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**THE ISAC MODEL: STRUCTURE,
IMPLEMENTATION AND STABILITY**

by

Leif Jansson, Tomas Nordström
and Bengt-Christer Ysander

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THE ISAC-MODEL: STRUCTURE, IMPLEMENTATION AND USE.

1 Introduction

In the following we present a model for the Swedish economy called ISAC - Industrial Structure And Capital Growth. The principal aim of our modelling efforts has been to form an instrument suitable for the medium and long term study of stability and growth. The model also reflects our concern to arrive at empirically estimable relations and functions, and to make possible projections over a longer time span in order to analyze some crucial policy problems concerning e. g. the balance of payment, energy policy, and the control of local government spending. The model has so far been mainly used for policy studies dealing with the time periods 1980-85 and 1980-2000, respectively.

1.1 Inertia and adjustment in a small open economy

In a small open economy like Sweden much interest is focused on the way in which the economy adjusts to changes in trade volume and prices on the world markets. There are many ways in which this adjustment process can be modelled. In a pure neoclassical model of competitive equilibrium the emphasis would be on the final results of the assumed price adjustments, disregarding the various sources of inertia and the effects of intermittent disequilibria. The assumed adjustment mechanisms would then usually not be directly estimable from the dynamic performance of real life economies and the model

would be best suited for comparative static studies of medium and long term tendencies.

In ISAC we have gone in an opposite direction, trying as far as possible to incorporate various kinds of adjustment obstacles, like the sticky wages and prices of markets characterized by monopolistic or oligopolistic competition, the immalliability of vintage capital, and the cash-flow restrictions on investment financing and the inertia and lags observed in both private and local government consumption. We recognize regulated prices like the rate of exchange and cost components mainly determined from abroad like the rate of return requirement. Market disequlibria - surpluses or deficits of foreign exchange and of production capacity and labor - will therefore be a normal feature of model projections and will have feedback effects in the form both of price modifications and a rationing of supply. From a disequilibrium situation the model economy may finally - with the help of or despite economic policy measures - fetch up in a new equilibrium or steady state growth barring new disturbances. Even then, however, the adjustment path will in most cases affect the final equilibrum in important ways. To study this interdependence between shortrun instability and long term growth is indeed one of the main purposes of the ISAC model.

The ambition to incorporate a realistic description of the "imperfect" adjustment mechanisms is a feature which the ISAC-model has in common with i.a.the LIFT-model of the University of Maryland and the MGM-model of the Cambridge Growth project (Almond 1978,Barker 1976). The development of ISAC has indeed run parallell with the development of

the MGM-model and has been influenced and aided by the experience earned from the Cambridge Growth project.

The history of the ISAC-model can, to a certain extent, be said to reflect the developments of the Swedish economy during the 70s.[1] The model work was started in the middle of the 70s. The aim was to construct a static planning model for the whole economy of the kind then used for medium term planning in many Treasuries around Europe. Starting out from the experience of fast growth and price stability in the 60s it was deemed sufficient and appropriate to limit the modelling ambitions to the description or prescription of balanced-growth paths from the present to a future target date. The emphasis was on developments in real terms with consistent price structures being computed afterwards.

The increased price instability and price uncertainty engineered in part by the 73 oil crisis was in Sweden followed by dramatic swings in industrial investment activity during the rest of the decade. In the second phase of model development priority was therefore given to the integration of price formation into the model computation and the introduction of investment functions for the various industrial branches.

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[1] For a detailed account of the first version of the model see "IUI:s långtidsbedömning 1976. Bilagor." (1977), in particular chapters 1-3 by Ulf Jakobsson, G Normann and Lars Dahlberg, respectively.

A second version of the model is described by the present authors in "Kalkyler för 80-talet." (1979).

At the the end of the 70s. the economic interest in Sweden was increasingly focused on the determinants of our international competitiveness and on the need for structural adjustment in industry in order to eliminating our mounting trade deficit. Thus, there were compelling reasons in the final phase of model development for introducing more explicit mechanisms for price and wage setting, for making the capital structure in industry more explicit with the aid of a vintage capital approach, and for incorporating a special submodel for local government spending. To make possible an explicit analysis of various means of reducing our oil dependence a relatively detailed treatment of industrial energy consumption was also incorporated into the model.

1.2 Market behavior

The markets explicitly treated in the ISAC model are throughout characterized by a monopolistic or oligopolistic competition. The nonregulated prices are set by the sellers, not by any neutral "market" mechanism. This certainly does not imply the absence of any adjustment towards market equilibrium. But "sticky" prices and wages can make the adjustment considerably slower and more indirect.

On the markets for tradable goods prices develop as weighted averages of changes in cost in world market prices and changes in capacity utilization, where different weights can be used for domestic and foreign sales, respectively. This can be interpreted as saying that basicly the firms are trying to cover costs, where costs are computed as avera-

ge variable cost plus planned depreciation and a
target rate of return on installed capital.[1] This
"cost price" is then modified to take account both
of the foreign competition and of variations in
capacity utilization.

There are no long-run returns to scale in industri-
al production but capacity within each branch is
distributed between vintages, typically differing
in technology and in productivity. In a world of
perfect competition only those vintages would be
used which can earn a quasi-rent at given world
market prices. The way we have modelled the Swe-
dish economy is quite different. Typically, a Swe-
dish industrial branch is dominated by a small
number of big firms - each comprising several
capital vintages, both in different plants and
within the same plant, which moreover often repre-
sent different technological stages of the produc-
tion processes. We therefore assume that, due to
technological reasons and to considerations of re-
gional employment responsibilities, the firms will
at each time have the same capacity utilization in
each vintage. In the short run this may imply
accepting current losses in some vintages. Since
the firms are assumed also to vary the relative
scrapping of vintage capacity in inverse propor-
tion to profitability, vintage use will, neverthe-
less, in the long run adjust to differences in
quasi rent. The short-run impact on the firm of,
say, a change in world market prices will thus be
to a certain extent cushioned both by the "sticky"
pricing and the evening out of capacity use - mak-

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[1] For a discussion of pricing with target rate of
return and of the empirical evidence for its use
cf. Eckstein-Fromm, 1968.

ing the compensatory change in trade volume corre-
spondingly greater. Since changing trade and cap-
acity use will react back both on pricing and -
together with profits - on investments, the adjust-
ment will be reinforced. The adjustment will, howe-
ver, still be somewhat slower and carried out on a
lower profit level than what would be the case in
a perfectly competitive world.

The response to the firms' price setting will on
domestic markets be determined by intra-firm
demand, by governmental demand, and by consumers'
final demand as expressed in a system of linear
expenditure equations. On the foreign markets, the
response, described by a set of export functions,
will be determined by the relative price develop-
ment and by the world market trade expansion.

For nontradable goods the prices are assumed to be
completely determined by cost, including a target
rate of return on capital.

Wage setting on the labor market is modelled by a
Phillips curve type of approach, making wages in
the private sector depend on past profits, produc-
tivity development and inflation, and current unem-
ployment. This outcome can be interpreted in a
manner somewhat analoguous to that used for the
price setting in the product market. The wage
earners will try to get compensated for both infla-
tion and productivity gains but the final result
will, however, be modified by current market condi-
tions, i.e., unemployment. Long-run wage adjust-
ment will thus be reinforced by the change in
total employment resulting from the bargaining.

For public employees a one year lag in wage settle-
ment has been ususal and has been assumed in the
model to continue also in the future. The sensiti-
vity of wages to employment conditions is obvio-
usly of strategic importance for the functioning
and the policy implications of the model. In the
model version documented here the empirical estima-
tes of this sensitivity may well be biased by the
choice of open unemployment as indicator of market
conditions and by our assumption of an aggregated
labor market with exogenously given supply.

A consequence of assuming immediate adjustment of
supply to demand at the set prices in the product
markets, i.e., no unplanned stock changes, is that
disequilibria will occur also in the another
factor market in the form of over- and underutili-
zation of capital. As already told above, a slow
adjustment of capacity will, however, take place
since investments are determined by the degree of
utilization as well as by past profit performance.

This kind of investment function is obviously in
line with the assumption of monopolistic competi-
tion in the product markets. The influence of past
profits can be said to reflect both profit expecta-
tions and the cash flow restrictions on investment
finance. A similar mixture of financial conditions
and utilization rates will also determine local
government investment in the various areas of ser-
vice production.

There are no explicit financial markets in the
model. Instead both the rate of exchange and the
required rate of return on capital are assumed to
be exogenously determined. The rate of exchange is
treated as an instrument of government policy.

Although some causes of exchange disequilibria may be weakened by self-correcting adjustments elsewhere in the model, there is thus no feedback mechanism leading automatically to exchange adjustment in the absence of government intervention.

A similar - and related - need of government intervention arises in the capital and the money markets. The required rate of return in the small open economy is assumed to be determined abroad by conditions in the international financial markets. This internationally determined rate of return is then transformed to a particular rate for each branch of industry by taking account of differences in depreciation rate, tax treatment and solidity. The required rate of return will influence the firm's pricing and investment and by that also its saving, but will not affect the saving ratio for households.[1] The main burden of adjusting total domestic saving to avoid surpluses or deficits in external payments will thus fall on the public budgets, particularly the state budget.

1.3 The Impact of World Markets

What happens in the world markets is of decisive importance for a small open economy like Sweden. The inter-relations between Swedish markets and foreign markets are in the ISAC-model described in

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[1] Having failed to arrive at any reliable estimate of the aggregate consumption function - partly due to methodological shifts in the official data base - we have in this model version kept the aggregate saving ratio for households constant at the 1977 level. The choice of level as such is important only by its implications for the net balance of the state budget.

the usual way by export- and import-functions with the relative price (domestic/world) and market expansion as determinants. The measurement and interpretation of the involved elasticities does, however, involve some rather knotty problems.

That most estimated relative price elasticiities both for exports and imports are rather low - in the estimates we use between 1.5 - 2.0 on the average - is well in line with our basic assumption of monopolistic competition determining foreign markets as well as the domestic ones. Unfortunately, we cannot be sure that the aggregate elasticities we measure reflect market condition for the commodities concerned. To be able to discern the various biases that might be involved in the estimates it might be worth while to start by recalling some main possible reasons or characteristics of monopolistic competition, explaining the existence of price differences between similar products.

One such characteristic may be simply product differentiation. The products of different firms - and countries - are then perceived as being different, even though the difference may only exist "in the eyes of the perceiver".

A second characteristic can involve differences concerning non price elements of transaction cost, i.e., differences in market strategies. The search cost of the buyer will, e.g., vary with advertising efforts.[1] Contractual forms and credit condi-

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[1] Limited information and a randomized search may indeed by itself explain why the individual firm faces a sloping demand curve.

tions will affect both cost and risk for the
buyer, etc.

A third possible reason for the emergence of a
monopolistic competition structure is the existen-
ce of entry costs and of various forms of restric-
tions on free competition.

It seems intuitively reasonable to assume that all
these three characteristics are to a certain
extent relevant on most markets for international
trade. If true, this means that unbiased estimates
of elasticities should require not only that all
transaction costs are taken into account but, even
more important, that data are disaggregated by
product, firm and market.

The realities of official statistics, however, are
far removed from these utopian ideals. That our
measurement of elasticities involves a specifica-
tion bias by not including other transaction costs
than price, is so obvious that we usually do not
bother to reflect on it. Of more immediate concern
is usually the aggregation bias, that comes from
measuring price on aggregates of commodities and
markets, that are different and moreover shifting
in composition. That we may be comparing aggrega-
tes of differrent compositions - e.g. domestic
sales versus imports of a certain composite good
or exports versus world market trade - means that
the measured changes in relative price may in part
not be due to different price development for
individual goods but simply reflect the different
composition of the aggregates. Changes in composi-
tion will moreover call forth changes in the aggre-
gate rate of price change even without any chang-
ing rate in any individual line of goods. A regis-

tered increase of the export price index for a certain aggregate commodity may, e.g., reflect the fact that the exporters - reacting, say, on sinking profits and trade - are falling back on a defensive market strategy, retiring to "safe" markets, where earlier market penetration allows them to raise prices faster while consciously staying away from too competitive markets and goods.

For these reasons aggregation will usually lead to a misrepresentation of behavioral responses. It means that we implicitly assume a two-stage maximization, where the buyer first reacts on an aggregate price, determining an aggregate volume of the composite commodity and then in the next stage "distributes" this composite demand volume optimally between the individual goods with respect to their respective prices. It is well known that such a two-stage maximization is in general only possible when the composite commodity from the buyer's point of view can be expressed as a linear homogeneous function of the individual commodities, and that even then "the correct"aggregate price index will be identical with the usual weighted price index only in the trivial case where individual price developments are identical, i.e., when the individual goods are perfect substitutes.[1]

The aggregation bias obviously makes interpretation of the elasticities involved very uncertain,

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[1] For a thorough treatment of aggregation and decentralization cf. i.a. Blackorby-Primont-Russel, 1975 and 1978, particularly chapt. 5-9. A detailed discussion of two-stage maximization as part of the aggregation problem is presented in Bliss, 1975, chapt. 7.

makes the long-run stability of measured relations questionable and the assumption of a constant elasticity - used in this model also - particularly suspect.

The Swedish official statistics, however, carry the aggregation one step further by aggregating in the usual way the imported and domestically produced quantities of the same industrial category of goods, and using this aggregate in estimating, e.g., input-output relations. Although the inconsistency or bias becomes particularly glaring in this case since different prices are explicitly quoted for the two parts that are treated as perfect substitutes, it really only means a new marginal strengthening of the general aggregation bias. Since there are no base in official data for a radically different approach, we have here chosen to follow the official statistics and accept this further approximation in estimating demand elasticities. All we can generally say is that the probability for a serious bias arising out of this particular kind of aggregation should decrease with the disaggregation of industrial sectors.

Most recent estimates of price elasticities in foreign trade in West-European countries are of the same low order as the ones we have used. Whether this should increase our confidence in the estimates is, however, questionable, since they may well contain common biases. If we accept the estimates as true, they imply that demand and/or supply of tradable goods is rather inflexible both for us and our trading partners - that there are rigidities in the economies concerned which may be due to monopolistic competition or to more general causes, e.g. obstacles to mobility in the factor markets.

Low price elasticities do, however, have some ob-
vious and important consequences for economic
policy. For one thing they make currency devalua-
tion - even without compensating wage change - a
more sluggish instrument for improving the trade
balance and for expanding employment. They can
also make a selective taxation or indeed tariff on
imported goods a more efficient way of improving
the external balance than, say, general export
subsidies or indeed devaluation of the currency.
In a full employment situation, e.g., taxing an
imported good with a highly elastic domestic
demand, involves a limited loss of consumers' sur-
plus to be compared to the resource cost and terms
of trade loss involved in trying to force a corre-
sponding general expansion of exports. Import tax-
ation might still be an efficient way of solving
trade deficit problems if instead of having a very
elastic total demand, you have a highly elastic
domestic supply - especially in a situation with
less than full capacity utilization.[1]

1.4 Government Behavior

In an open economy with a large public sector like
Sweden, government behavior can affect the adjust-

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[1] One should perhaps at this point add three cau-
tionary notes. The possible efficiency of import
taxatory - remarked upon by many economists around
Europe - is of course conditional on no retalia-
tion measures being taken by the trading partners
and no losses of dynamic efficiency resulting from
the decrease in specilization. Secondly, the pos-
sible relative efficiency of selective import tax-
ation has nothing to do with the optimal tariff
arguement, since it does not involve any change in
terms of trade. Thirdly, the possible advantage
tends to be grossly exaggerated by those who are
calculating in fixed prices and thus neglecting
all losses of consumers' surplus.

ment of the economy in important ways. It may
serve as a source of inertia or as an inbuilt
stabilizer in the traditional sense, it may on the
other hand give rise to new oscillatory movements
and it is, finally, expected to provide the means
to facilitate the necessary adjustment through
economic policy.

In analyzing government behavior it is, however,
necessary to distinguish between local and central
government. Local government in Sweden has up till
now not been independently involved in income dis-
tribution and stabilization policy except to a
very limited extent. Economic policy has largely
been left as a responsibility for central govern-
ment, whose budget is dominated by transfer pay-
ments. Local government has traditionally been the
main provider of public services.

Local government

The restructuring of Swedish economy in postwar
years has been rapid. While agricultural employ-
ment has been drastically reduced, a matching inc-
rease has occurred in the service sector, particu-
larly in the public services, which have doubled
their share of GNP and trebled their employment
share. The major part of this expansion - in
education, medical care and social welfare -took
place within the local governments which now
employ almost a quarter of the labor force and
channel almost a third of the national income
through their budgets. Local governments have in
this way grown into the same order of size as
manufacturing industry, which meanwhile has kept
its share both of GNP and of employment relatively

unchanged. There is also a substantial degree of decentralization and freedom from central government control within the 300 different local government units. There are 277 municipals and 24 counties.

There are several potential ways for central government to control local government. However, when it comes to actual effective control of total expenditures or investments - or the consumption share of local government - postwar history makes it indeed very doubtful if local governments have really been more controlled or more needful of the wishes of central decision makers then the big manufacturing corporations. Although about a fourth of local government financing comes from central government grants, until recently there was no attempt to use grant policy for controlling total local government expenditures.

