

**HOW DOES INFLATION AFFECT GROWTH?**  
**- experiments on the Swedish Micro-to-Macro Model**

Gunnar Eliasson, IUI, Stockholm

INFLATION AND GROWTH

1. Introduction

The absolute price level can change for various reasons. We often tend to associate a higher growth rate with more inflation due to excess demand phenomena internal to the economy. There has been very little written or said on the characteristics of the reverse relationship. How does an exogenous change ("shock") in the general price level affect the rate of economic activity? This is a very relevant possibility for any economy engaged in extensive foreign trade. In fact it would be quite odd to assume a one to one correspondence between the rate of economic growth on the one hand and the rate of change in the general price level on the other, irrespective of the origin of growth and of inflation.

The same comment is in fact equally applicable to the relationship between price change and unemployment since so many and so different factors are at work on the two variables. The complexity of the originating and transmitting machinery certainly would generate an asymmetrical price-volume response pattern.

We may say that this study is an essay on estimation. We have been through a series of frustrations when trying to load an extended version of the Swedish micro-macro model with numbers that resemble Swedish conditions. Some inconsistent pieces of empirical evidence still remain to sort out. The very fact that we can give an exact definition of what empirical information we do not possess in terms of the model should be interesting enough and conducive to further empirical research.

The model system operates on a market price signalling-interpretation-decision making mode among individual firms. At some critical inflation rate such a market based system tends to break down, if the inflation process is irregular enough and the interpretative learning mechanisms are not allowed time to adjust. Break down characteristics depend on certain market impulse time coefficients and (NB) the magnitude of the impulses being transmitted. We can study the behavior of the total system under alternative conditions and specifications and we can check some details although empirical evidence is distressingly scanty. The problem is that evidence on the speed of price transmission so far is not wholly consistent with a model specification that can withstand external price shocks of the same magnitude as those witnessed during the Korean boom and the recent oil crisis.

Preliminary experiments on an extended version suggest, however, that these instability properties will be satisfactorily reduced when we have introduced a full public sector and a complete taxation system. Sometimes an exogenous price increase in the foreign markets operates as a deflationary policy measure on the economy by reducing real incomes (as indeed the oil price hike did to the OECD countries); sometimes not, for instance the Korean boom where price hikes were concentrated to typical Swedish raw material exports. This series of experiments will however be structured so that we obtain the same aggregate price change on the import and export sides.

We have allowed some of the simulations to run for 20 years to study the convergence properties of the model system. For such a long time the *ceteris paribus* clause is of course utterly absurd and we expect the reader not to draw any empirical conclusions from this. The idea of this paper is to study the properties of the model economy of Sweden under somewhat refined and unrealistic conditions.

After we have formulated our problem more clearly we will first study how fast exogenous price changes are transmitted through the model economy described already in an earlier paper of mine to this seminar and in Eliasson (1976). We will then proceed to investigate the secondary effects on economic activity levels caused by the market disequilibria occasioned by the price transmission process, and finally we will tell in more easy language what is in fact happening during the model simulations.

## 2. The problem

This paper combines three observations and asks one question.

First, never before in statistically registered time has such an intensive shock wave of enduring inflation encompassed so many countries and such a large total volume of economic activity as has been witnessed since 1968.

Second, we have found that one macro economic property of the Swedish micro-macro economic model is that exogenous step changes (shocks) in the economic environment of business firms, even if conventionally considered conducive to growth, if large enough in fact, are strongly detrimental to long run growth - if no counter-measures can be found.

One such exogenous step change that we have investigated at length is inflation in two forms;

a) a once and for all (sustained) change in the international market price of all Swedish export goods and

b) a temporary inflation pulse.

The results we are about to report on have been systematically maintained through several extensions of the model. If they can be shown to be reflections of real life phenomena and be substantiated by more empirical evidence, they have to mean a radical revision of our way of looking upon inflation and what it means for a market based industrial economy. Since we believe there is evidence to support the existence of the effects to be reported on but that their magnitude has as yet to be ascertained we should caution the reader to regard the results as theoretical for the time being and to be subject to further testing.<sup>1)</sup> I should also add that the numerical results reported on in this paper are based on a model specification that we are gradually improving.

A price step impulse is transmitted through the model economy quite slowly and at different rates depending upon both the size of the initial step and the rate with which individual

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I am currently carrying out some of this testing work jointly with professor Hans Genberg, Institute of International Studies, Geneva.

export firms reallocate their supplies between foreign and domestic markets as a result of the new price differentials. The initial price impulse eventually overshoots in the sense that the ensuing consumer price increase becomes a multiple of the original step impulse, before a contractive process sets in. In those cases we have followed the process long enough - the consumer price effect tends to converge towards a price-price multiplier somewhere around unity in domestic markets for industrial goods (wholesale price index) and somewhere between zero and two in the consumer price end.

The overshooting mechanism feeds on the market price signalling system. When large, absolute and relative price changes are transmitted through the business sector interpretation-decision rules of individual firms become temporarily faulty and generate disorderly production, employment and investment decisions. Since market price arbitrage is faster than volume adjustments the net result is less growth in the long run if the price step is large enough and positive, negative or reversed back after a while; and the more so the more the economy swings off from a steady state growth path.

Very much so this paper is concerned with the stability properties of an open industrialized economy when the market pricing-interpretation-decision making system that holds it together is jolted by disturbances.

