
Annual percentage increase

	1953-73	1973-80	1976-80	Difference* -73/80	Difference* -76/80
Japan: Productivity	8.7	4.6	6.3	4.1	-2.4
Contribution from					
capital intensity	4.5	3.8	2.3	-0.7	-2.2
capacity utilization	0.5	-1.2	2.2	-1.7	+1.7
technical progress	3.7	1.9	1.7	-1.8	-2.0
W Germany: Productivity	5.3	4.4	3.4	-0.9	-1.9
Contribution from					
capital intensity	2.3	2.2	1.5	-0.1	-0.8
capacity utilization	-0.1	-0.5	-0.5	-0.4	-0.4
technical progress	3.2	2.7	2.5	-0.5	-0.7
France: Productivity	5.3	4.1	4.2	-1.2	-1.1
Contribution from					
capital intensity	1.5	2.6	2.4	+1.1	+0.9
capacity utilization	1.1	-1.0	-0.4	-2.1	-1.5
technical progress	2.6	2.6	2.1	+-0	-0.5
Great Britain: Productivity	3.6	1.4	2.0	-2.2	-1.6
Contribution from					
capital intensity	1.6	2.0	2.2	+0.4	+0.6
capacity utilization	-0.2	+2.0	-1.8	-1.8	-1.6
technical progress	2.1	1.5	1.5	-0.6	-0.6

* Compared to 1953-73

	1953-73	1973-80	1976-80	Difference* -73/80	-76/80
Sweden: Productivity Contribution from	5.5	1.9	3.4	-3.6	-2.1
capital intensity	1.7	2.0	1.9	+0.3	+0.2
capacity utilization	0.9	-1.7	0.6	-2.6	-0.3
technical progress	2.9	1.6	0.9	-1.3	-2.0
USA: Productivity Contribution from	3.5	2.1	1.4	-1.4	-2.1
capital intensity	1.1	1.1	0.7	+-0	-0.4
capacity utilization	1.1	-0.1	-0.2	-1.2	-1.3
technical progress	1.2	1.2	0.8	+-0	-0.4
Canada: Productivity Contribution from	4.2	2.4	1.9	-1.9	-2.3
capital intensity	1.9	1.8	1.2	-0.1	-0.7
capacity utilization	0.7	-0.6	0.3	-1.3	-0.4
technical progress	1.6	1.2	0.5	-0.4	-1.1

* Compared to 1953-73

Source: Produktivitetsutvecklingen i industrin i olika OECD-länder 1953-1980, by Yngve Åberg, IUI 1983.
(Productivity development in manufacturing in OECD countries 1953-1980).

From this table it would appear that a major part of the productivity slow-down from 1953-73 to 1973-80 was caused by the decline in capacity utilization. In Japan, it was 1.7 percentage units out of 4.1, in Great Britain 1.8 out of 2.2, in Sweden 2.6 out of 3.6, in the USA 1.2 out of 1.4 and in Canada 1.3 out of 1.9 percentage units.

The same is not true, however, when 1953-73 is compared to 1976-80. Only in Great Britain did the contribution from capacity utilization constitute a higher proportion of the "productivity slow-down" in 1976-80 than in 1973-80. Thus, it seems that, in most countries, the impact of lower capacity utilization was concentrated to 1973-76.

NOTES

[1] Frank Knight, Risk, Uncertainty and Profit, New York, 1921.

[2] See Eliasson-Lindberg; Allocation and Growth Effects of Corporate Income Taxes - Some Experiments in Quantification on a Micro-to-macro Model of the Swedish Economy in Eliasson-Södersten (eds) Business Taxation, Finance and Firm Behavior, IUI Conference Reports 1981:1 (in particular pp. 411 f.). and Pehr Wissén, Wages and Growth in an Open Economy, Stockholm School of Economics 1982.

[3] The 'Expectations Augmented Phillips Curve' can be traced back to Milton Friedman: The Role of Monetary Policy, American Economic Review, Vol. 58 (1968), pp. 1-17, and E. S. Phelps: Money Wage Dynamic and Labour Market Equilibrium, in E. S. Phelps (ed.), Microeconomic Foundations of Employment and Inflation Theory, New York 1970. See also: Milton Friedman, Inflation and Unemployment. Nobel Lecture, Journal of Political Economy 1977:3, pp. 451-471.

[4] R.A. Batchelor, A Natural Interpretation of the Present Unemployment. Paper presented to the City University Conference on Monetarism in the United Kingdom, Sept. 23-29, 1981. (Mimeo.)

[5] F. Papadia and V. Basano, EEC-DG II, Inflationary Expectations. Survey based Inflationary Expectations for the EEC countries. EEC Economic Papers No. 1, May 1981.

[6] R.A. Batchelor, Expectations, Output and Inflation. The European Experience. European Economic Review 1982, pp. 1-25.

[7] Paul Wachtel, Survey Measure of Expected Inflation and Their Potential Usefulness. Studies in Income and Wealth, Vol. 42, Analysis of Inflation 1965-1974, pp. 361-395.

[8] James W. Albrecht and Bo Axell, General Search Market Equilibrium, The Industrial Institute of Economic and Social Research, Stockholm. Working Paper No. 63, 1982.

[9] Henry Montgomery and Ola Svensson, A Think Aloud Study of Dominance Structuring in Decision Processes. Third Conference on Experimental Economics, Wingenhohl, West Germany, Aug. 29-Sept. 3, 1982.

Michael Jefferson, Economic Uncertainty and Business Decision-Making, in Beyond Positive Economics pp. 122-159, London 1983.

10 Thomas S. Kuhn, The Structure of Scientific Revolutions, University of Chicago 1970.

11 For a discussion of this issue based upon risk theory (not uncertainty) see: Jo Anna Gray, On Indexation and Contract Length, Journal of Political Economy, 1978:1, pp. 1-18.

12 John von Neumann and Oskar Morgenstern, Theory of Games and Economic Behavior, Princeton 1947.

13 Produktivitetsutvecklingen i industrien i olika OECD-länder 1953-1980, (Productivity development in manufacturing in OECD countries), by Yngve Åberg, IUI, 1983.

14 See Eliasson, G., Relative Price Change and Industrial Structure - The "Norwegian Case", in Carlsson-Eliasson-Nadiri (eds); The Importance of Technology and the Permanence of Structure in Industrial Growth, IUI Conference Reports 1978:2.