Against this background the assumption - common to almost all national policy models - that local government expenditures can be treated as a central policy parameter, seems particularly unwarranted. The treatment of local government expenditures as an exogenous parameter can obviously lead to misrepresentations of economic policy problems in several important ways. It overestimates both the effectiveness of existing policy means and the degree of inbuilt stability and inertia guaranteed by the existence of the public sector. At the same time it neglects the importance of swings in local government activity, generated independently and/or reinforcing disturbances from elsewhere in the economy, and makes it impossible to study explicitly the problems of central control of local government expenditures.

For these reasons local government actions are
treated endogenously in the ISAC -model by way of
a special aggregate sub-model.

The sub-model is represented by a 10-equation
system explaining production expenditures (1-5),
transfer payments to housholds (6 - 7), invest-
ments (8), loans (9) and - residually - taxes
(10).The production technology used by local go-
vernments are throughout assumed to be of the
Leontief type with fixed coefficients, so that
production volumes can be directly transformed
into required inputs from the business sector.

The sub-model is derived from an additive quadra-
tic goal function maximized under a budget constra-
int and can be generally described as a model of
budgeting behavior for local government decison-
makers. The goal function includes consideration
not only of service and transfer targets but also
of private disposable income, of capacity utiliza-
tion and of the net real wealth of local govern-
ment.

The explanation for service production derived
from this kind of quadratic goal function can be
interpreted as reflecting a certain kind of budge-
tary procedure. To begin with, demographic fac-
tors, the need and cost of capacity expansion and
private income developments determine the maximum
amount of money that the decision makers in local
government would like to spend on a certain catego-
ry of service. These maximal claims must then
somehow be cut down to fit into the available tax
income, defined by a two-year lag in disbursment
of the tax yield. The cutting ratio for a certain
category - determining how much of the total reduc-

tion required that will have to fall on this cate-
gory - will vary directly with the price of the
service and and inversely with the rate of decline
of the marginal utility for the service. This
"two-stage" budgetary procedure can be viewed as
corresponding to the two-level hierarchy of budge-
ting and of political representation used in Swe-
dish local governments.

Local government transfers have been classified
into two categories of housing subsidies to house-
holds - subsidies to rent and subsidies to other
current housing expenditures, i.e., water, electri-
city, heating etc. Local government is in both
cases modeled as trying to maximize the housing
standard that can be bought for a given amount of
money. How big the total transfer expenditure will
be, given a certain subsidy level, is then determi-
ned by housing demand - or more exactly by the
local governments' expectations of housing demand.

The corresponding investments will be determined
by capacity utilization, liquidity and credit
market conditions. The two latter factors will
also decide to what extent the investments should
be loan financed. Finally, current tax rate will
be residually determined by the budget restraint.

Because of the two year lag in final dispersement
of taxes to the local governments and because many
of the expenditure decisions must be based on
expectations formed on the experience from the
preceding year, there may also be unplanned chang-
es of liquidity. These lags together with the
interaction between local government expenditures
and wage determination in the total economy can
give rise to cyclical swings in local government
expenditure.

Central government

A relatively disaggregated treatment of the cent-
ral government budget is a necessary prerequisite
for the intended use of the ISAC-model for policy
analyses. The central government budget expenditu-
res are slightly bigger in total amount than those
of the local government but are in constrast to
these dominated by transfer payments.

Central government consumption is treated as exoge-
nous and is divided up into six categories. The
corresponding investments are determined by a
simple accelerator principle. The production tech-
nology, like that of local government, is assumed
to be characerized by fixed input-output ratios.

There are altogether ten forms of central govern-
ment transfer payments distinguished in the model:
industrial subsidies, local government grants and
eight types of transfers to households, ranging
from various pensions to sickness and unemployment
benefits. The size of these transfers is exogenou-
sly determined by existing laws or by government
decisions. The same is true for the four types of
transfers to central government which apart from
the national income tax also includes social secu-
rity contributions and other payroll taxes. The
final incidence of payroll taxes is hard to measu-
re and still open to controversy. We have, howe-
ver, throughout made the simplifying assumption
that payroll taxes are entirely rolled back onto
the wage earners.

Besides the budget items there are other policy
parameters for central government, e.g., the ex-
change rate, tax rate limits for local government

and "wage policy". With "wage policy" we here mean the possibility under certain conditions to shift the "Phillips curve". This can be interpreted in terms of a labor market policy - changing mobility or matching on the market - or as an adjustment of the marginal tax structure, making it easier to co-ordinate wage settlements for different wage groups without inflationary effects.

1.5 Income Formation and the Level of Aggregation

It would have been desirable to be able to use the model also for analyzing income distribution problems, particularly the interaction between income distribution on the one hand and allocation and stabilization policies on the other. Unfortunately this has proved possible to do only to a very limited extent.

Many different kinds of income are distinguished in the treatment of income formation in the model but only a few types of income recipients. Transfers that help to make up disposable income for the households mirror the tranfers in the government sector which we have already dealt with above. As for factor incomes a first distinction is made between wages and entrepreneur income.

When it comes to income recipients, however, there are only two categories, pensioners and wage earners, although the latter can be split into entrepreneurs and other wage earners. The unemployed are here grouped together with the employed. As long as we cannot make a corresponding separation of the expenditure system for private consumption - and the available data do not allow this as yet

- the value for distributional analysis of a further disaggregation of income recipients is anyhow limited.

The expenditure system for private consumption - the same for all consumers - distinguishes between 14 different commodities. Production within the business sector is more disaggregated, recognizing altogether 23 different sectors. Within each sector there are five different types of factors used, i.e., besides intermediate inputs, capital, labor, fuel and electricity.

Production capital is, however, further disaggregated through the vintage approach, with each vintage being not only ear-marked for a specific branch but also reflecting the relative price expectations in the investment period and thus being potentially different from the rest of the vintages. The difference between different vintages is further enhanced by the fact that a major part of technical development is treated as embodied, which also means incidentally that a major part of productivity changes in manufacturing is explained endogenously in the model by investments and structural change.

Compared to production capital, aggregation has been carried much further with respect to labor. Although there are different wage levels in different manufacturing branches and a lagged development of wage for public employees, labor supply is treated in the model as one homogeneous aggregate. If capital can be said to be treated as "putty-clay", the treatment of labor could be characterized as "putty-putty". Not only are there no human capital distinctions between different kinds of

labor, but there is also no branch or vintage
specific labor. In keeping with our ambition to
model the various kinds of inertia or adjustment
obstacles, it would undoubtedly have been desirab-
le to have a regionally and branchwise segmented
labor market with explicit mobility obstacles.

The choice of a suitable level of aggregation is
generally difficult and all the more so when, as
in our case, you want to be able to do model
projections into a distant future. For the use of
models over long time periods there are both obvio-
us advantages and disadvantages of aggregation.

The advantages are well-known. Aggregate models
are easier to handle and easier to understand.
They require less detailed future projections
which in turn may make them appear, as more gener-
ally valid. From the estimation point of view,
there is also the hope that some random or specifi-
cation errors may get swamped in the aggregation.

The disadvantages are equally self-evident. First
of all, there are all the usual statistical pro-
blems connected with aggregation. By aggregating
relations over different micro units and thereby
also hiding their interaction, the derived aggrega-
te relations will be less autonomous the parame-
ters therefore less stabile and you may be facing
increasing problems of simultaneity between your
variables. On top of that you will have the kind
of aggregation bias in estimating behavioral reac-
tions which we already discussed above. Many of
these aggregation problems become, almost defini-
tionally, more serious as you extend the projec-
tions in time.

Equally important is the economic argument against aggregation in long-term studies, which says that by carrying aggregation too far you may altogether miss the possibility of analyzing structural changes that should be a primary concern for any long-term economic study. It is after all mostly in the relation between sectors and more specifically in the capital structures that you have enough inertia and long enough lead-times to be able to make meaningful statements about long-term effects.

Our choice of aggregation levels in the ISAC-model has been pragmatically guided both by the availability of data and by our focus of interest. We chose a more disaggregated treatment of manufacturing because of its importance for foreign trade and international specialization which has been one of our primary concerns. The government sector and particularly the local government sector were likewise dealt with in rather great detail because of our belief that the rapid growth of the government budgets represent a major structural change of importance also for the functioning of the rest of the economy.

1.6 The Short-Run and Long-Run Dynamics

Already the short introductory comments above may have raised the following question in the reader's mind. Is the model mainly meant to describe the short and medium-term functioning of the economy or should it be primarily regarded as an instrument for the analysis of long-term growth and growth policy?

There are undoubtedly many short-run dynamic
aspects of the model, that seem to indicate that
short-term policy analyses should be its main ap-
plication. It is meant to be solved year by year,
it contains a great number of lag structures, all
the usual types of Keynesian multiplier and accele-
rator loops, a large number of stabilization poli-
ciy instruments and also some dynamic mechanisms
like the Phillips curve and local government beha-
vior, which are central to any explanation of
cyclical movements in prices and production.

On the other hand, the emphasis on structural
change, the rather detailed treatment of capital
formation and capital structure in manufacturing
and of long-term energy substitution possibiliti-
es, with concommittant explanations of endogenous
productivity developments would rather .seem to
point to an interpretation in terms of long-term
growth.

Since the model is neither a full-fledged business
cycle model but still close enough to play havoc
with any simple and straight-forward growth pat-
tern, the reader might well ask what this hybrid
model could really be suited for. As we will be
returning to this question of model use later on
in the last section, a short comment may be suffi-
cient at this point.

Let us start by granting that the model by no
means is competent to handle all short-term ef-
fects of short-term policy. Already the absence of
financial markets makes its use as a full-fledged
business cycle model somewhat suspect. It is undo-
ubtedly more convincing as an instrument to study
the long-term effects of long-term policy, a perma-

nent change, say, in currency regime, in the given
rate of return requirement, in average profit
levels or in household saving habits.

There are, however, two other kinds of studies
which particularly require a mixture of short and
long-run features in the models used. One is con-
cerned with studying long-term effects of short-
term policies,i.e., the way short-run stability
characteristics of the economy and the chosen sta-
bilization policy affects long-term growth pat-
terns and possibilities.

The second deals with the contrary problem: the
effects on short-run stability and stabilization
possibilities of long-term policies. How can,
e.g., long-term choices of, say, taxing structure,
consumption shares for households, local and cent-
ral government, respectively, or government price-
/interest regulations or guarantees, affect the
way the economy reacts later to disturbances from
the world markets and the measures required and
available for stabilization policies? The ISAC-
model has, to a large extent, been particularly
tailored for this type of studies of the policy
interrelations between short and long run.

2 An Outline of the Model

The full version of ISAC contains hundreds of variables and relationships. The large size of the model is an inevitable outcome of our attempts to model explicitly the structure of i a the industrial sector. This task requires disaggregation not only between branches but also, we believe, within branches to capture the economy's sluggish accommodation to changing relative prices through dated capital formation.

Since we have also tried to take a policy approach to our modelling efforts the submodels for the household sector as well as the local government sector has been given a detailed design to allow for a fairly realistic treatment of different possible economic political measures.

Although the disaggregation contributes to the size of the model what makes it complex is rather the kind of relations between variables that is specified in the model. The purpose of this chapter is to describe some of these relations in an aggregated model setting. Section 2.1 will give an overview of the model structure while one important mechanism, the wage-price formation, is presented in more detail in section 2.2.

2.1 A key map of the model

Figure 2.1 is an attempt to illustrate the overall structure of ISAC. The figure shows main variables
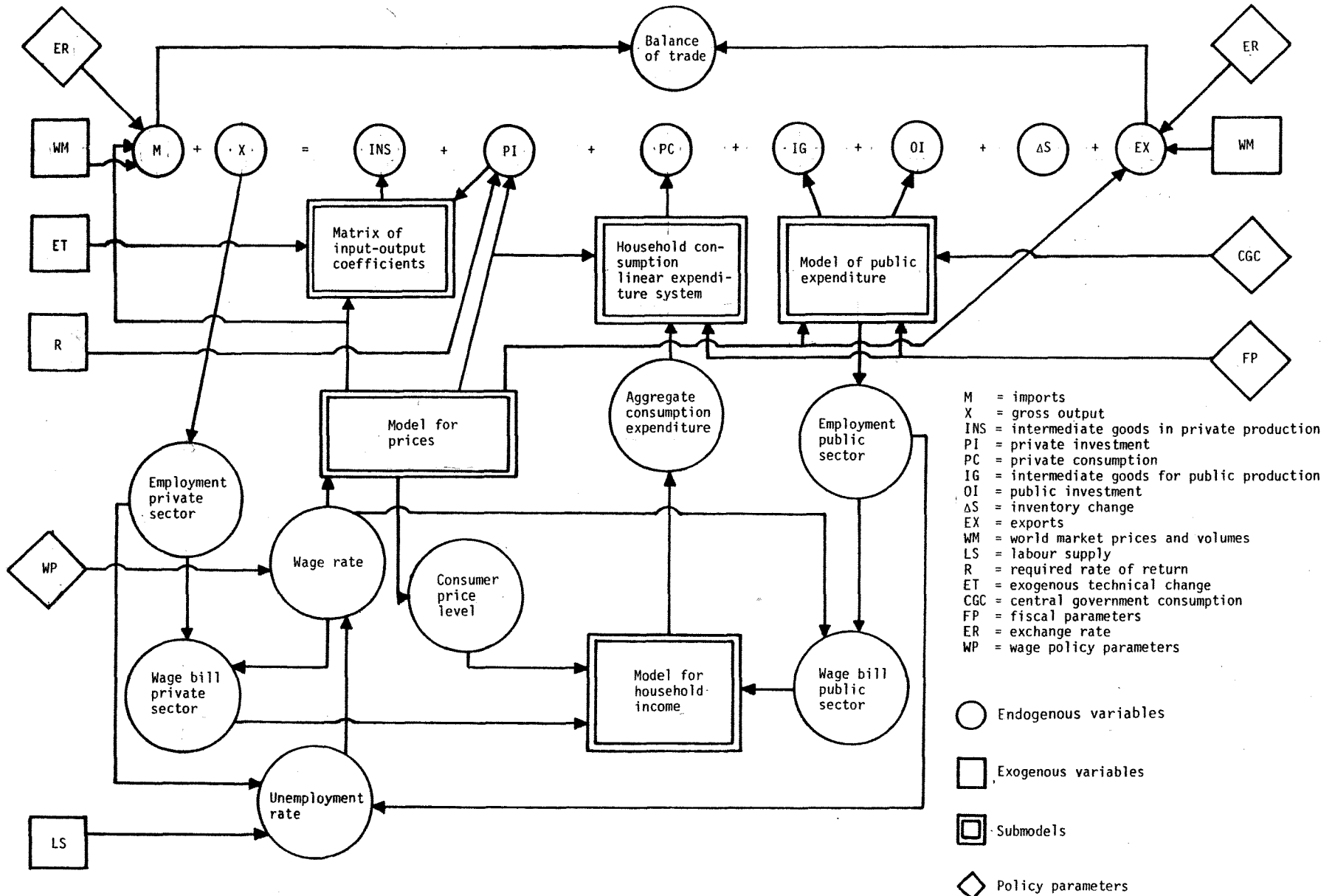
and submodels and the most important relations
between them. The block diagram is built around a
sector balance for industry which assures that
supply equals demand. The exogenous determinants
of the development of the model economy can be
divided into two sets. The first set of variables
are external to the economy in the sense that
neither the development of the economy nor the
economic political decision-making is assumed to
exert any influence on them. These variables,
marked by single-squares in figure 2.1, are world
markets (prices and volumes), disembodied techni-
cal change, labor supply and, finally, a rate of
interest that is assumed to be imposed on the
economy from abroad.

The other set of exogenous variables are the
policy instruments, indicated by rhombs. They are
the exchange rate, central government consumption
and various kinds of fiscal parameters affecting
the household sector through taxes and transfers
as well as the local government sector through
i.a. the grant system.

Finally there is assumed to be a policy instrument
to influence the wage rate albeit not necessarily
completely control it.

Given these two sets of exogenous variables every
item of the sector balance will be determined in
the way that is outlined below. The demand for
intermediary goods in industry (INS) is of course
given by current production (x) and the i/o-
matrix. Since the present model version only
allows for substitution of energy, capital and
labor in production processes and no exogenous
trends are attached to commodity input koeffici-
ents the i/o-matrix is almost constant over time.

Figur 2.1   ISAC-modellens struktur 1981

M   = imports
X   = gross output
INS = intermediate goods in private production
PI = private investment
PC = private consumption
IG = intermediate goods for public production
OI = public investment
ΔS = inventory change
EX = exports
WM = world market prices and volumes
LS = labour supply
R   = required rate of return
ET = exogenous technical change
CGC = central government consumption
FP = fiscal parameters
ER = exchange rate
WP = wage policy parameters

◯ Endogenous variables

☐ Exogenous variables

▣ Submodels

◇ Policy parameters

<u>Investments in industry</u> (PI) are determined by investments functions taking account of influences from profit expectations as well as current capacity utilization. Through the vintage mechanism the volume of investment will affect avarage capital- and labor-productivity in industry. Productivity growth also depends on the rate of scrapping of old vintages which is assumed proportional to quasi-rents earned in each vintage. So far the vintage approach is only implemented for branches in the manufacturing sector while capital in other branches is treated as homogenous in each branch. Also investment functions are specified and estimated only for manufacturing branches and otherwise set either as an exogenous trend or related to production in some simple way.