Third, the existence of a "price overshooting" property of our economy, in this case Sweden, is an hypothesis almost intractable to direct testing. If the overshooting lags are as long and as unstable as indicated in model simulations we do not have enough time series data to ascertain them properly. As the mechanics is a price-volume-price interaction, a conventional application of a stable lag to describe the price transmission with volumes kept constant will give biased results. We need a complete macro economic model. This we have, but to be relevant this model brings us far beyond the capabilities of conventional econometric techniques. We can, however, note the following. The overshooting property systematically remains after several extensions of the model. The model has also been quite successful in tracing the post-war growth patterns of Swedish industry.

Furthermore, the overshooting property means that a simple distributed lag regression of the consumer price change on the exogenous input change of foreign exogenous prices of an open economy like Sweden should display first positive and then negative time weights, the sum of the positive weights exceeding unity. Some support for such a lag profile was reported on in Genberg (1974). The lag length used by Genberg was, however, arbitrarily cut off at 2 1/2 years and the properties of a polynomial lag estimator are very sensitive to such a priori restrictions. Later experimentation with different and longer lags by Genberg and myself, however, preserve this property. Even though we cannot say that we have empirical control of the transmission rate time profile we believe that the overshooting property as such is empirically established.

The question to be posed finally is peripheral to the paper but central to the current economic debate in Sweden. If domestic prices and wages overshoot export firms can counter this only by cutting into profit margins and/or raising productivity. In the model productivity increases come by way of new investment reductions in output and employment and of slack. Depending upon the character of the disturbance firms respond differently. But the back side of the price overshooting mechanism normally is that firms are pricing themselves out of foreign markets in an economy subjected to international import and export competition, in a vain attempt to maintain profit targets. The more price- (or rather profit) sensitive foreign trade the faster exports and imports respond. Volumes shrink, profits plunge and the ensuing impact on investment spending brings the economy down onto a lower growth trend for a long time if everything else is the same. To many observers this seems to be exactly what has now been going on for some years in Sweden, beginning with the extreme profit boom of 1973/74 and threatening to break an almost uninterrupted 55 year steady state growth record of industrial production of close to 5 per cent. And we think that we can observe price overshooting going on around us.

The original export price steps associated with the 1973/74 profit boom (and with oil) have already been transmitted to the CPI index more than in full. The causal relationships in fact seem to have been turned upside down compared to what we were taught in the 60ies, when exogenous excess demand was thought to generate first more growth and then - as a consequence - more inflation.

Let us see what sort of evidence a sensitivity analysis<sup>1)</sup> of the Swedish micro-macro model, described already in an earlier paper, can shed on this peculiar issue.

### 3. The rate of price transmission

Figures 1 picture the rate of transmission of an exogenous (a) step change in foreign prices and (b) a pulse wave through several production stages to the consumer price. All "price" diagrams shown in this paper exhibit the cumulative domestic (wholesale or CPI) inflation effect either in per cent of the original price step or on index form with the reference case with no price step as the base. All activity diagrams in the next section are of the second index type. Five things can immediately be observed.

First, the larger the step increase the larger (each period) the response in the consumer price index but the longer it takes for the full effect to work itself through.

Second, transmission is somewhat faster to the wholesale price index than to the consumer price index and also in markets with relatively high foreign trade that are immediately affected by the first transitory growth impulse from inflation (intermediate and investment goods (not shown)). The speed of transmission also depends positively on the speed by which export firms and importers adjust their supplies in foreign and Swedish markets in response to foreign domestic price differentials. This can be seen from a comparison of Figures 1A and 1B. We may say that the high price elasticity case of Figure 1A represents a more open economy than the low elasticity case of Figure 1B.<sup>2)</sup>

1) This experiment series has been run on what we call the 350 version of the model. It includes an elaborate interindustry market and inventory system but no tax and money systems. The government can only figure as an exogenously imposed surplus or deficit. See Figure 6 in my description of the Swedish model in this conference volume.

2) In the high elasticity case exports increase by half the quarterly foreign-domestic percentage price differential the next quarter and in the low elasticity case with 20 per cent. Part of the story is that the higher the elasticity the faster the price difference closes through volume responses. However, also see Albrecht's somewhat different way of distinguishing between an open and a closed economy in this same model in his paper for this conference volume.

Third, some overshooting displays itself throughout and is more persistent the slower supply responses by exporters and importers. Since this response time defines the openness of an economy we may perhaps say that the difference between Figures 1A and 1B picture the extent to which a foreign inflationary impulse can spin off a domestic inflationary spiral.

Fourth, in the longer run convergence is not towards a one to one correspondence between initial step and final change in the consumer price level as is often conventionally assumed. Some of the price effect may be absorbed or reinforced by profit margins. The equilibrium conditions (cyclical, etc.) characterizing the point in time when the price step hits the economy strongly affects the relative sizes of step inputs and whole sale and consumer price effects. The ensuing investment and relative sector growth effects may modify the transmission further.

Fifth, there is no necessary symmetry in time response patterns between step increases and decreases of equal magnitude. The reason is of course that firms do not respond symmetrically to plus and minus changes in their prices.

In Figure 1A the shaded area is the cumulated lag estimated on Swedish data by Genberg and myself using a polynomial lag, 12 years long assumed to add up to unity. It is one of a few trial estimates from a project initiated by the controversial findings of the model study reported on in this paper. The estimated lag represents the average lag response of all the ups and downs in the Swedish export price index since 1950. We will return to it in the next section, but we note in passing that if supportive at all it lends support to the faster supply reactions on the part of exporters and importers or for a more open economy. The econometric results furthermore are consistent with overshooting as well as the faster transmission to the wholesale price index.

Figure 1C finally pictures the transmission to the consumer price index of a 10 and 20 per cent step increase in the export price index respectively in year 2 that is reversed back to its beginning position in year 4 in the low elasticity case. We notice that the long run CPI effect is practically zero.

#### 4. Asymmetric activity responses

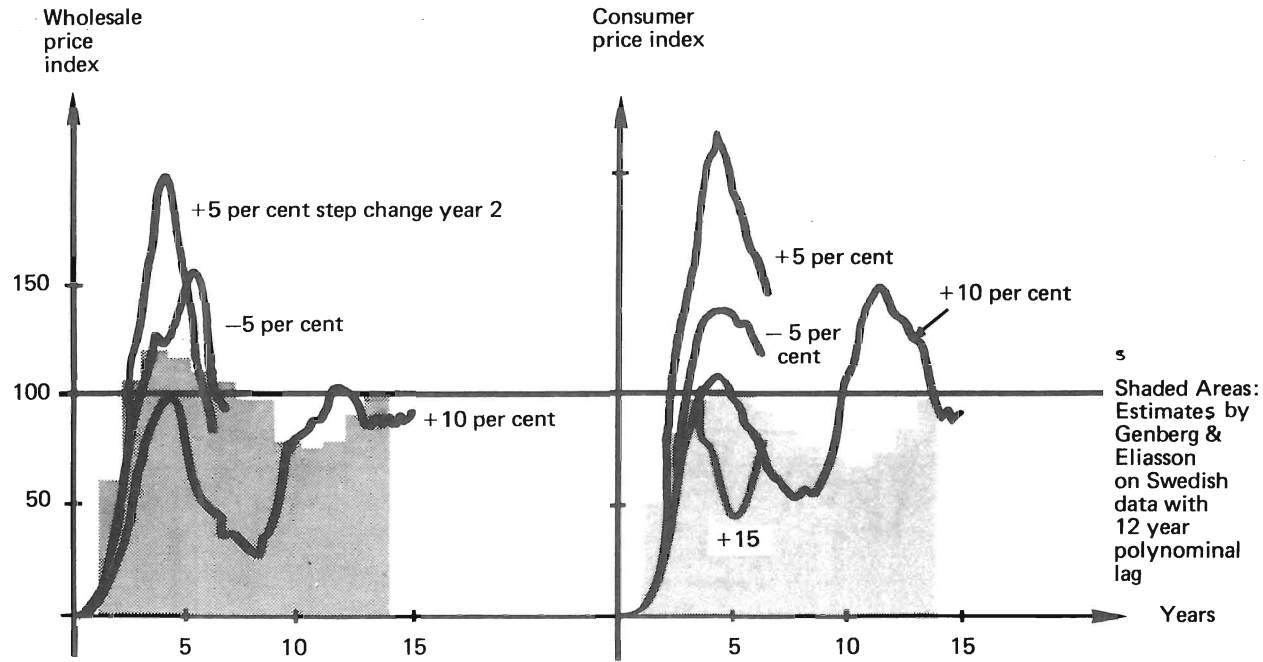
Figures 3 picture the volume (output and employment) and Figure 2 the profit margin responses of a Swedish-like economy to the same series of step changes and pulses in the export price level the second year. Index 100 is the chosen reference case that traces the Swedish post war growth history quite well. We have allowed one simulation (the one with +10 per cent) to run for 30 years to ascertain the long run convergence of repercussions generated by the exogenous step change.

The initial profit margin effect of a foreign price increase is upward in all cases. However, over a 5 year period (whether up or down) the exogenous change spins off profit margin oscillations around a downward trend in the case with faster export and import volume reactions, seemingly supported by empirical evidence. After a few years the oscillation is replaced by a smoother development that eventually reverses into an upward tendency with the profit margin deviation converging towards zero in the 30 year run. However, for price step changes above +20 per cent market disorder gets out of hand and the economy shrinks substantially. This property was not there in the simpler, earlier versions of the model with no inter-industry markets and inventories. In this more extended version we have to slow down foreign trade price elasticities to make the economy stable enough to withstand extreme rates of export price change during the postwar period. In the low elasticity case the profit margin (Figure 2A) effect is first up from a positive price step, then down normally, until negative. Over the longer run total economy responses seem to cancel the profit effect altogether.

With lower foreign trade price elasticities the properties of the entire model economy changes. The positive activity (industrial growth) effect persists at least for some years even for large positive price steps in the case with smaller export and import price elasticities. On this point, when this paper is being written, we are at a loss exactly which case or which compromise to favour. Even though we need more evidence to decide, the high elasticity case seems to be the one to be preferred to allow a sufficiently fast transmission of foreign price impulses through the economy. However, we do not yet know