<u>Private consumption</u> is determined by a rather de tailed specification of income and expenditure in the household sector. The main source of gross income is wages and salaries from industry, thus providing the model with a multiplier link between the activity level in the economy and private consumption expenditures shown in Figure 2.2. Starting, as in the figure, with some exogenous change in fiscal parameters (FP), e g a reduced income tax rate, household income will increase. Since the savings ratio is a constant fraction of disposable income most of the tax reduction will result in consumption expenditure thus increasing demand for commodities. Some of these will be imported but domestic production and employment will increase creating more wage income and so on. The size of multiplier is also affected by wage inflation as a consequence of the higher activity level in the economy. This mechanism, which is not shown in Figure 2.2., will on the one hand positively

Figure 2.2 The production-consumption loop
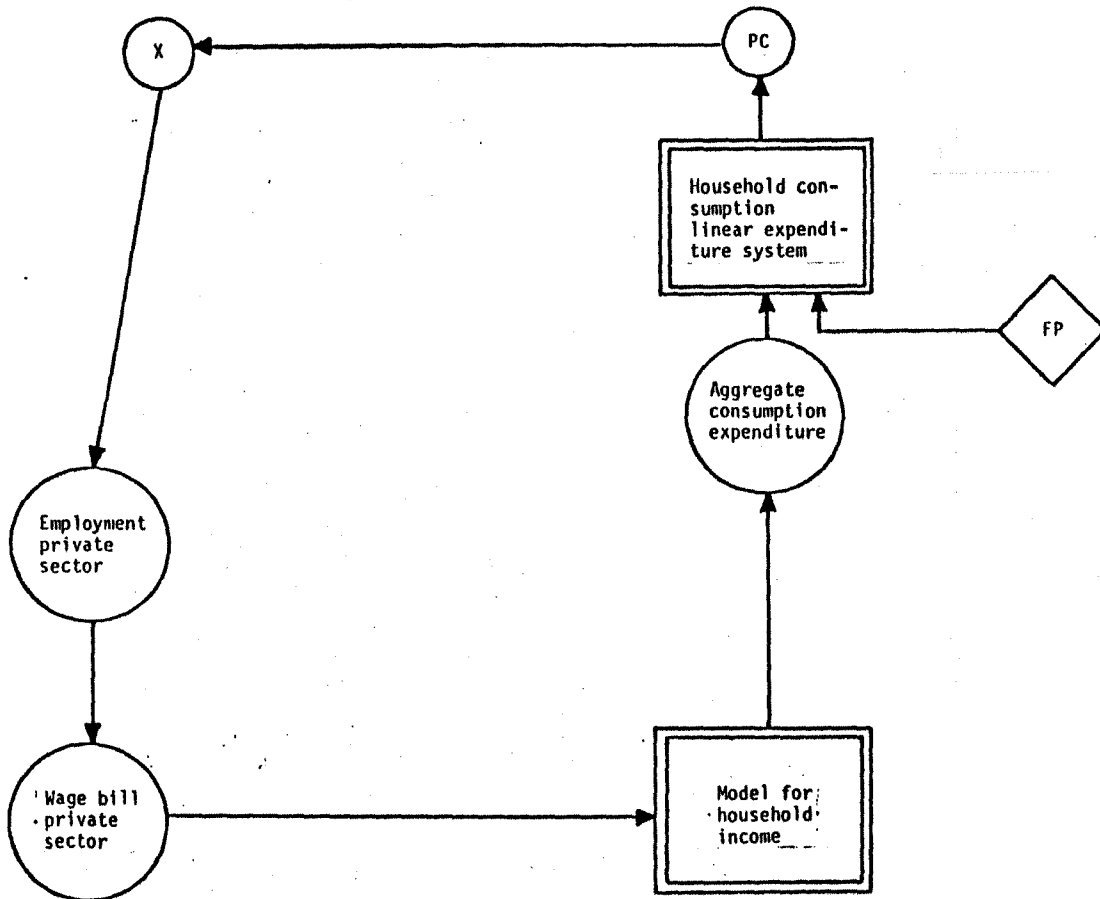
affect total wage income through higher wage rates. On the other hand it will, however, also limit the real multiplier effect through higher inflation, and increased imports and reduced exports following the rise in the domestic price level. The net real effect of these secondary mechanisms after 2-3 years may be positive or negative depending i a on price elasticities in foreign trade and the sensitivity of wages to increased preassure on the labour market. Other important sources of household income are wage, salaries and transfers from the public sector. After deduction of various taxes households are left with disposable income. The savings ratio is assumed fixed and real consumption expenditure is distributed between fourteen consumption categories by a linear expenditure system. The feed-back mechanism between the production system and consumption demand through the household sector is important to explain the model's short term response to an exogenous disturbance, either in the form of e.g. a change in world market growth or in the form of some fiscal measure towards the household sector.

Public sector demand for intermediary and investment goods (IG, OI) is partly a policy variable (central government), partly endogenous (local government). The local government model, as it is presently implemented, tends to produce fairly strong oscillations in the economy through its interactions with the labor market on the one hand and the household sector via the endogenous local tax rate on the other. These links are shown in Figure 2.3.

Figure 2.3   The local consumption - labor market loop
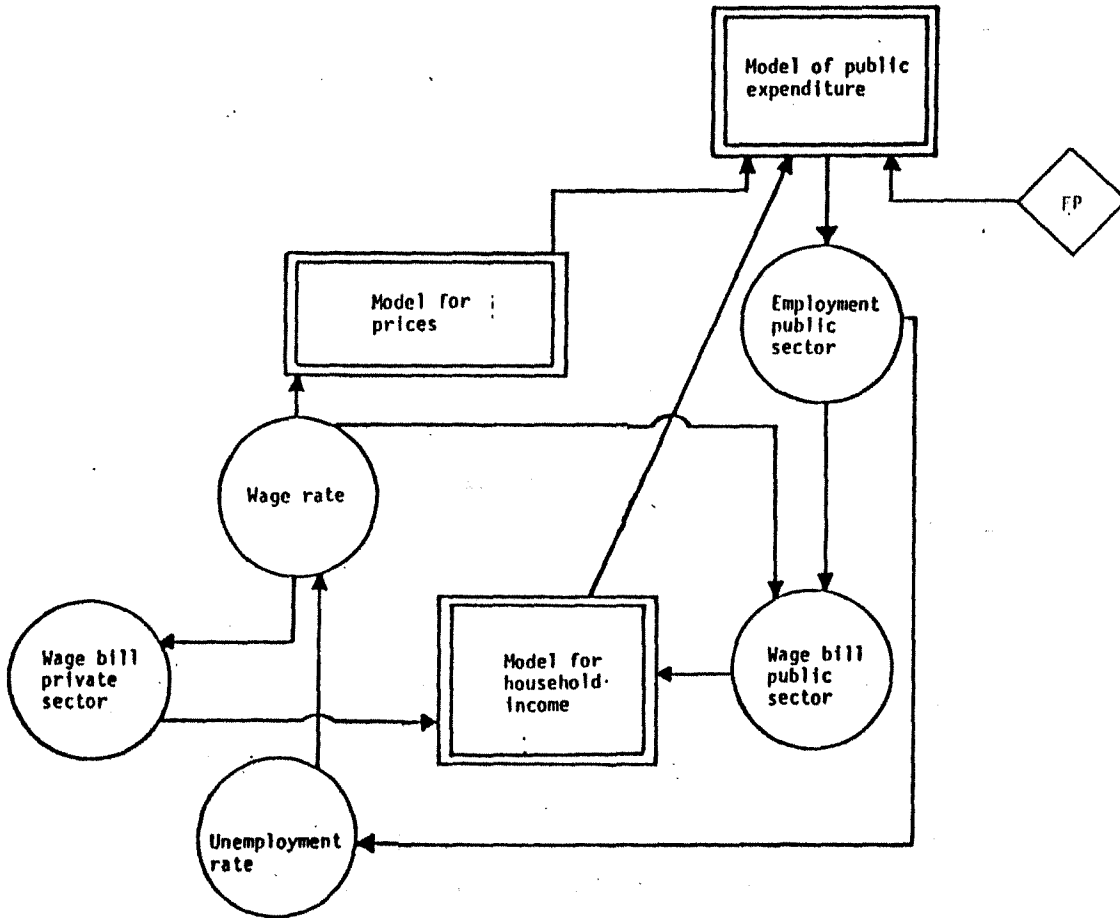
Suppose central government increase their cathego-
rical grants to local governments, indicated by a
change in fiscal parameters (FP) in the figure.
The immediate impact of this measure will be to
decrease local governments' net costs of produc-
tion and hence induce them to step up real expendi-
tures. The grants will also improve their financi-
al situation making tax increases unnecessary.
Since no other fiscal measures are assumed, i e
the original grants increase is not financed by
central government taxes, the activity level in
the economy will increase and so will employment.
The resulting wage inflation will partly "finance"
the local government expenditgure increase by ero-
ding households' income and by worsening the exter-
nal balance. But the wage increase will also lead
to increased net costs of production for local
governments and slow down their expansion. Howe-
ver, because of the two year lag in the disburse-
ment of centrally collected local tax-income,
local governments' financial situation will again
improve at a time when wages are moderate as a
consequence of weak demand. Thus with a two year
lag the inflated household income will feed back
to local governments' acting as a stimulus to
increased expenditures.

Simulation experiments carried out so far with
this submodel, reported in Nordström-Ysander
(1981) are still on an explorative level[1] and the
stability tests discussed in chapter 5 are accom-
plished with exogenous local governments.

Changes in stocks (ΔS) are modelled in a very
simple fashion with total stocks in the economy
proportional to production in some "stockholding"
branches. Mostly, however, the model is run with
exogenous stock investments.

Finally the sector balance for industry includes
imports and exports (M,EX). These are, of course,
of great importance considering the large export-
and import-shares, especially for the manufactu-
ring branches, in the Swedish economy. As discus-
sed in chapter 1 we assume, for aggregational and
market structural reasons, that price differenti-
als between imported and domestically produced
goods can persist over long periods, and also that
Swedish exporters are not necessarily price-takers
on the world market. The implication of these
assumption is that imports and exports will depend
on relative prices and that domestic producers can
price themselves out of domestic as well as fore-
ign markets as was the case in the middle of the
seventies.

Used together with the wage equation, the foreign
trade functions introduce a mechanism that tend to
dampen the effects of world market disturbances.
The immediate impact of a general world market
price increase, for example, will be higher domes-
tic inflation through imports and a preassure on
the labor market due to improved relative prices
and hence increased net demand from abroad. This
will however create both inflation expectations
and wage drift on the labor market pushing up
wages. The higher wages will not only remove preas-
sures on the labor market but also reduce the
initial surplus on foreign account. These mecha-
nisms, indicated in figure 2.4, is further dealt
with in Chapter 5.

2.2 Price and wage formation

The previous section gave a summary description of
the determination of industry's fixed price sector

Figure 2.4   The foreign trade-labor market loop
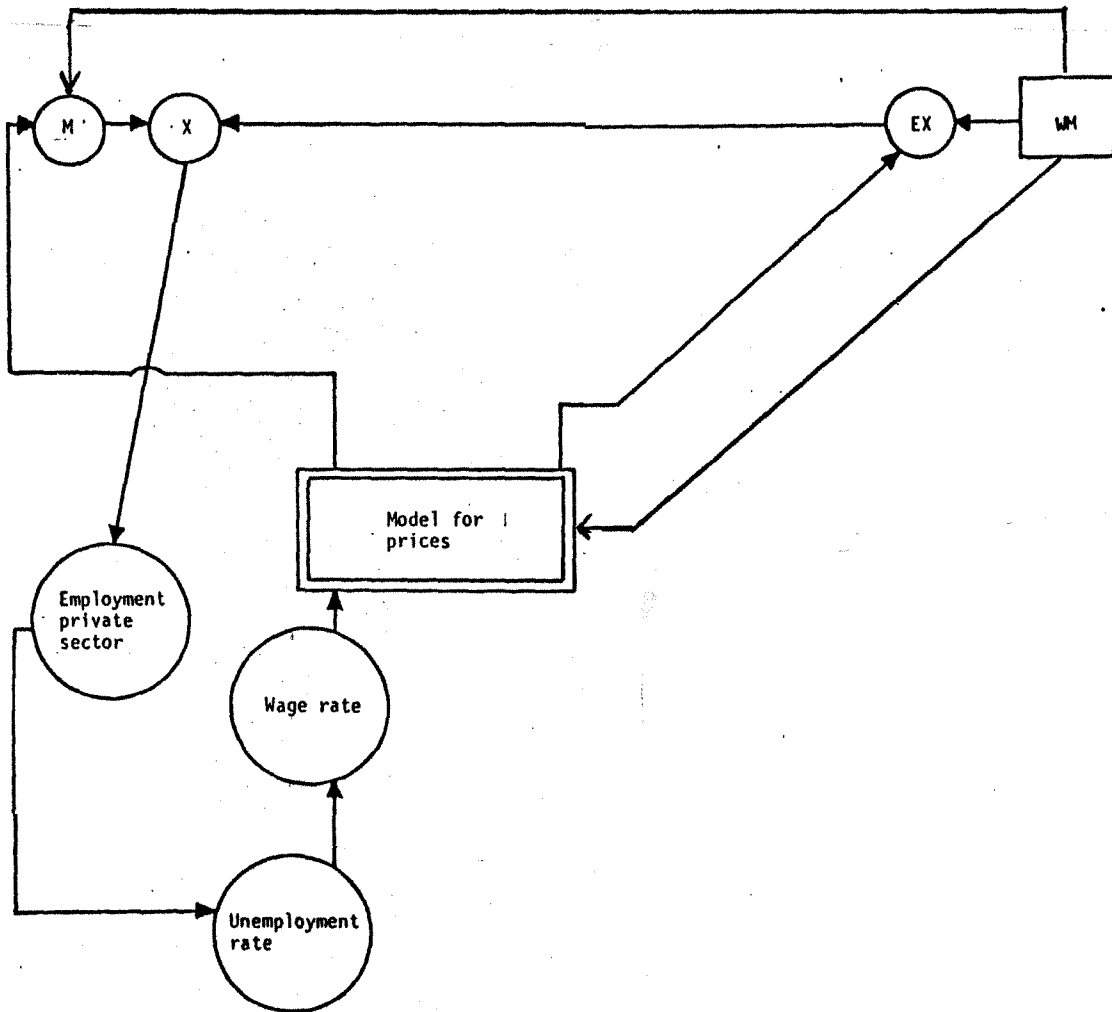
balance in the model. Obviously prices play an important role for the solution of the model. We shall therefore describe the price formation hypotheses and equations that are used in the model.

As mentioned in chapter 1 prices are based on average rather than marginal costs. Unit cost is taken to include "normal" profits, i.e. the mark-up over average operating costs is equal to avarage capital cost share. Theoretically this kind of pricing can be underpinned by assuming market imperfections and adjustment costs. It also seems to be well in accordance with observed behavior.

For a small country, however, with large export shares it seems natural that producers not just pass on their costs to the world market without regard to competitors' prices. The price equations in ISAC also allows for such an influence and are accordingly specified as a geometric avarage of unit cost and world market price (in Swedish currency):

$$P \sim C^{\alpha} \cdot PW^{(1-\alpha)} \quad \text{or} \quad \dot{P} = \alpha \cdot \dot{C} + (1-\alpha) \cdot \dot{PW}$$

where dotted variables are growth rates. The size of the parameter α is of crucial importance. Obviously α equal to unity implies pure mark-up pricing. On the other extreme, with α equal to zero, producers are assumed always to follow world market prices. The implications of the two extremal points of the interval for α are shown in figure 2.5. Initially domestic prices, costs and world market prices are assumed to coincide ($P_O = PW_O = C$). Facing the demand curve E_O^D for Swedish products, exports will amount to E_O. Now we introduce a shift in world market prices, ΔPW.