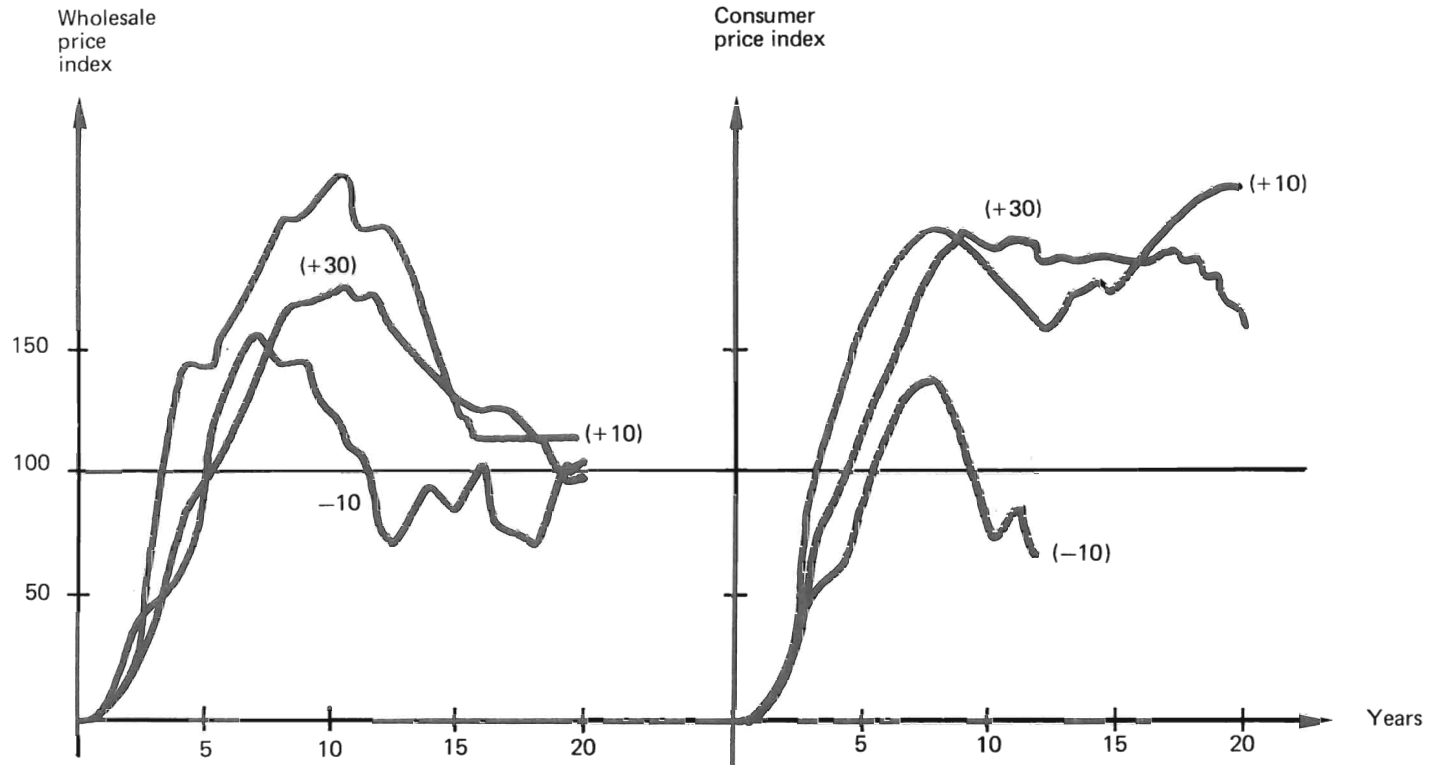


**Figure 1A. Export-Domestic price transmission, with high foreign trade price elasticity**



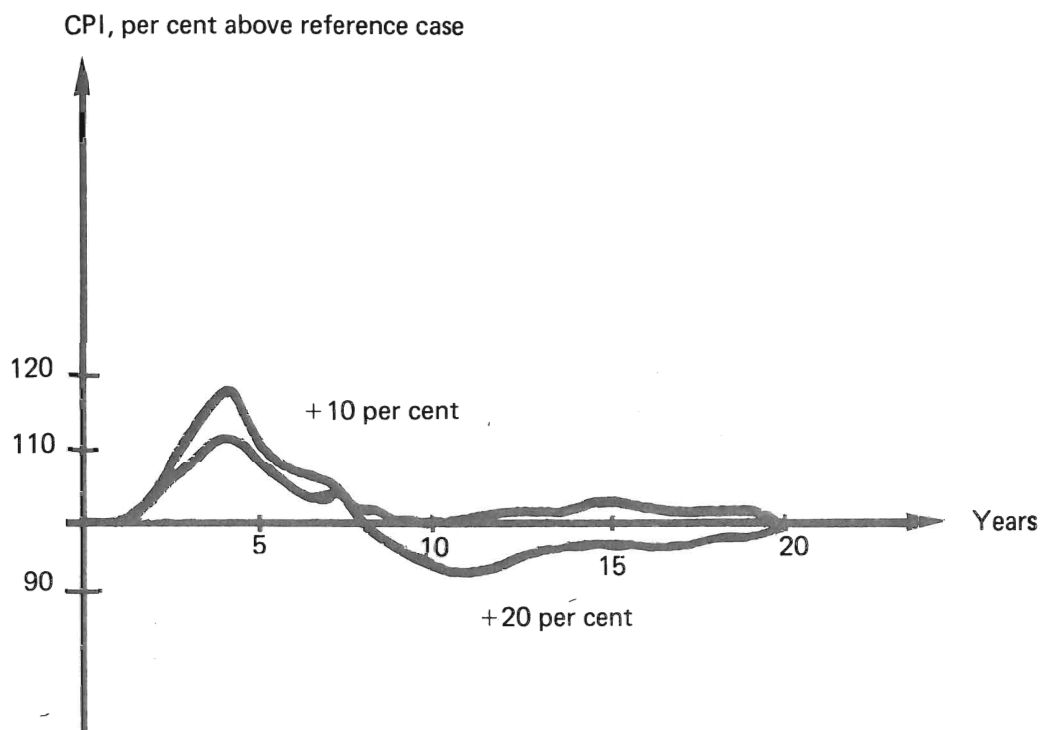
*Note: Index = 100 means that an initial step change in the export price index year 2 of x per cent has resulted in an x per cent change in the whole sale price index or the CPI above a reference case with no such change in the export price.*

Figure 1B, Export-Domestic price transmission,  
with low foreign trade price elasticities



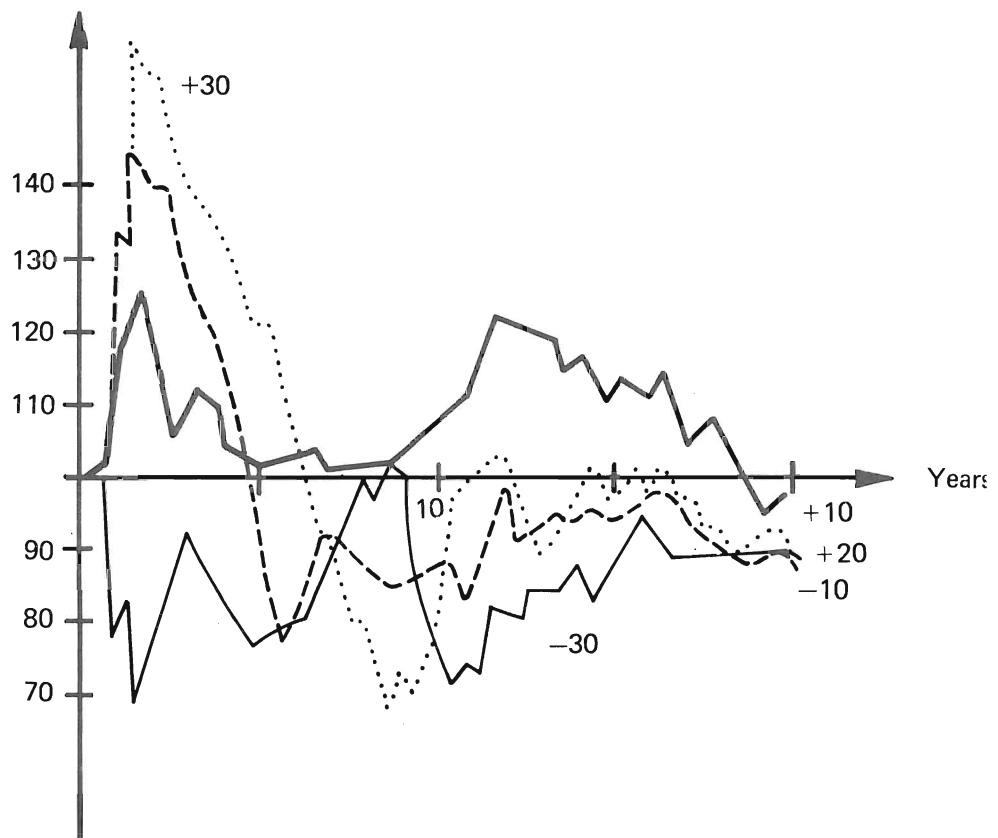
Note: Index = 100 means that an initial change of  $x$  per cent in the export price index has resulted in an  $x$  per cent change in the wholesale or consumer price index of the same sign.

**Figure 1C. Export-Domestic price transmission with temporary price step**



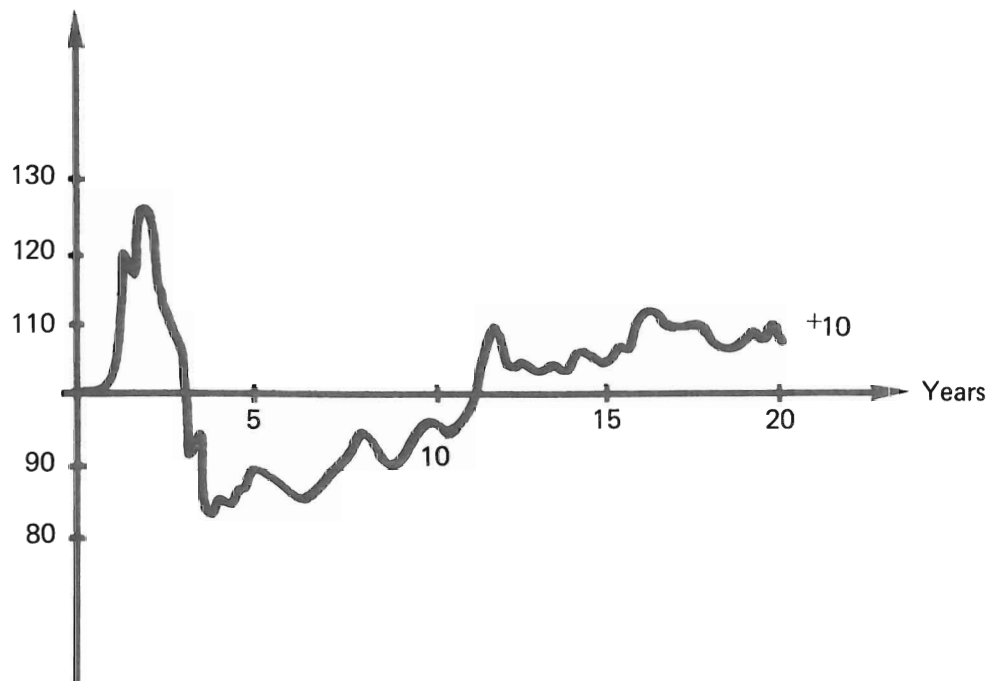
*Note: The export price rises with 10 and 20 per cent respectively the second year. In the fourth year it then drops back to its original time path in the reference case.*