Figure 2.5 <u>Export Effects of Different Pricing Parameters</u>

$PW_1 = P_1 \ (\alpha = 0)$

$P_O = PW_O = C =$
$= P_1 \ (\alpha = 1)$

$P_O^S \ (PW_O)$

$E_1^D \ (PW_O + \Delta PW)$

$E_O^D \ (PW_O)$

$E_O = E_1 \ (\alpha = 0)$ $E_1 \ (\alpha = 1)$ E
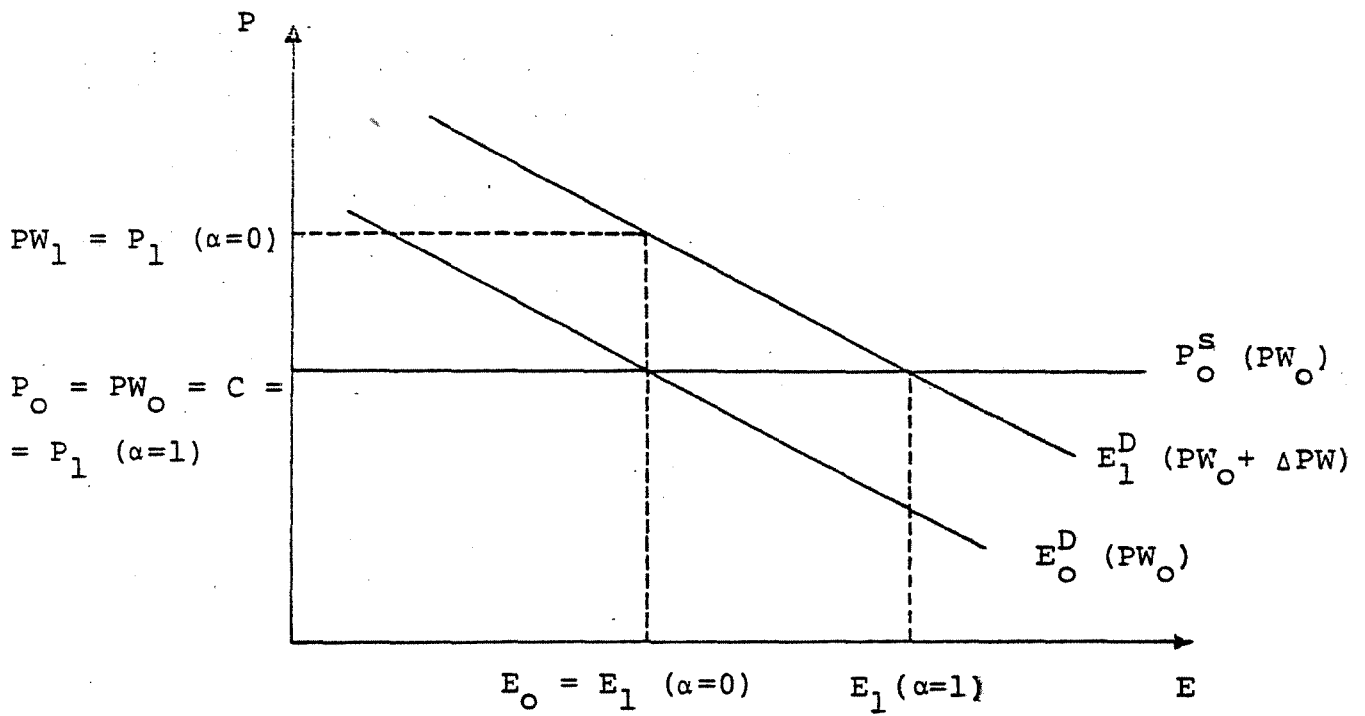
<u>Equations:</u>

$$P^S \sim C^{\alpha} \ PW^{1-\alpha}$$

$$E^D \sim (P/PW)^{-\beta}$$

Suppose that $\alpha = 1$, i e that pure mark-up pricing
is used, and that the cost curve does not shift.
Then the Swedish export price will still be equal
to P_o making it possible to gain market shares in
face of the new export demand curve E_1^D as a result
of competitors' price increase ΔPW. Exports will
rise to $E_1(\alpha = 1)$ in the figure. If on the other
hand α is zero exports will not change at all
despite the world price increase since domestic
producers will simply let their prices follow on.
Of course, with constant costs this will increase
profits.

This situation does however not correspond to the
common "small country assumption" with purely
price taking domestic producers. Although export
prices are set by the world market, producers are
also assumed to face a totally elastic demand
curve meaning that they can sell all they want at
prevailing prices. With our assumption that fore-
ign demand for Swedish products have limited price
elasticities, producers setting their price equal
to the average world market price, will only
retain their market share and may not be able to
sell all they wish at that price.

In the discussion above costs were for simplicity
assumed to be unaffected by the world price increa-
se. Of course price increases abroad will influen-
ce domestic inflation. One way world inflation
will be felt is through imported goods. Another is
through price increases by domestic producers if
they take the opportunity to raise their profit
margins.

However, the model economy also includes an inter-
nal source of inflation in the shape of a kind of

an expectations augmented Phillip's curve where the overall wage rate growth is explained by last year's consumer price growth, the inclusion of which can be thought of as either an expectational or a compensatory element in the wage formation process,[2] the current rate of unemployment, profit levels and finally productivity growth.

Theoretically justifiable Phillip's curves can be specified in a great many ways. Two features of this particular specification should be noted since they are important to the model behavior. The first one is the rather unsofisticated formation of expectations that is assumed. It rather may seem more natural to view the one year laged consumer price variable as a compensatory mechanism for past inflation especially since the parameter was estimated not to differ significantly from unity. The second noteworthy characteristic of the chosen wage equation is the absence of lags in the unemployment variable.[3] These two properties make wages react very quick and strong to inflationary preassures making e.g. the domestic consequenses of external inflationary shocks fade away in a rather short period.

Notes

[1] Cf Nordström-Ysander, 1981.

[2] Estimated parameter values are given in chapter 4.

[3] Various lags were tried when estimating the equation, cf Jansson, forthcoming.

3 The equations of the model

3.1 Definitions and conventions

The following definitions and conventions have been used in this chapter

Large romans = matrices

Small romans without subscripts = vectors

Small letters with subscripts = scalars

Superscripts = indices of categories etc.

Subscripts = indices of branches, goods etc.

"Roofed" letters are vectors turned into diagonal matrices

The transpose of a vector or matrix is denoted by "'", e.g. x'.

(t-n) = n-year lag. When no time indication is given, time t is assumed.

Dotted variables indicate growth rates, e.g. $\dot{x} =$

$$= \frac{dx}{dt} \cdot \frac{1}{x}$$

Parameters are mostly named by small greek letters or in the case of simple constants by roman a or b with appropriate subscripts and occasionally a superscript indicating explained variable or the like.

3.2 Commodity balances in fixed and current prices

The following two accounting identities state that total domestic demand (right hand side) is equal to total domestic supply (left hand side) for every commodity.[1]

$$m + x = Ax + inv + pc + pu + ds + e$$

$$\hat{p}^m m + \hat{p}^x x = \hat{p}^h (Ax + inv + pc + pu + ds) + \hat{p}^e e$$

3.3   The i/o matrix

The i/o matrix for the manufacturing industry is calculated from a vintage model of production technique for each of the 14 branches in the sector.[2]

Aggregated input koefficients in a new vintage at time t are given by a constant elastic function in last year's input prices:

$$Q^t_{m,i} = a_{m,i} \prod_n p_{n,i} (t-1)^{\alpha_{m,n,i}}; \quad i = 1,\ldots,14$$

where m,n = 1 for intermediate goods

2 for electricity

3 for fuels

4 for labor

5 for capital

The sum of the elasticities $\alpha_{m,n,i}$ over n is zero which makes the input share function homogenoeous of degree zero, i.e. a proportional increase in all prices will not affect the choise of technique.

The input share equations can not be achieved from cost minimization of a common production structure, so the constraints derived from the classical demand theory are not satisfied. The reason to leave the firm theoretical grounds is purely pragmatic. The constant elastic form used makes it practically possible to foresee and track the

impact of price changes on the technical development.

The $\alpha_{m,n,i}$ used are calculated from estimated translog functions, see Dargay, J. (1981), at the observed sample average. Since the variations in the elasticites calculated over the observed period are moderate in spite of considerable changes in relative prices the constant elastic functions can be regarded as approximations to proper share functions.

Assuming that i/o koefficients in a vintage are independent of utilization ratios and that all vintages are used at the same intensity level the capacity distribution over vintages can be used to calculate overall i/o koefficients in a branch. The capacity distribution in a branch is calculated from gross investments and scrapping of old vintages.

New capacity in branch i is given by gross investments and the chosen capital output koefficient

$$\bar{x}_i^t = g_i/Q_{5,i}^t$$

Remaining capacity in old vintages depend on the rate of scrapping which is assumed inversely proportional to the quasi-rent earned by each vintage

$$d_i^v = \sum_{n \neq 5} Q_{n,i}^v p_{n,i}(t-1)/p_i^x(t-1)d_i; \qquad v =_o t, \ldots, t-1$$

Although this criterion will speed up the scrapping of old capacity in times of changing relative prices it will still allow vintages earning negative quasi-rents to be run for several years.

Given the rate of scrapping current production capacity in old vintages in manufacturing branch i is straight forward

$$\bar{x}_i^v = (1-d_i^v) \cdot \bar{x}_i^v(t-1) \; ; \; v = t_o, \ldots, t-1$$

and the distribution of capacity over vintages is

$$\bar{\bar{x}}_i^v = \bar{x}_i^v / \bar{x}_i$$

where $\bar{x}$ is total capacity

$$\bar{x}_i = \sum_v \bar{x}_i^v$$

This will finally give us overall aggregated input koefficients for manufacturing branches as

$$Q_{n,i} = \sum_v Q_{n,i}^v \bar{\bar{x}}_i^v \; ; \quad \begin{array}{l} n = 1, \ldots, 5 \\ i = 1, \ldots, 14 \end{array}$$

The matrix of aggregate input koefficients for the manufacturing sector thus depends on the pace with which new capacity (and technology) is installed and old phased out and accordingly becomes a slowly moving function of relative prices in the economy.

The aggregated i/o koefficients $Q_{n,i}$ with $n = 1,2,3$ is transformed to the standard 23 input goods format by matrix H giving the i/o matrix A for the manufacturing sector

$$A_{j,i}^m = \sum_n Q_{n,i} H_{j,n,i} \; ; \quad \begin{array}{l} n = 1, \ldots, 3 \\ i = 1, \ldots, 14 \\ j = 1, \ldots, 23 \end{array}$$

The $Q_{4,i}$ is and $Q_{5,i}$:s are the inverse of respectively labor and capital productivity in each branch.

For the 9 branches outside the manufacturing sector there is no vintage approach adopted as yet in the model. For these branches capital stocks are assumed to be homogenous and aggregate input shares are given by a constant elastic function in input prices. The disaggregated i/o matrix for these 9 branches, A^o, is then compiled in the same way as A^m.

Finally A^m and A^0 are combined to give the total 23x23 i/o matrix $A = (A^m, A^0)$.

Investments, input shares and depreciations are all functions of only predetermined variables which means that they are not dependent on the model solution for year t and accordingly neither is A.

The assumptions that all vintages are used at the same intensity level and that i/o ratios are independent of the utilization rate implies that the A matrix describes the input-output relations not only at full capacity production but also at any other actual production level. It also means that the utilization rate can be calculated at "branch level" for the whole business sector, disregarding the vintage structure in manufacturing branches:

$$ur_i = x_i/\bar{x}_i \quad ; \quad i = 1,\ldots,23$$

3.4   Energy substitution[3]

Five energy carriers are distinguished in the model: electricity, distant heating, oil, coal and domestic fuels. Energy consumption is accounted for in these five categories for each of the 23 business sectors, for the public sector and for the household sector.

The substitution between different energy forms in the business sector is assumed to take place in two stages. In the first stage a new production technique with five inputs is selected: electricity, fuel (incl. heating where appropriate), other intermediate goods, labor and capital as described in section 3.3.

In the second stage the choice between different kinds of fuels is made. It is assumed that ex post substitution is possible in all branches in this stage. The shares q^f for coal and domestic fuels of total fuel consumption depend on price according to the following relation:

$$q^f_{j,i} = a_{j,i} \cdot (b_{j,i} - p_{j,i}{}^{\mu_{j,i}}) \; ; \; \begin{array}{l} i = 1, .., 23 \\ j = 1, 2 \end{array}$$

where j = 1 for coal
        2 for domestic fuels

The p:s are up to five year lagged energy prices, including capital cost, relative to the price of oil produced energy. Since the aggregate use of fuels is the sum of oil, coal and domestic fuels (all measured in Twh), the share of oil is determined as a residual. The above relation thus does not describe the choice of optimal fuelshares at

given prices, but rather the sluggish accommodation of energy demand to changing price relations.

The rationale behind the two stage procedure for determination of energy demand in the business sector is the assumption that the choice of fuel have negligible effects on the rest of the installed production technique. This seems to be a good approximation in many cases since fuel is mostly used to produce heat and the heat production unit may be fairly separate from the rest of the production process.

3.5 Investments in the business sector

Investments in each branch of the manufacturing sector is determined by past profits and capacity utilization

$$g_i = k_i(t-1) \left(\sum_{j=1}^{4} \gamma_{j,i} \ ep(t-j)_i + \delta_i \right) ur_i(t-1)$$

where the parameters $\gamma_{j,i}$ are all > 0 ep_i is an "excess profit" index relating realized gross operating surplus to the user cost of capital

$$ep_i = (va_i - \omega_i \ell_i)/p_i^k k_i$$

p_i^k is the cost of capital in branch i defined as

$$p_i^k = p_i^g(r_i(r_\omega))$$

where r_i is the required rate of return in branch i, calculated as a function of the exogenous rate

of interest r_ω, and p^g the price of investment goods for branch i.

In branches outside the manufacturing sector investments are either exogenous or related to production in the branch.

To account for demand for different goods generated by investment activities the composition of gross investments is assumed to differ between branches but to be constant over time:

$$inv = G\ g$$

where G is a matrix converting investments in investing branches into commodity demand directed towards producing branches.

3.6 Foreign trade

The volume of export, e, and import, m, depends on market size and relative price for each commodity.

The general form of the export functions are

$$e_i = a_i^e \prod_{j=0}^{1} [p_i^e(t-j)/(\theta\ p_i^W(t-j)]^{\beta_{i,1+j}}\ wm_i$$

where p^e and p^W are Swedish export price and world market price respectively. The export price is expressed in Swedish currency while the world market price is expressed in foreign currency. θ is the exchange rate. The size of the world market is given by index wm for each good.

The import functions have a similar structure:

$$m_i = a_i^m \prod_{j=0}^{1} \left[\theta\, p_i^w(t-j)/p_i^{xh}(t-j) \right]^{\gamma_{i,1+j}} h_i^{\gamma_{i,3}}$$

Swedish producers' price of commodities sold on the domestic market, competing with imports, is p^{xh}. The variable h is total domestic demand.

As the foreign trade equations show exports and imports depend on prices relative to the world market with at one year lags. For many commodities lagged relative prices affect current export/import volume as much as current price relations.

3.7 Disposable income in the household sector

The submodel for household income distinguishes between two kinds of individuals. "Pensioners" are people with most of their income from the social security system. The remainder is simply called "wage-earners" although it includes the total labor force, i.e. entrepreneurs as well as unemployed persons.

Individuals receive factor-income, capital-income and transfers from other sectors. After deduction of income- and payroll-taxes, and transfers to other sectors they are left with disposable income.

Factor income

The main part of factor income is gross wages and salaries, including payroll taxes and other collective fees, but factor income also includes part of net surplus in producing sectors.

Gross wages and salaries is the product of wage/
hour and the number of hours worked in different
sectors plus the public sector:

$$Y_{11} = \omega' \cdot \ell + w^{s'} \cdot \ell^s + \omega^{\ell'} \cdot \ell^\ell$$

$$Y_{12} = he' \cdot \ell \cdot va$$

where he is entrepreneurs' share of total hours
worked in each branch and va is value added (i.e.
their productivity is assumed equal to the employe-
es'). Accordning to National accounting conven-
tions Y_{12} also includes imputed income from owner-
occupied houses.

Capital income

Capital income include interest-payments calcula-
ted as a constant fraction of entrepreneurs'
income:

$$Y_{21} = a_{21} \cdot Y_{12}$$

Other net capital income is calculated from finan-
cial assets, fa, which in turn are accumulated
from total financial surpluses and deficits of the
household sector.

$$Y_{22} = a_{22} \cdot fa$$

Transfer income

This part of the submodel is fairly disaggregated
and to a large extent exogenous except for infla-
tion. There are six different types of transfer
incomes:

1: National general pension (old age plus others)

2: Ditto local

3: National supplementary pensions
   (old age plus others)

4: Private (collective) pensions (old age)

5: Other transfer income (non-taxable)

6: Other transfer income (taxable)

The first four items are calculated as number of persons, np, times real income per capita, rp, and inflation (consumer price index):

$$Y_{3i} = np_i \cdot rp_i \cdot cpi; \qquad i = 1,\ldots,4.$$

Other transfer income, which mainly goes to wage earners, is divided according to whether it is taxable or not.

Non-taxable transfer income is set by an exogenous trend plus inflation:

$$Y_{35} = a_{35} \cdot \exp(b_{35} \cdot t) \cdot cpi.$$

Taxable transfers are divided into sickness benefits, unemployment benefits and others. Sickness benefits are assumed to be proportional to wage sum while unemployed persons receive a constant fraction of average wage income per employee.

$$Y_{36} = a_{36} \cdot Y_{11} + a_{37} \cdot Y_{11} \cdot u + a_{38} \cdot \exp(b_{36} \cdot t) \cdot cpi$$

Transfer payments

Five types of transfer payments are distinguished:

1: National income tax

2: Local income tax

3: Social security contributions

4: Other payroll fees

5: Other transfer payments.

National income tax is calculated from an aggregate progressive tax-function:

$$Y_{41} = a_{41} \cdot skind \cdot n_b (besk/skind/n_b) \; b_{41}$$

where the tax index skind is one year lagged consumer price index and n_b is number of assessed persons.

Taxable income, besk, is a fairly complicated function taking account of different kinds of deductions from gross income

$$besk = F_b \; (Y_{11}, \ldots, Y_{36})$$

Local tax is calculated from taxable income using the local tax rate utd:[4]

$$Y_{42} = utd \cdot besk$$

Payroll taxes and fees are shares of total gross wage:

$$Y_{43} = a_{43} \cdot Y_{11}$$
$$Y_{44} = a_{44} \cdot Y_{11}$$

Other transfer payments are calculated as:

$$Y_{45} = a_{45} \cdot \exp(b_{45} \cdot t) \cdot cpi.$$

Disposable income

Summing up incomes and payments we get disposable income for the household sector as

$$y_d = \sum_{j=1}^{6} [\sum_{i=1}^{3} y_{ij} - y_{4j}]$$

3.8 Private consumption

Consumption expenditures per capita equals disposable income less savings. Savings are set as a constant fraction, s_r, of disposable income and total population is n_s

$$cp = (1-s_r) \cdot y_d/n_s$$

Total consumption expenditure per capita is distributed on 14 consumer goods by a linear expenditure system:

$$p_i^c c_i = \gamma_i p_i^c c_i(t-1) + \beta_i (c_p - \sum_{k=1}^{14} \gamma_k p_k^c c_k(t-1))$$

where $\sum_{j=1}^{14} \beta = 1$ $i=1,\ldots,14$

The price vector p^c represents the prices of domestic absorption, p^h, converted to the consumer goods level by a constant matrix PK:

$$p^c = PK \cdot p^h.$$

Private consumption per capita is then transformed to total private consumption at the 23 commodity level:

$$pc = PK \cdot c \cdot n_s$$

3.9 Central government

The development of central government consumption is exogenously determined. Seven different consumption purposes are distinguished.

1:      National defense.

2:      Public order and safety.

3:      Education.

4:      Health.

5:      Social security and welfare services.

6:      Roads.

7:      Other services.

The rate of growth of production, xs, and consumption, cs, for the various purposes is a constant proportion, gr, of an exogenously given common growth factor g_0.

$$xs = g_o \cdot gr$$

$$cs = (I-sa) \cdot xs$$

where the sa:s are shares of sales from production.

The need for intermediate goods is related to production in each central government sector. Together with exogenous investments this gives central government demand from the 23 business branches:

$$fs = SG \cdot xs + sg \cdot i_s$$

where aggregate central government investment is i_s. SG is a constant conversion matrix and sg a ditto vector.

3.10 Local government

Production within local governments are split into five categories.

1. Education.
2. Health.
3. Social welfare.
4. Roads (total expenditures).
5. Central administration, fire service etc.

These expenditures are explained by linear expressions of the following form:

$$x\ell_i = a_{1i}z_{1i} + a_{2i}z_{2i} + a_{3i}z_{3i} + a_{4i}z_{4i} + a_{5i}z_{5i}$$

where z_{1i} are shift variables, z_{2i} and z_{3i} stand for investment consequences and capacity restrictions, while z_{4i} and z_{5i} reflect the impact of changes in real income, local tax rates and relative prices[5].

As with central government sales made by local authorities of goods and services at market prices are assumed to be a constant fraction of local production giving local consumption as

$$c\ell = (I-\ell a) \cdot x\ell$$

Aggregate investments by local authorities are explained by a gradual adjustment to desired capital stock levels, with the rate of adjustment depending on capital good prices, interest rates, liquidity situation and real income development.

$$\Delta kp = a_{16}z_{16} + a_{26}z_{26} + a_{36}z_{36} + a_{46}z_{46} + a_{56}z_{56}$$

$$z_{16} = kp; \quad z_{26} = \Delta kp^*; \quad z_{36} = \Delta liq(t-1) \cdot z_{16};$$

with kp is actual and kp* desired real capital stock and Δliq is the change in local authorities' liquidity.

$$z_{46} = \phi_6 \cdot kp^2 \cdot r \cdot \frac{besk}{besk(t-2)}$$

with ϕ_6, net real price of capital goods, defined in the same way as ϕ_i.

$$z_{56} = (1-utd-av_0)besk \cdot z_{46} \cdot z_{16}$$

where av_0 is nominal fees.

The depreciation is assumed to be a constant fraction of existing capital stock. Gross investments then becomes

$$i_\ell = \Delta kp + a_{66}z_{66}$$

where a_{66} is the depreciation rate and $z_{66} = kp(t-1)$.

Investments may also be computed in a simplified manner as equal to desired capital stock changes plus reinvestments.

The local governments' expenditures on production and investments are converted final demand of commodities from the business sector by LG and ℓg:

$$f\ell = LG + x\ell \cdot + \ell g \cdot i_\ell$$

Together with central government's demand this gives total public sector demand for commodities from the business sector:

$$pu = fs + f\ell$$

Transfer payments, t, are split into two categories, - subsidies to public utilities and direct transfers to the household sector. In the model the explanation of these payments is derived from the idea that the provision of housing space and of public utilities are arguments in the local governments' goal function, pursued indirectly by way of "price subsidies".

$$t_i = a_{2i}\zeta_i + a_{3i}\mu_i + a_{4i}\gamma_i$$

i=1,2   1 = public utilities subsidies
         2 = direct household (housing) subsidies,

where ζ_i represents the cost for the households relative to disposable income and μ_i and γ_i express the impact of developments in real income, local tax rate and relative prices.

The transfer payments can alternatively be treated in a simplified manner. The net amount of subsidies to public utilities are then approximated as a constant fraction of production in sector 18 (electricity, heat etc.). Direct household transfers are set as a linear function of households' housing expenditures (z_{13}).

Local government expenditures are financed by
taxes and state grants with liquidity changes
acting as a buffer against planning failures.
Given state grants (sb_0), net borrowing (Δdt),
other net income (C_0), and interest payments (rdt)
the local tax rate is determined residually by way
of the budget restriction:

$$utd = \frac{besk}{besk(t-2)} \left[-utd(t-2) \left(besk(t-2) - besk(t-4) \right) -sb_0 \right.$$

$$\left. - \Delta dt - e_0 + rdt \right]$$

To simulate possible restrictions or inertia in
local government political behavior, the model can
alternatively be supplemented with a floor restric-
tion on the tax rate complemented with a rule,
prescribing that planned surpluses un above a cer-
tain relative level are used to scale up current
expenditure.

3.11 Stock building

Total change of stocks, ds_a, in the economy is
exogenous in the model. The commodity composition
of stock investment goods, sc, is assumed constant
over time. Inventory demand for commodities thus
becomes

$$ds = sc \cdot ds_a$$

A simple stock building model can be included when
necessary. Still only one aggregate inventory good
is distinguished but demand for inventories is
generated by four aggregate stockholding branches.
The four branches are foresting, agriculture and
fishing, producers of intermediate goods, produ-

cers of finished goods and the wholesale and retail trade. Stocks are assumed proportional to production, y_i, in these aggregate branches which gives total stockholding as:

$$s_a = \sum_j s_j = \sum_j a_j y_j; \quad j=1,\ldots,4$$

and

$$ds = sc \cdot ds_a = sc \cdot \left[s_a(t) - s_a(t-1) \right]$$

3.12 Prices

As is evident from foreign trade equations Swedish prices on foreign and domestic markets are allowed to differ from world market prices. These differences make Swedish producers loose or gain market shares. It is furthermore assumed that the export price, p^e, may differ from the price, p^{xh}, set for the domestic market.

$$p_i^e = a_{i1}(p_i^w \theta)^{a_{i2}} uc_i^{a_{i3}} ur_i(t-1)^{a_{i4}}; \quad i = 1,\ldots,23$$

$$p_i^{xh} = b_{i1}(p_i^w \theta)^{b_{i2}} uc_i^{b_{i3}} ur_i(t-1)^{b_{i4}}; \quad i = 1,\ldots,23$$

The unit cost of production, uc, is calculated as
$$uc = A'p^h + vac$$

with

$$vac_i = \left[w_i \cdot \ell_i + p_i^k \cdot k_i \right]/x_i$$

that is, value added at normal profits.

The price equations above can be seen as a (more realistic) compromise between the common extreme assumptions of either a pure "cost plus" behavior or a "EFO" assumption, where producers exposed to foreign competition are pure price takers.

Given the Swedish producers' prices on the domestic market and import prices the implicit price index for commodities on the domestic market, p^h, is calculated as

$$p_i^h = [(x_i - e_i)p_i^{xh} + m_i \cdot \theta \cdot p_i^w]/h_i$$

with

$$h = x - e + m$$

Adding export value and value of home market sales gives the unit price of domestic production:

$$p_i^x = e_i \cdot p_i^e + (x_i - e_i) \cdot p^{xh}$$

For all business sectors gross profit Π_i will be determined residually:

$$\Pi_i = (p_i^x - A_i' p^h) x_i - w_i \ell_i - i_i$$

where A_i denotes column i of the matrix A and i_i is indirect taxes.

3.13 Employment

Total employment in the economy is derived from production and productivity in each sector.

For the business sector employment in branch i is given by

$$\ell_i = x_i \cdot Q_{4,i} \quad ; \quad i = 1,..,23$$

For the public sector labor input koefficients, q^s and q^ℓ, are exogenous although occasionally subject to a trend development:

$$\ell_i^s = xs_i \cdot q_i^s \quad ; \quad i = 1,..,7$$

$$\ell_i^\ell = x\ell_i \cdot q_i^\ell \quad ; \quad i = 1,..,7$$

Together with an exogenous labor supply, ℓ_s, these equations give the unemployment rate:

$$u = (\ell_s - x \cdot Q_4 - xs \cdot q^s - x\ell \cdot q^\ell)/\ell_s$$

where Q_4 is the vector of labor input koefficients in the business sector.

3.14 Wages

The changes in the wage rate is the same for all branches in the business sector and is determined by a kind of Phillips curve:

$$\dot{w}_0 = a_0 + a_1 \cdot cpi(t-1) + a_2(u-u_0) + a_3 [\Pi^m(t-1) - \Pi_0] + a_4 \dot{Q}_4^m(t-1)$$

Thus the change in the wage rate is a function of current deviation of the unemployment rate from a "normal" or "frictional" unemployment rate (u_0), past inflation, $cpi(t-1)$, past deviation from a "normal" level of aggregate gross profit margin Π_0 in the manufacturing sector and finally past

change of aggregate labor productivity in the manu-
facturing sector (Q_4^m is aggregate labor input koef-
ficient, i.e. the inverse of labor productivity).
It is assumed that wage changes in the public
sector is lagging one year behind the business
sector.

Wage rate growth is thus given by

$$\dot{w}_i = \dot{w}_o \quad ; \quad i = 1,..,23$$

$$\dot{w}_i^s = \dot{w}_o \ (t-1); \quad i = 1,..,7$$

$$\dot{w}_i^\ell = \dot{w}_o \ (t-1); \quad i = 1,..,7$$

NOTES

[1] A list of symbols is found in Appendix B.

[2] A detailed account of the vintage approach as applied to the iron and steel industry is given in Jansson, 1981.

[3] A more thorough account of energy substitution in the model is given in Nordström-Ysander, 1983.

[4] Y_{42} is the local tax payed in year t. However, as spelled out in the local government model below it only reaches local authorities in year (t-2).

[5] All expressions explaining local authority behavior are derived from maximizing a quadratic goal-function under a budget restriction. A detailed account of the model is given in Ysander, 1981.

4   Implementation

This chapter deals with some aspects of the implementation of the model to make it fit for practical use. The data base is fairly large and will not be given in full here. We will be satisfied to report parameter values for some important equations. This is done in section 4.2. Before that, however, section 4.1 will list the level of disaggregation of some main variables.

Since the model is large and complex the method used to solve it will be of paramount practical importance. The solution algorithm is described in Section 4.3.

4.1   Level of aggregation

The fundamental level of aggregation in the model is the distinction between 23 producing branches in the business sector. These are listed in Table 4.1 along with their SNI-classification numbers. Branches 4-17 (sometimes including branch 3) are referred to as the manufacturing sector. To give a hint of the relative size of the branches the last column also show fixed price value added in percent of sector total in 1980.

The basic classification shown in Table 4.1 is also used for commodities and it is assumed that output of every branch is homogenous at this level of aggregation.

Public consumption is disaggregated into thirteen real expenditure purposes - seven in central government sector and six in local government

Table 4.1   Classification of branches in the business sector

Name	SNI	Value added[a] (percent)
1. Agriculture, fishing	11,13	3.0
2. Foresty	12	2.4
3. Mining and quarrying	2	0.8
4. Manufacture of food (sheltered)	3111-1 3116-8	2.1
5. Ditto (exposed)	3113-15 3119,3121-1	0.9
6. Manufacture of beverages and tobacco	313-4	0.4
7. Textile, wearing apparel	32	1.2
8. Manufacture of wood, pulp and paper	33,341	6.1
9. Printing and publishing industries	342	2.0
10. Manufacture of rubber products	355	0.3
11. Manufacture of industrial and other chemicals, and plastic products	351-2	2.3
12. Petroleum and coal refineries	353-4	0.2
13. Manufacture of non-metallic products (except products of petroleum and coal)	36	1.1
14. Basic metal industries	37	1.9
15. Manufacture of fabricated metal products, machinery and equipment, excl ship-building	38 excl 3841	13.8
16. Ship building	3841	0.6

Name	SNI	Value added[a] (percent)
17. Other manufacturing industries	39	0.2
18. Electricity, gas and water	4	3.3
19. Construction	5	9.7
20. Wholesale and retail trade	61-2	13.8
21. Transport, storage and communication	7	8.7
22. Letting of dwellings and use of owner-occupied dwellings	83101	10.4
23. Other private services	Rest of 6,7,8 and 9[b]	14.9
Total business sector	1-9	100.0

[a] At 1975 producer prices.

[b] Private part. Public authorities do have some activities also in other branches These are, however, disregarded.

sector.[1] These thirteen categories, listed in Table 4.2, are also used to describe production within the public sector. It should be noted, however, that public enterprises are classified among business branches according to Swedish national accounting conventions.

Finally, private consumption is divided into fourteen categories, shown in Table 4.3, which are more suitable for analysis of demand than the basic 23 commodities division. The distribution of domestic private consumption expenditures between categories are determined by a linear expenditure system (cf sections 3.8 and 4.2) and converted to demand for commodities.

4.2   Values of essential parameters

This section presents parameter values of the main behavioural equations. Most of them, but not all, are estimated from historical data. Technical matters about estimation procedures will be omitted but references are given to more complete presentations.

The main set of parameters that are not properly estimated relates to the price formation equations, which give domestic producers' prices as functions of costs and world market prices. There is a distinction in the model between domestic producers' export prices (p^e) and import competing prices (p^{xh}):

$$p_i^e = a_{i1} cost_i^{a_{i2}} (\theta p_i^w)^{a_{i3}}; \quad a_{i2}+a_{i3}=1$$

$$p^{xh} = b_{i1} cost_i^{b_{i2}} (p_i^m)^{b_{i3}}; \quad b_{i2}+b_{i3}=1$$

Table 4.2   Classification of public consumption

Name	Classification according to Swedish national accounts	Central government consumption in 1979 (percent)[a]	Local government consumption in 1979 (percent)[a]
1. National defence	20	10.5	–
2. Public order and fire protection	13	4.0	0.9
3. Education	30	2.9	17.9
4. Health	40	1.2	23.2
5. Social security and welfare services	50	4.2	13.6
6. Roads	85	0.9	1.5
7. Other public services	6,7,rest of 8,9	8.2	11.0
Total public consumption	1-9	31.9	68.1

[a] Of total public consumption at 1975 year's prices.

Table 4.3   Classification of private consumption

Name	SNA	Per cent[b]
1. Food	11,7132,7136	19.9
2. Beverages, tobacco	12-14	6.9
3. Clothing and footwear	20,822(p)[a]	9.4
4. Cultural services	723-5,73,862	4.9
5. Personal care and effects	452,512,81	1.8
6. Gross rents and water charges	31	19.4
7. Private transport	611,621(p),623	5.5
8. Recreation	4114,52,612, 621(p),71 excl 71320 and 71360 721-2,821 822(p)	7.4
9. Furniture	41 excl 4114 42-4,451	6.9
10. Other consumption	Rest of 1-8	6.7
11. Electricity	321	2.0
12. Gas, fuels, steam	322-5	2.1
13. Gasoline	622	2.6
14. Purchased transports	63	2.6
Total private domestic consumption expenditure	1-8	98.1
Foreign travel, net	9	1.9
Total private consumption	1-9	100.0

[a] P(p) denotes part of SNA-number

[b] Of total private consumption expenditure 1980 in 1975 year's prices.

The sum of exponents for each branch (commodity) is in both cases restricted to unity giving domestic producers' prices as geometric averages of production costs and world market prices.[2,3] With a_{i2} and b_{i2} equal to unity companies are assumed to compensate all domestic cost increases on the world market thereby protecting their profit ratios even in the face shrinking market shares - at home as well as abroad. On the other hand such price behavior also make companies use reduced costs or increased world market prices (e g through currency devaluation) to improve their competitiveness with increased demand on domestic and foreign markets as a consequence. (Cf section 2.2.) The reverse will of course follow if the a_{i2}:s and b_{i2}:s are close to zero.

As stated above we have not carried out any econometric analysis of price parameters of our own. Intuitively it seems reasonable that the sensitivity to world market prices will vary considerable between branches, depending on type of commodity and on the degree of exposure to foreign competition. This conclusion is supported by Calmfors and Herin (1979) which so far is the only attempt to estimate price equations on Swedish data at a disaggregated level. Contrary to conventional wisdom, Calmfors and Herin estimated a rather low influence from world market prices and a corresponding high sensitivity to domestic cost factors.
This was the case even for highly exposed branches with fairly homogeneous outputs such as paper and ulp, and iron and steel industries.