Figure 2A. Effects on profit margins with low foreign trade price elasticity



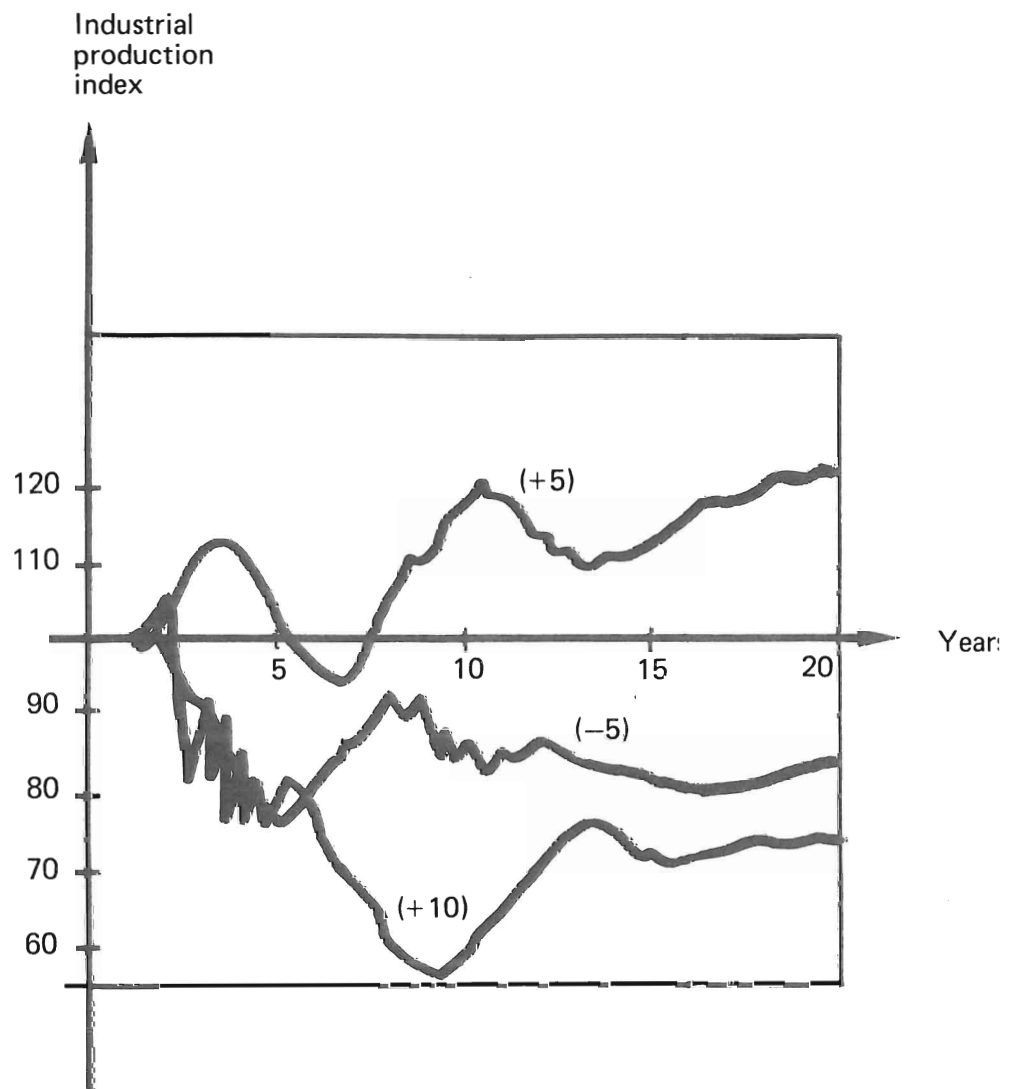
Note: Index 100 = profit margin in reference run.

**Figure 2B. Effects on profit margins, temporary foreign price step between 2nd and 4th year**



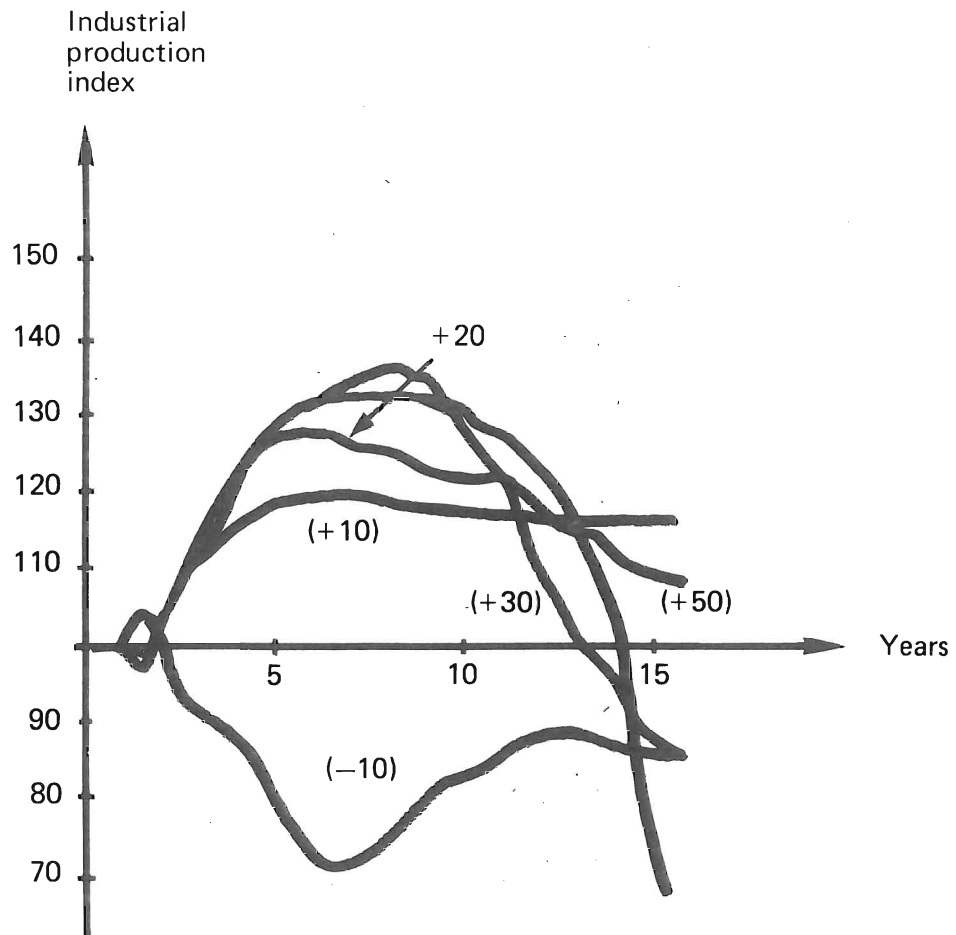
*Note: Index 100 = profit margin in reference run.*