We have felt free to vary the price parameters in different applications of the model and also some-

times to let the price behavior differ between foreign and domestic markets (i e $a_{i2} \neq b_{i2}$ and $a_{i3} \neq b_{i3}$). The standard set of parameters are shown in Table 4.4, which give the industrial branches in order of assumed increasing influence from world market prices on their own price setting behavior. As can be seen from the table manufacturing branches (excluding petroleum rafineries) are assumed to be equally sensitive to cost and world market price. It is, however, important to realize that the direct influence from foreign prices in the equations is not the only one. Domestic producers' prices will also to a varying degree react to world market prices through imported input goods which will affect production costs. The total foreign price influence will therefore always be greater than showed in Table 4.4.

For most branches Calmfors and Herin found no significant influence on price setting from capacity utilization. In the model simulations we have, however, frequently exploited a capacity variable in the price equations to speed up the adjustment to normal capacity utilization levels.

The wage formation is given by a kind of Phillips curve as described in section 3.14:

$$\dot{w}_0 = a_0 + a_1 \cdot \dot{cpi}(t-1) + a_2 \cdot (u-u_0) +$$

$$a_3 \cdot \left(\Pi^m(t-1) - \Pi_0 \right) + a_4 \cdot \dot{Q}_4^m(t-1)$$

where dotted variables are growth rates.

The consumer price influence, $\dot{cpi}$, was first estimated not to differ significantly from unity and

Table 4.4   <u>Values of parameters in price equations (standard set-up)</u>

Branch[a]	$a_{i2}=b_{i2}$	$a_{i3}=b_{i3}$
1, 18, 19, 22	1.0	0.0
2, 20, 21, 23	0.75	0.25
3-11, 13-17	0.5	0.5
12	0.0	1.0

[a] Names of branches are listed in Table 4.1.

Table 4.5   <u>Values of parameters in wage equation</u>

Variable	Parameter
Constant	2.63
$\dot{cpi}$	$1.0^{[a]}$
$(u-u_0)$	-4.14
$\Pi^m - \Pi_0$	0.56
$\dot{Q}_4^m$	-0.47

[a] Restricted

was therefore restricted in the final estimation the outcome of which is given in Table 4.5. Estimation procedure and results are reported in Jansson (1982) and will not be repeated here. Suffice it to emphasize that the full compensation for past consumer price increases, as well as the rather high absolute value of the labour market coefficient, is a bit exceptional and that parameters in these kinds of wage equations are notoriously instable.

As the wage inflation neutral "normal" unemployment (u_0) and manufacturing gross profit share (Π_0) we have in most simulations used 2 percent and 27 percent respectively.

The <u>ex ante choice of production technique</u> in manufacturing branches is based upon a constant elastic function in relative input prices (cf section 3.3)

$$Q^t_{m,i} = a_{m,i} \prod_n p_{n,i}(t-1)^{\alpha_{m,n,i}}; \quad \begin{array}{l} i=4,\ldots,17 \\ m,n=1,\ldots5 \end{array}$$

The $\alpha_{m,n,i}$:s are based on Dargay (1981) and are shown in Table 4.6. They are, however, modified in two ways. The first relates to the number of energy inputs where the estimates only covered energy as a whole at the time when figures were put into this part of the model. In order to, at least to some extent, account for possible substitution effects of changing relative prices for electricity and fuels energy elasticities were split in parts. On the disaggregated branch level elasticities of substitution between electricity and fuels on the one hand and other inputs on the other hand were simply assumed to be equal in

Table 4.6   Values of parameters in the functions for ex ante
choice of technique in manufacturing branches

		$\alpha_{m,n,i}$				
i	m/n	1	2	3	4	5
	2	-0.090	-0.390	0.0	0.120	0.360
	3	-0.090	0.0	-0.390	0.120	0.360
4	4	1.410	0.0	0.0	-1.620	0.210
	5	-0.240	0.060	0.060	0.540	-0.420
	2	1.440	-1.410	0.0	0.450	-0.480
	3	1.440	0.0	-1.410	0.450	-0.480
5	4	1.860	0.015	0.015	-1.950	0.060
	5	0.510	-0.045	-0.045	0.120	-0.540
	2	1.500	-0.450	0.0	-0.960	-0.090
	3	1.500	0.0	-0.450	-0.960	-0.090
6	4	1.770	-0.060	-0.060	-2.190	0.540
	5	-0.630	-0.015	-0.015	1.140	-0.480
	2	3.570	-2.940	0.0	0.300	-0.930
	3	3.570	0.0	-2.940	0.300	-0.930
7	4	1.290	0.015	0.015	-1.5690	0.270
	5	-0.090	-0.105	-0.105	1.080	-0.780
	2	1.650	-1.230	0.0	-0.240	-0.180
	3	1.650	0.0	-1.230	-0.240	-0.180
8	4	1.740	-0.030	-0.030	-1.830	0.150
	5	0.630	-0.030	-0.030	0.300	-0.870

$$\alpha_{m,n,i}$$

i	m/n	1	2	3	4	5
	2	0.900	-1.590	0.0	1.440	-0.750
	3	0.900	0.0	-1.590	1.440	-0.750
9	4	1.050	0.015	0.015	-1.260	0.180
	5	0.660	-0.015	-0.015	0.570	-1.200
	2	1.110	-1.530	0.0	0.450	-0.030
	3	1.110	0.0	-1.530	0.450	-0.030
10	4	0.930	0.015	0.015	-1.290	0.330
	5	-0.270	0.0	0.0	0.810	-0.540
	2	0.960	-0.780	0.0	-0.150	-0.030
	3	0.960	0.0	-0.780	-0.150	-0.030
11	4	1.680	-0.015	-0.015	-1.620	-0.030
	5	0.810	-0.015	-0.015	-0.060	-1.720
	2	1.650	-1.230	0.0	-.240	-0.180
	3	1.650	0.0	-1.230	-0.240	-0.180
13	4	1.740	-0.030	-0.030	1.830	0.150
	5	0.630	-0.030	-0.030	0.300	-0.870
	2	2.130	-1.920	0.0	0.030	-0.240
	3	2.130	0.0	-1.920	0.030	-0.240
15	4	1.650	0.0	0.0	-1.710	0.060
	5	0.510	-0.015	-0.015	0.240	-0.720
	2	1.500	-1.680	0.0	0.330	-1.500
	3	1.500	0.0	-1.680	0.330	-0.150
16	4	1.800	0.0	0.0	-1.950	0.150
	5	-0.030	-0.015	-0.015	0.510	-0.450

size. Moreover, changing as few estimated parameters as possible required that cross price elasticities between electricity and fuels to be zero. As estimates for different energy forms now are available on a disaggregated branch level these will be implemented in the next version of the model.

The second way in which we have modified the estimates arises from the ex ante - ex post disinction. The stimates are based on observed input coefficients for the whole production capacity in a branch. The response of these average coefficients to changing input prices is much weaker than the response in marginal additions to capacity. We assume that the influence from prices is increased by a factor three. All parameters in Table 4.6 are thus three times the estimated values.

None of these modifications are of course satisfactory. However, given the very scant empirical basis for the disaggregated ex ante functions some kind of ad hoc modifications along these lines are unavoidable.

Investments in manufacturing branches are explained by expected (past) profits and capacity utilization (cf Section 3.5):

$$g_i = k_i(t-1) \left[\sum_{j=1}^{4} \gamma_{j,i} \cdot ep(t-j)_i + d_i \right] ur_i(t-1)^{a_i}$$

The basis for the parameter values in Table 4.7 is found in Jansson (1981), which also provides the assumptions behind this specification of the investment function. The capacity utilization varia-

Table 4.7   <u>Values of parameters in investment functions</u>

Branch	$\gamma_{1,i}$	$\gamma_{2,i}$	$\gamma_{3,i}$	$\gamma_{4,i}$	$\sum_j \gamma_{j,i}$
4	0.0316	0.0000	0.0197	0.0000	0.0513
5	0.0000	0.0000	0.0322	0.0000	0.0322
6	0.0326	0.0739	0.0497	0.0285	0.1847
7	0.0470	0.0349	0.0104	0.0144	0.1067
8	0.0000	0.0101	0.0000	0.0175	0.0276
9	0.0838	0.0000	0.0163	0.0068	0.1069
10	0.0324	0.0124	0.0000	0.0000	0.0448
11	0.0119	0.0113	0.0000	0.0214	0.0894
13	0.0050	0.0291	0.0124	0.0000	0.0465
14	0.0132	0.0125	0.0433	0.0220	0.0910
15	0.0000	0.0201	0.0000	0.0235	0.0436
16	0.0753	0.0516	0.0000	0.0000	0.01269
17	0.091	0.0000	0.0000	0.0000	0.0917

ble is, however, added afterwards with the a_i:s assumed equal to 3.0 for all branches in the standard version of the model. Compared to an outright accelarator this is a fairly modest influence. Together with the price equations this will provide the model with stabilizing responses to disturbances that affects capacity utilization. A higher rate of utilization will on the one hand lead to higher prices thereby reducing demand, and to increased investments on the other, thus expanding capacity.

The distribution of <u>private real consumption</u> expenditures between consumer goods is explained by a linear expenditure system (cf Section 3.8):

$$c_i = [\gamma_i p_i^c c_i(t-1) + \beta_i (c_p - \sum_{k=1}^{14} \gamma_k p_k^c c_k(t-1)]/p_i^c$$

where $\sum_{j=1}^{14} \beta_j = 1$ and $i = 1, \ldots, 14$.

The consumption goods are listed in Table 4.3. Parameter values, which are given in Table 4.8, are estimated in Dargay (1981).

<u>Foreign trade</u> is explained by market size and relative prices (cf Section 3.6):

$$e_i = a_i^e \cdot \prod_{j=0}^{1} [p_i^e(t-j)/\theta \cdot p_i^w(t-j)]^{\beta_{i,1+j}} \cdot wm_i$$

and

$$m_i = a_i^m \cdot \prod_{j=0}^{1} [\theta \cdot p_i^w(t-j)/p_i^{xh}(t_{\bar{i}}j)]^{\gamma_{i,1+j}} \cdot h_i^{\gamma_{i,3}}$$

Table 4.8   Values of parameters in private con-
             sumption expenditure system

Consumer	β	γ
1	0.1081	0.9405
2	0.1135	0.7998
3	0.0717	0.9000
4	0.0110	0.9797
5	0.0041	0.9498
6	0.0000	1.0100
7	0.3025	0.2502
8	0.1116	0.7600
9	0.0716	0.8301
10	0.0920	0.8898
11	0.0110	0.9306
12	0.0362	0.8700
13	0.0602	0.6697
14	0.0065	0.9500

The export price elasticities are shown in Table
4.9. Only four export equations are based on esti-
mated parameters (indicated by * in the table) but
those branches nevertheless account for about x
percent of total export volume. Total elasticities
range from -1.0 to -2.0 with lower absolute values
assumed for export of services (except for export
of chemicals).

As shown in Table 4.10 65 percent of total import
volume are based estimated prices and market-elas-
ticities. Generally import is less sensitive to
relative prices than exports with textile and ma-
chinery as notable exceptions. Since there is no
indigeneous production of coal and oil imports are
purely complementary but is affected by substit-
ution with domestic energy.[4]

4.3   The solution algorithm

Since the number of equations is so large and
there are so many nonlinear relations between va-
riables, there is no way to explicitly express the
endogenous variables as functions of exogenous and
predetermined variables. Therefor it is not possib-
le to solve the model in one step but we need an
iterative procedure. The technique used in ISAC is
the Gauss-Seidel algorithm. This algorithm is ele-
mentary, very simple to implement and has proved
robust, efficient and cheap to use in terms of
computer time. Through the iterative procedure it
is also easy to add or detract equations without
bothering about the order in which they are comp-
uted, which variables are endogenous etc. This
possibility greatly increases the flexibility of
the model.

Table 4.9   Values of parameters in the export functions

Branches	$\beta_{i,1}$	$\beta_{i,2}$	$\sum_j \beta_{i,j}$	Share of total export volume[b] in 1980 (percent)
1-6,9,10 13,14,16,17	-1.0	-1.0	-2.0	17.9
7*	-0.56	-0.92	-1.48	2.7
8*	-0.82	-1.34	-2.16	19.8
11*	-0.71	-0.39	-1.10	6.2
15*	-1.55	-0.51	-2.06	38.4
20,21,23	-1.3	0.0	-1.3	12.6
12,18,19,22[a]	-	-	-	2.4

* Estimated parameters.

[a] Zero or exogenous exports

[b] At 1975 year's prices

Table 4.10   Values of parameters in the import functions

Branches	$\gamma_{i,1}$	$\gamma_{i,2}$	$\sum_j \gamma_{i,j}$	$\gamma_{i,3}$	Share of total import volume[c] in 1980 (percent)
8-10,13, 16,17	-0.5	-1.0	-1.5	1.5	8.0
4-6*[a]	0.0	-0.53	-0.53	1.88	5.6
7*	-0.87	-1.63	-2.50	1.49	8.1
11*	-0.67	0.0	-0.67	1.27	10.3
14*	-0.69	-0.76	-1.45	1.32	5.8
15*	0.0	-2.71	-2.71	1.88	34.9
20,21,23	-1,3	0.0	-1.3	1,5	8.2
3,12[a]	-	-	-	-	15.4
1,2,18,19,22[b]	-	-	-	-	3.7

* Estimated parameters.

[a] Imports of coal and oil is given directly by demand since no import competing domestic production exists.

[b] Zero or exogenous imports.

[c] Cif at 1975 year's prices.

Let us for descriptive purposes represent the ISAC model as a number of equation one for each endogenous variable as follows:

$$x_1 = g_1(x_1, x_2, \ldots, x_n, z)$$
$$x_2 = g_2(x_1, x_2, \ldots, x_n, z)$$
$$\cdot$$
$$\cdot$$
$$\cdot$$
$$x_n = g_n(x_1, x_2, \ldots, x_n, z)$$

where the x:s are endogenous variables and z is a vector containing all the exogenous and predetermined variables. The iteration starts with an initial guess of the x:s-normally the previous period's solution. Computing the right hand side of the first equation gives a new value of x_1 which substitutes the old value in the subsequent calculations. The second equation gives a new value of x_2, which substitutes the old value etc. This procedure is repeated through all n equations and is then started all over again from the first equation. It goes on until the process converges i e until the computed values of the x:s on the left handside are close enough to the old ones on the right hand side in the equation system above.

This method have proved to be very useful and robust for the type of models that ISAC represents and this is also the experience gained by the use of the MGM and LIFT models. For a more thorough discussion of the Gauss-Seidel method in connection with macro models, see Barker (1976).

Notes

[1] This is when local government expenditures are exogenous. In the present version of the expenditure model two of the six categories are put together.

[2] The exchange rate (θ) times world market prices in foreign currency (p^w) may differ from import prices because of tariffs as well as for aggregational reasons.

[3] The capacity utilization variable is omitted, cf section 3.12.

[4] Imports of branch 3 commodities is a mix of coal and other mineral raw material (excl oil). For simplicity, however, all imports are treated as complementary.

5 Stability

Having treated above in some detail the structure of ISAC we should now say something about the working and dynamic properties of the model. We emphasized already at the beginning that ISAC is better suited to analyze stability and stabilization problems than to deal with allocational or distributional policies because of its degree and form of aggregation. Without e.g. a sub-grouping of households and of private consumption, no serious incidence studies can be attempted. The situation is not quite so clearcut when it comes to long-term resource allocation. Structural change and productivity developments in manufacturing, shifting government shares in consumption and income formation are aspects of long-run economic adjustment which are explicitly recognized and analyzed in the model. The absence of financial markets, of an explanation of household saving and of regional dimensions still, however, makes it difficult to use the model for full-fledged studies of growth policies. What the model can be used for with advantage is studies of stability and of medium-term stabilization policies and their relation to growth and structure.

5.1 A pragmatic frame-work of stability
and control

Anyone setting out to study the stability properties of a real-life dynamic system like the Swedish economy is bound to become frustrated at the very start in trying to assemble a suitable conceptual

tool-box or frame-work. The stability concepts articulated and used in the mainstream of economic theory are so far removed from the dynamic problems of real economies as to be almost irrelevant to our purpose here. The systems treated in the literature are usually autonomous, i.e. time is not an essential variable. Stability definitions turn to empirically indetermnate concepts like "neighborhoods arbitrarily close to the origin" while any empirically useful stability concept should be concerned instead with the system staying within certain specified bounds. The systems usually discussed are moreover closed, i.e., do not explicitly contain exogenous variables like world market trade or stabilization policy instruments etc.

We are thus forced to make a detour in order to define our concepts. To make this detour as short as possible, the presentation or definition of the five different stability notions used will be sketchy and direct without any side-glances on existing literature.

To simplify the discussion let us assume that the ISAC-model could be represented by a system of first order difference equations[1]:

$$\Delta x_t = f(x_{t-1}, \ y_t, \ u_t, \ z, \ t)$$

where   x = endogenous variables

y = exogenous variables

z = system parameters

u = control variables ("policy instruments")

and   t = time

If we specify a development over time for exogenous variables ($\bar{y}$) and policy instruments ($\bar{u}$), and an initial position for the economy (x_o) we can solve the system of equations for a __growth path__ ($\bar{x}$).[2]

Let us now introduce our first "stability" concept by defining a __stable growth path__ as one for which growth rates of all endogenous variables are fairly constant:

$$\left| \Delta x_{i,t}/x_{i,t-1} - \Delta x_{i,s}/x_{i,s-1} \right| < \varepsilon_1 \; ; \; t_o < t, s < t_f$$

Our definition of stable growth should correspond to the use of that expression in common parlance but can not be applied strictly. It does not embrace all endogenous variables e.g. the balance of payments which, being a difference between external income and expenditure, obviously may show large relative changes. The definition should be applied only to "basic" endogenous variables such as volumes of production and demand, price indices and the like.

As stated several times before the ISAC-model does not assure strict equilibrium solutions in the sense that excess demand may arise in some markets for shorter or longer periods. These possible excess demands, E_j, will concern currency (the balance of payment), labor and __production__ capacity.

We can now define an __equilibrium growth path__ where all excess demands are limited:

$$\left| E_{j,t} \right| < \varepsilon_2 \; ; \; t_o < t < t_f$$

Equilibrium growth in the ISAC-model implies stable growth as we have defined the concepts. This is the rationale behind our almost exclusive analysis of excess demands in the model simulations that will be discussed below. Although the proposition is hard to prove strictly - because of the size and complexity of the model - it is intuitively reasonable and confirmed by extensive experimentation with the model. Assuming that values of exogenous variables and policy instruments does not exhibit large jumps it is e.g. obvious that production capacity equilibrium is sufficient for stable growth in output. This is so because of considerable inertia in capacity growth. Turning to the demand side of the model the composition of every category is fairly stable since no sudden relative price shifts between different goods are likely to occur given stable exogenous prices. Also equilibrium in the external balance assures no sudden shifts in domestic prices relative world market prices and hence no drastic shifts in exports and imports. Finally equilibrium in the labor market rules out sudden shifts in unit labor costs.

Although the model is not solved for equilibrium in some markets it contains adjustment mechanisms that tend to make market disequilibria bounded and keep them from reinforcing each other. These mechanism together with suitable choice of policy instruments assures that an equilibrium growth path is always possible to find. This will accordingly also be stable as defined above.

Next we want a measure of what we will call the resilience of the system, i.e. the ability of the system, to absorb outside shocks by itself or with-

out intervention in the form of policy changes. Given a stable growth path, $\bar{x}^*$, we introduce "disturbances" or major changes in some exogenous variables, while keeping everything else including the preset policy, unchanged. We call the system - or the specific growth path - resilient if it adjusts back to a stable growth path close to the original one:

$$| x_t(y_o+\Delta y_o) - x^*_t(y_o) | \leq \varepsilon_3 \; ; \; t \geq t_s$$

To quantify the concept of "degree of resilience" - and the same goes also for the other stability concepts introduced below - we obviously need to answer at least four kinds of questions. How big, relatively speaking, is the disturbance and where is it located in time and place? How long does it take - and at what amplitude of fluctuations - to bring back growth into a stable pattern? How big are the "stabilization" costs, measured in terms of some social "loss function"? How big is the following growth loss, if any, measured by that same function?

In the next step we assume that the resilience of the system is not sufficient, so that explicit policy intervention must be brought about to counteract the external disturbance.

We call the system <u>controllable</u> or <u>manageable</u> if there always exists a policy packet, $\bar{u}$, that will bring the system back close to the original undisturbed growth path:

$$| x_t(y_o+\Delta y_o,\bar{u}') - x^*_t(y_o,\bar{u}) | \leq \varepsilon_4 ; t \geq t_s$$

Given a "loss function", defined in terms of well
fare effects of growth paths as well as political
costs of policy measures, optimal policies can be
defined. No explicit loss function is however in-
tegrated in the model but far less sofisticated
measures such as total private consumption, real
wage rate, tax rates etc. are used to compare
different policies. The reason is twofold. First-
ly, the specification and estimation of a compre-
hensive social loss function is no easy task.
Secondly, a strict optimization would require seve-
ral iterations over possible policies and there-
fore significantly greatly increase computer time.

So far we have taken the model structure, Z, as
given. If we take into account the possibility of
changes in the system parameters we can define
<u>structural stability</u>:

$$|x_t(Z+\Delta Z)-x_t^*(Z)| \leqslant \varepsilon_4 \; ; \; t \geqslant t_s$$

that is small exogenous changes in Z at a given
time - i.e. "sensitivity tests" - will only pro-
duce small shifts in the growth path.

Finally one may think of a system exhibiting a
learning behavior in the sense that structural
parameters are allowed to change as a consequence
of shifts in exogenous variables. Such a learning
property can be stabilizing as well as destabiliz-
ing. In the former case we will call the system
<u>adaptive</u>, defining the concept as

$$|x_t(y_o+\Delta y_o,Z_t')-x_t^*(y_o,Z_t)| \leqslant \varepsilon_5 ; t \geqslant t_s$$

From the definitions it is obvious that resilience
is a more restrictive concept of stability than

adaptiveness. However the difference between the
concepts can to some extent be attributed to the
level of aggregation in the model.

To return to a stable growth path after some dis-
turbance in world markets an adaptive parameter
shift may be required for instance in export and
import functions. In a more disaggregated model
this parameter shift may correspond to redistribu-
tions of export- and import shares between goods
with parameters in the functional relationships
unchanged. The latter disaggregated system would
then be said to be resilient.

After this very cursory introduction of stability
concepts let us try to illustrate them by some
simple applications on the ISAC-model.

5.2 Stable growth and resilience

To ease an understanding of the stability behavior
of the model let us first recall some of its
fundamental properties. There are three main types
of markets where disequilibria or excess demand
may occur. Production capacity may differ from the
quantity actually produced, the unemployment rate
may be higher or lower than the rate assumed to be
caused by frictions in the labor market, and final-
ly, foreign payments on current account may not
balance, indicating an over- or undervalued curren-
cy.

For the first two of these disequilibria the model
includes relations that tend to reduce deviations
from "normal" values. If capacity falls short of
demand, the reaction will be both to limit the

increase in demand and to expand production capac-
ity. To keep down the demand increase the price
and wage equations are of great importance. The
increased production will push up capacity utiliza-
tion. This gives a direct upward pressure on
supply prices. But there is also an indirect price
effect. The increased demand will reduce unemploy-
ment below "normal" levels and wages will raise
faster than otherwise.

Although producers are not assumed to use pure
mark-up prices some of the wage inflation will be
passed on to consumers. Increased demand will thus
to some extent transform into higher prices. There
will also be a tendency to expand capacity through
investments, which will increase, ceteris paribus,
when producers become short of capacity. Produ-
cers' prices will respond to demand increases af-
fecting utilization ratios in the short run, but
it may take several years before capacity, growing
through higher investment, will catch up with pro-
duction to reach "normal" utilization ratios.

The third disequilibrium, the current account,
does not set directly in motion any balancing
forces. The exchange rate is assumed fixed or
rather exogenously determined and is included in
the set of control variables used to steer the
model (cf. section 5.3).

With this in mind we can go on to construct first
of all a stable growth path, that can then serve
as a reference path for the evaluation of system
resiliance when outside disturbances occur. To
simplify the example the local government submodel
has not been used, making all government consump-
tion exogenously determined.

World market development and other exogenous va-
riables for the period studied, 1980-2000, have
been chosen from current Swedish projections, also
used by us in other model simulations (cf. Nord-
ström - Ysander 1981 for a detailed discussion of
the assumptions). The model economy has then been
steered through the eighties by use of tax and
wage policy into a "turn-pike" 1990, characterized
by narrowly bounded excess demand on the markets
concerned as shown in Figure 5.1. New permanent
values have then been set for the policy variab-
les, so that the growth path during the nineties
remains stable in this sense. (The steering techni-
que will be further discussed in section 6.3)

This is indicated by Figure 5.2 where growth rates
for some aggregated real and price variables is
given. The short run fluctuations in the beginning
of the eighties are mainly due to the need to
restore profit margins in industry. During the
rest of the decade the slow growth of private
consumption is explained by the need to restore
the external balance. Having achieved that in 1990
(cf. Figure 5.1) taxes can be relaxed to let priva-
te consumption grow at a one percentage point
faster rate than during the second half of the
eighties. (Public consumption growth is assumed
equal during the whole simulation period):

Generally Figures 5.1-2 show that variations in
growth rates of endogenous variables are fairly
small if exogenous variables and policy instru-
ments are given, and that there are no tendencies
for the solution to "explode". More specifically,
the figures indicate that possible excess demand
can be kept within certain limits and that this
implies a stable growth path during the same

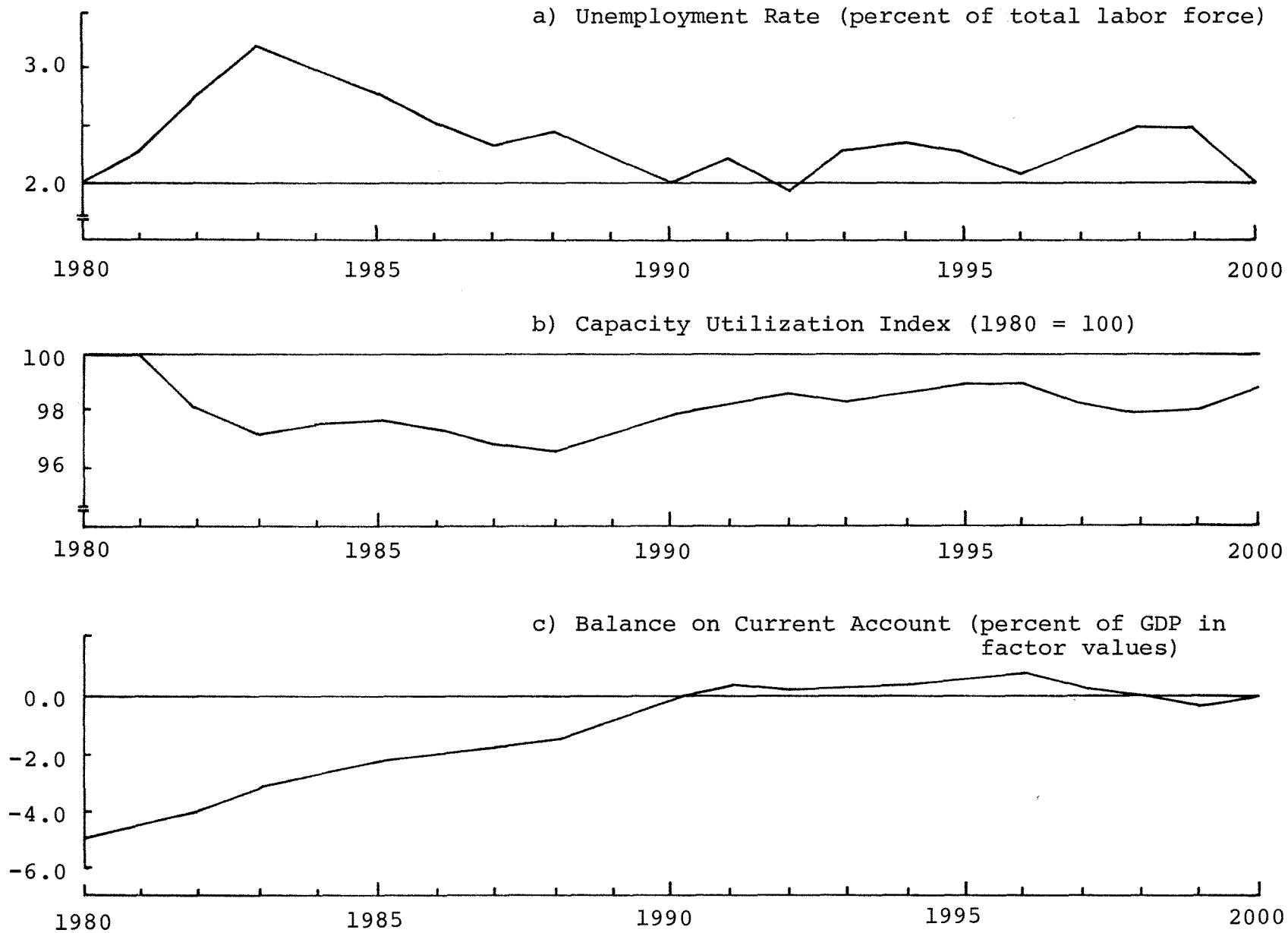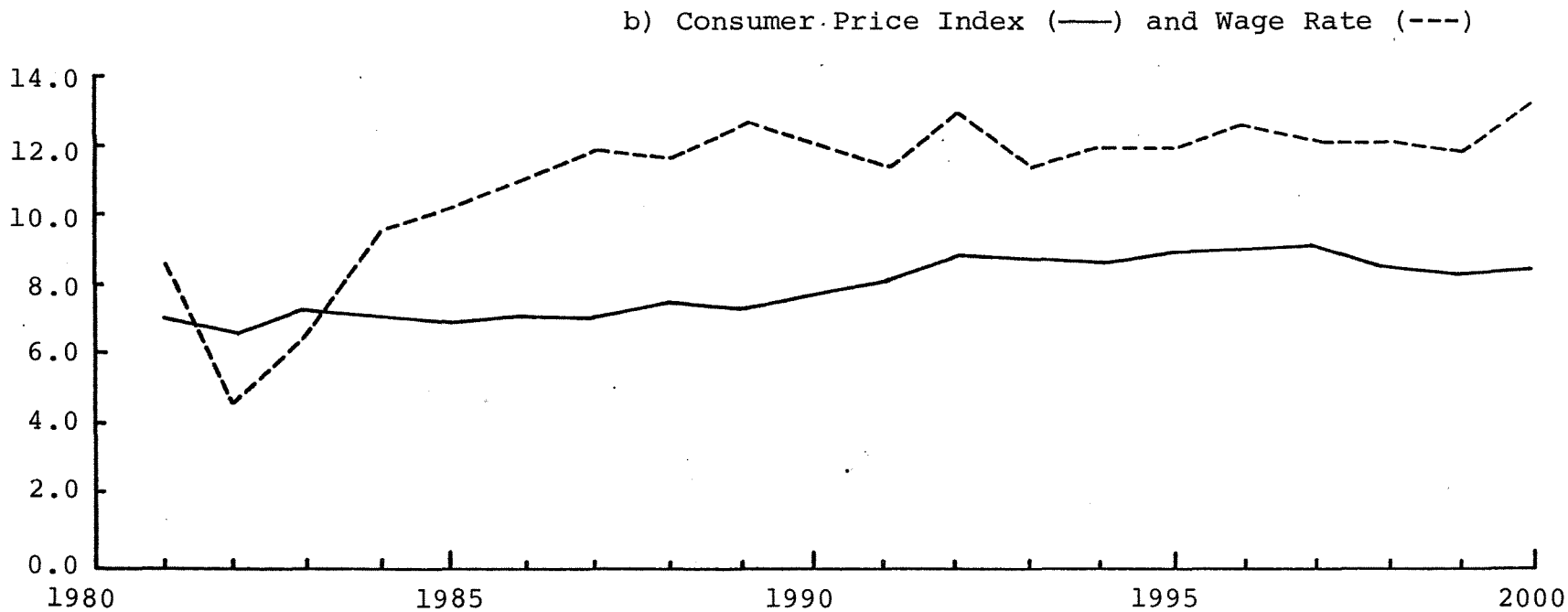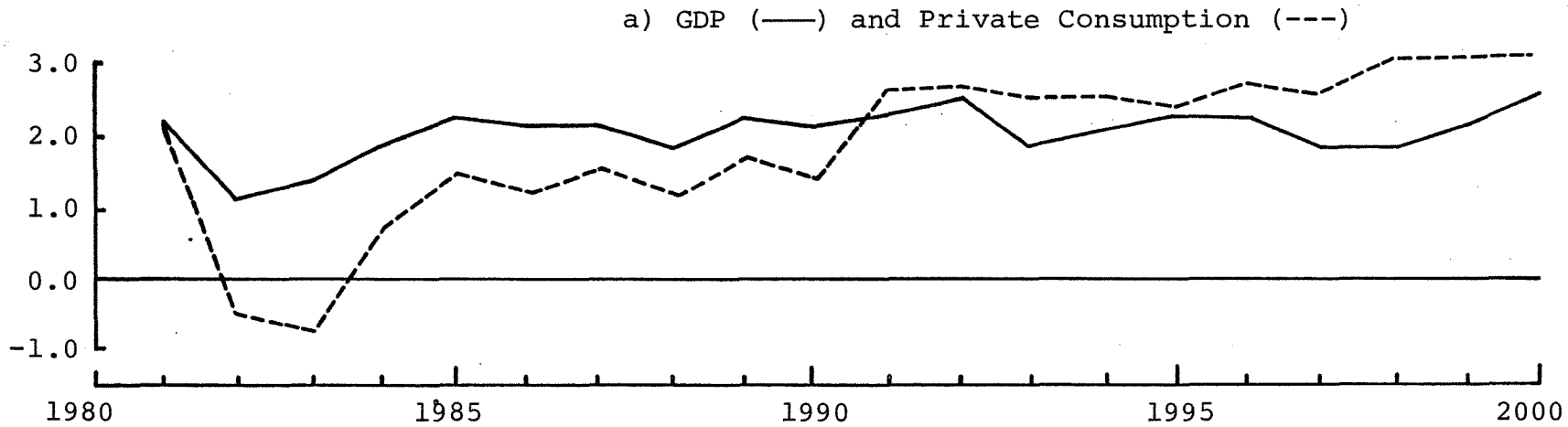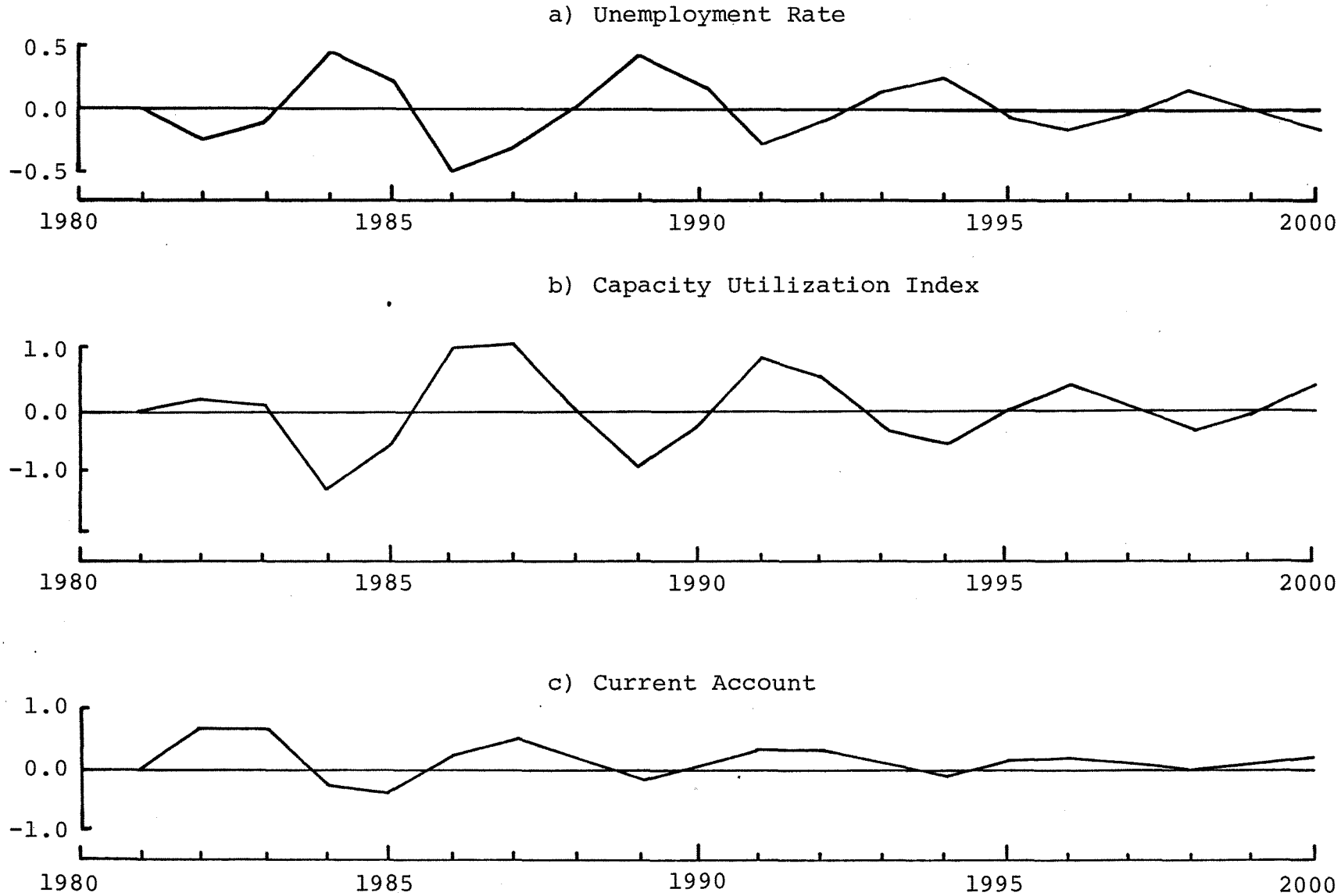Figure 5.1   The Reference Case