**Figure 3A. Effects on industrial production with high foreign trade price elasticity**



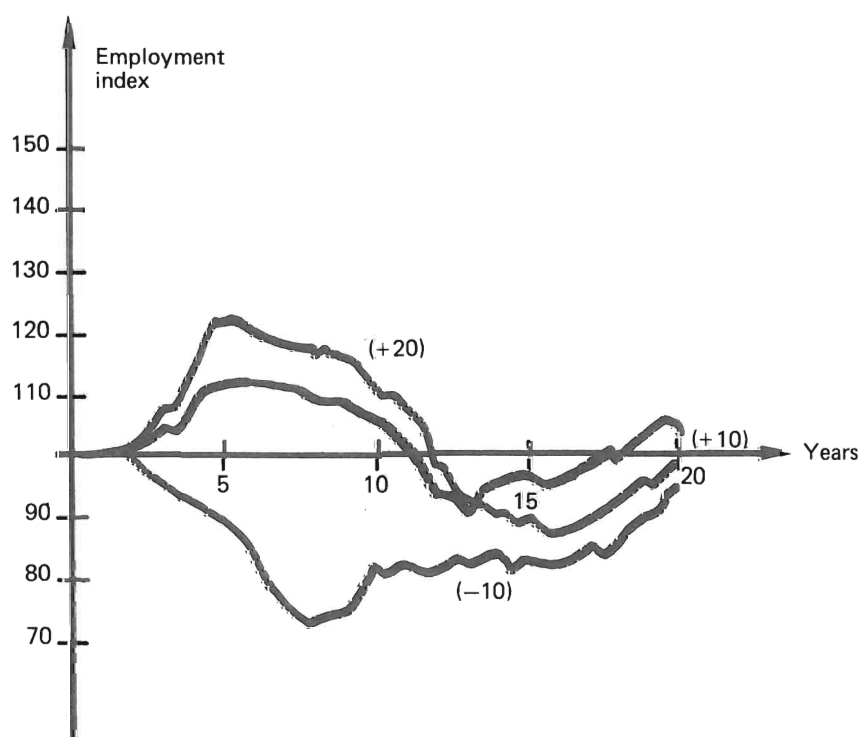
*Note: The Index shows the deviation of the simulation with a price step from the reference case.  
Index 100 = Reference run*

Figure 3B. Effects on industrial production with low foreign trade price elasticities



Note: Index Scaling, see Figure 3A.

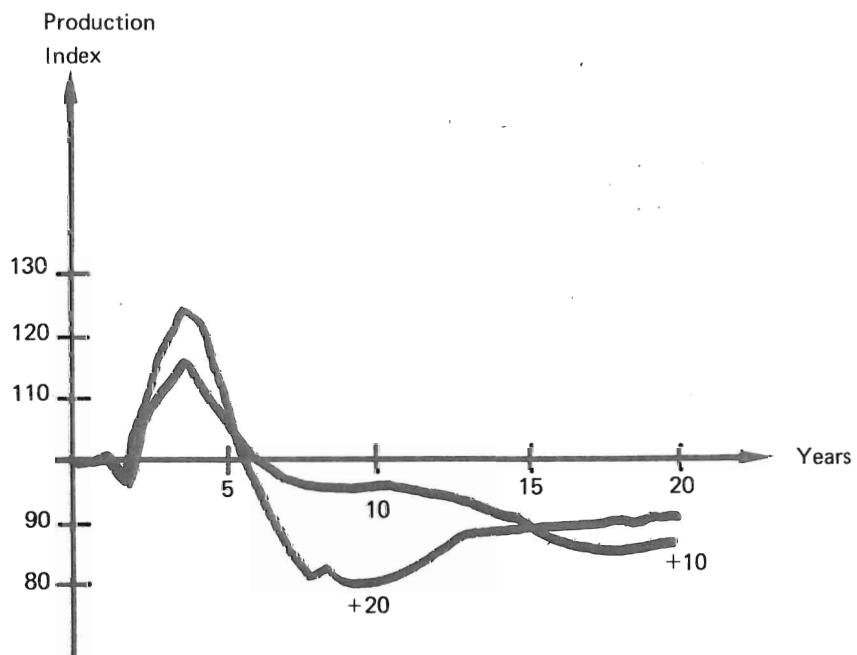
Figure 3C. Effects on industrial employment,  
low foreign trade price elasticities



Note: Index scaling see Figure 3A.



Figure 3D. Effects on industrial production from temporary foreign price step between years 2 and 4



Note: Index scaling, see Figure 3A.

how exactly to adjust the market response parameters to obtain realistic stability of the entire economic system. Can domestic inflationary expectations of an overshooting nature alone generate such disorder? Not really if we consult Albrecht's simulation experiments on the Swedish model reported on later in this conference volume. To what extent can inflation of domestic origin, say of a wage cost-push nature, not caused by shocks external to the system retard economic growth? Is there a difference if the cost-push is of a steady state type or irregular? We know that a set of not particularly unrealistic, fast labour market - wage change - job change time parameters in combination with excessive expectations is capable of creating labour market disorder that affects growth negatively. Since fast price (wage) responses in the labour market favour short term allocative efficiency we have obviously identified an interesting conflict between short term efficiency and economic stability. This we will have to probe deeper into. If relevant as an empirical phenomenon a number of policy implications will follow. Similarly, such a conflict between efficiency and stability bears directly on the relevance on much steady state theorizing in growth economics.

Figure 3D, however, only partially supports the conclusion that the higher foreign trade elasticities are to be preferred. It pictures the activity effects of a temporary foreign price step in year 2 that is reverted back again in year 4. This assumption is more like the Korean price experience while the permanent price step is similar to what we believe will be the consequence of the present inflation experience. This simulation operates on the lower foreign trade price elasticity model. For year 1 through 3 the response is identical to that pictured in Figure 3C. As soon as the foreign price drops back again, however, bad experience is recorded. The output and employment effects are negative in the long run. So is also the profit experience of firms for more than 10 years after the first transitory two year period of exhilaration. The only comfort one can derive is that this temporary foreign inflation leaves no permanent domestic inflation effect (Figure 1C).

##### 5. The micro process

This is what happens in the model:

The initial profit improvement from the positive price step spins off erroneous overexpansion in

capacity and also output. Even though the overly optimistic expectations and initial expansion generate wage drift and more demand the final outcome proves detrimental when the domestic price level, after overshooting and reinforced by the reversal in foreign prices, begins to wind down again.

Firms respond by cutting back on output growth and investment to restore profit margins. Such measures increase productivity. However, labour is laid off, demand growth slackens and a backward multiplier gets going. In the long run industrial output growth seems to stabilize on a trend lower than that of the reference case even though the initial profit, investment and growth effects were positive.

We can compare these results with the effects of a permanent foreign price increase in Figure 3A (high elasticity case). In the +5 per cent case recovery is fast and strong. In the +10 per cent case the net impact of inflation is still negative but recovery is on its way after 30 years.

As it seems, however, the economy is in an even healthier condition after some 15 years after a moderate deflation than in the case with a somewhat larger inflationary shock and it is just about to move onto a faster growth path towards the end of the 20 year period.

In conclusion I would like to say that for smaller disturbances the model responds in a well behaved way. However, for larger disturbances it overreacts and much more so in the extended version that we are now experimenting with (with an elaborate interindustry delivery and inventory system) than in the earlier, simpler versions.

## 6. Summary

What can we learn from this? How reasonable are these results that are not forthcoming out of conventional Keynesian or neoclassical models?

The new properties of our (model) economic system originate in the misinterpretation of market signals by business firms in particular when they bounce outside well-known boundaries. The initial positive effects on business profits amplify this misinterpretation and spread the response pattern over a longer period.

In the tougher price decrease case firms are forced to do something about profits directly and the situation therefore improves sooner than in the more easygoing case with effortless price induced profit hikes that create problems in the longer run. The special, individual firm, feed back, profit targeting device that gears firms' future ambitions to past performance plays an important rôle here. We think this device is very realistic.

The high and low foreign trade elasticity alternatives may be said to picture the degree of openness of the economy. We have not been successful in "estimating" these elasticities but we have seen that the more closed the economy the stronger the tendency for the consumer price to run off on its own and higher than the initial foreign price impulse.<sup>1)</sup>

If the foreign price impulse is small enough this might even be conducive to growth. However, the results warn us that our market based economies may not be such stable systems as all of us no doubt thought during the steady state, non inflationary 50ies and the 60ies. For large foreign price shocks only the closed (low elasticity) model alternative responds with a stable future time path. I am very unhappy that we are not yet ready to allow the Government to enter the model together with business firms, also to misinterpret the situation and to policy the economy accordingly.

Perhaps we can also learn that the profession has more or less forgotten (or not observed) the experience from the inflationary Korean boom in the early 50ies. At that time the initial export price hike was even larger than during the "oil crisis" (+61 per cent 1951 in Sweden). After this price hike followed a prolonged period of relatively slow growth, in Sweden at least. The impact was not as hard as during the recent so-called oil crisis and the reason - in terms of the model - may be that the wage cost escalation from "overoptimistic" price expectations on the part of business firms was not as strong, probably due to a substantial rebound downward of export prices almost immediately after 1951.

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1) Also cf. Albrecht's experiments on the Swedish model and a parallel version loaded with US data reported on in this conference volume.

Perhaps the results also tell us something about the advisability of devaluating a currency to solve an immediate problem rather than stubbornly living on with a somewhat overvalued currency. It perhaps does if we are not overly concerned with the immediate employment effects.

LITERATURE

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