a) Unemployment Rate (percent of total labor force)

b) Capacity Utilization Index (1980 = 100)

c) Balance on Current Account (percent of GDP in factor values)

Figure 5.2 The Reference Case
(Percentage increase per year)

a) GDP (——) and Private Consumption (-----)

b) Consumer Price Index (——) and Wage Rate (-----)

period. In the stability experiments discussed in
the rest of the chapter we will therefore be con-
tent to show only excess demand diagrams.

In the first resilience test, we assume a 5% jump
upwards in world market prices in 1981/82 compared
to the reference case. The higher price level is
assumed to persist implying equal growth rate
during the rest of the simulation period. Public
policy remains unchanged, since we want to study
the "self-correcting" mechanisms in the system.
The result is shown in Figure 5.3 as deviations
from the reference case in the three "excess
demand" markets. The immediate effect will be im-
proved profits in export companies. However, there
will also follow increased net demand from abroad
since producers will partly take advantage of
their improved relative cost position by capturing
market shares. The current account will be impro-
ved by more than one half percent of GDP in 1982
and 1983 compared to the reference case. This
development will, however, bring about reactions
in the labor market and in the production system.
As a consequence of increasing pressure from the
demand side, wages and prices will shift upwards.
The imported inflation in 1982 will add to infla-
tion expectations and make wage inflation in 1983
even more severe. This price-wage spiral will re-
verse the process described above and will lead to
unemployment and overcapacity in industry and so
forth. As shown in Figure 5.3 the induced cycles
will be gradually weakened and the economy will
stabilize itself around its new long run equilibri-
um growth path. In this particular case the only
persistent effect is of course a 5% rise in all
price levels relative to the reference case.

Figure 5.3   Effects of Permanent 5 % World Price Increase 1982
              (Difference from Reference Case)

a) Unemployment Rate

b) Capacity Utilization Index

c) Current Account

In the second resilience test the economy is expo-
sed to an overall 5% increase of world market
growth relative to the reference case in 1981/82.
The story is told in Figure 5.4. In this case net
export demand is affected directly without any
improvement in relative prices. The same mecha-
nisms as before will however produce reactions
from the price side to hold back demand.

The fluctuations will fade away within a few years
in this case but there will persist a surplus on
current account even during the nineties. The
model economy will accordingly not absorb this
kind of exogenous disturbance and return to equili-
brium growth. The reason for this is obvious since
the exchange rate is exogenous and thus remains
the same as in the reference case despite the
significantly improved world trade. With floating
exchange rates the current account surplus would
have brought about currency appreciation.

The fact that not all excess demands vanish after
a world trade disturbance does however not necessa-
rily rule out the stability of the corresponding
growth path as defined in section 5.1. This is
indicated by Figure 5.5. Although effects of the
disturbance on prices and quantities is registered
for the whole simulation period they will fairly
soon be confined to small deviations from the
reference growth path.

In the simulations accounted for above we tested
the resilience of the model for permanent shifts
in world market variables. Figures 5.7-8 show the
results of temporary disturbances of the same va-
riables, i.e. the initial 5% extra growth in 1982
will be followed by a 5% fall two years later as

Figure 5.4   Effects of Permanent World Trade Increase 1982
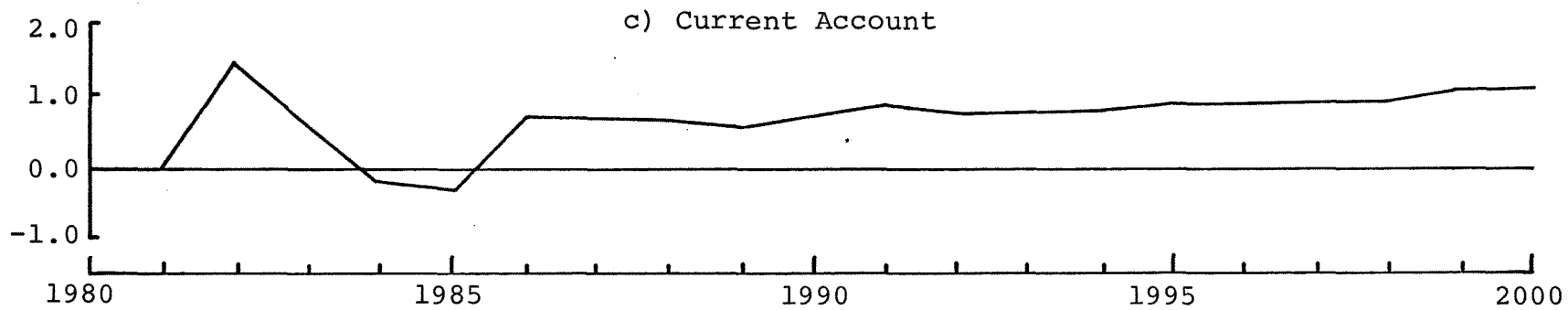   (Difference from Reference Case)

a) Unemployment Rate

b) Capacity Utilization Index
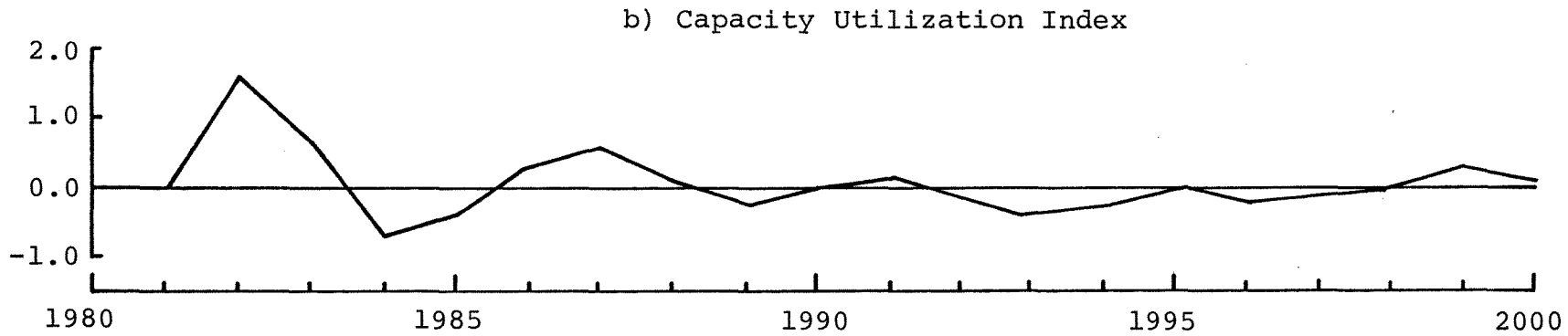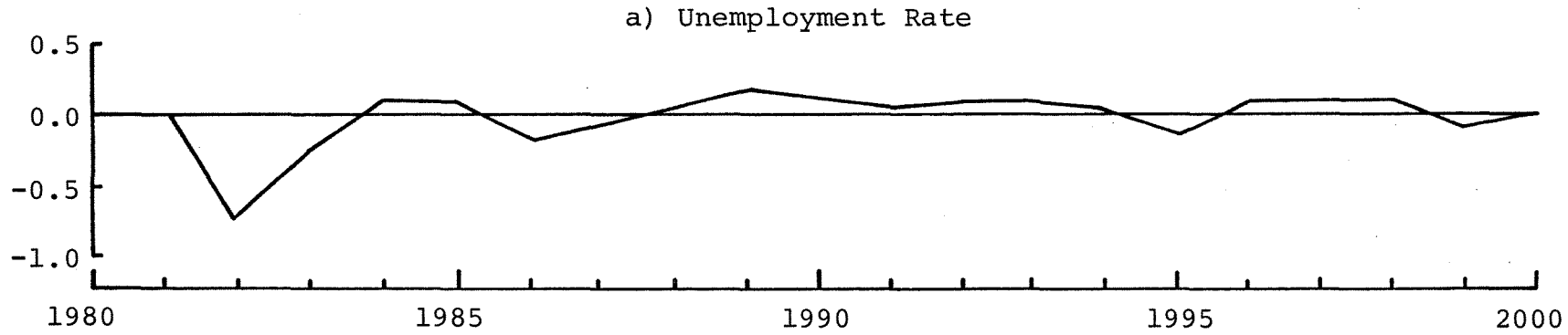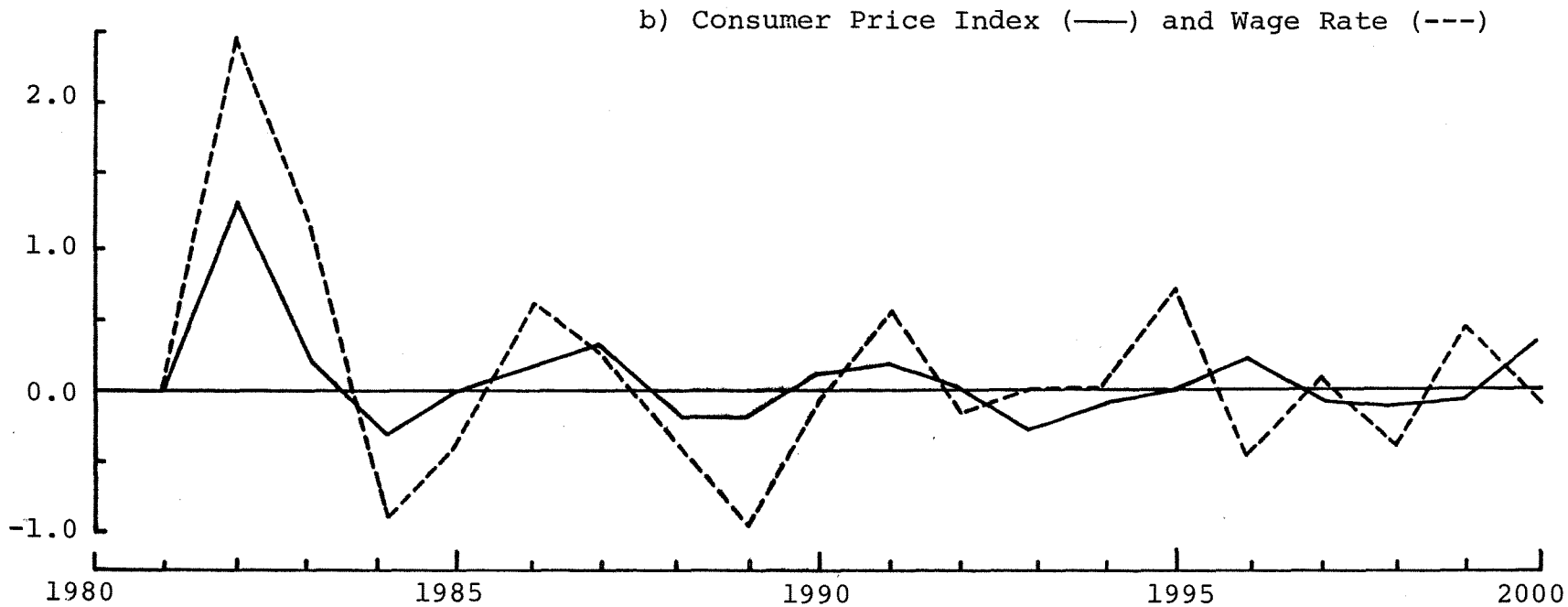

c) Current Account

Figure 5.5   Effects of Permanent 5 % World Trade Increase 1982
             (Growth Rate Differences from Reference Case)

a) GDP (———) and Private Consumption (———)

b) Consumer Price Index (———) and Wage Rate (———)
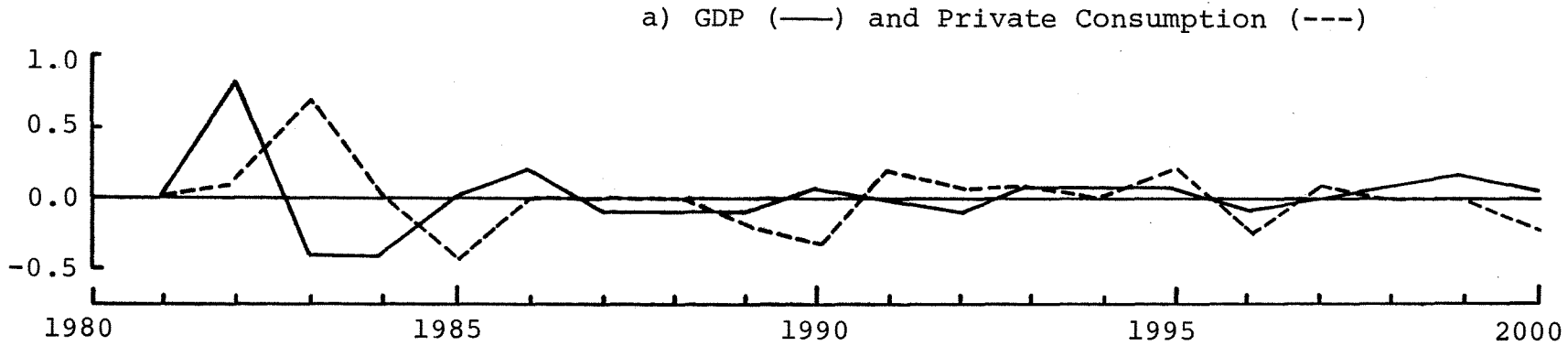
compared to reference case growth rates. Although
the excess demand cycles are clearly amplified in
this case - especially when it comes to the world
price disturbance - the oscillations still are
smoothed out over time. However Figure 5.6 also
indicates that current parameters in the model may
not be too far from producing non-damped excess
demand cycles, at least in response to certain
kind of external price disturbances. Finally we
may note that this time the system will resume
equilibrium growth even in the face of a trade
disturbance. The balance on current account given
in Figure 5.7 will show no persistent surplus
since the level world trade does not differ from
the reference case as from 1984.

5.3 Controlling the model

The need to steer the model solutions arises from
the desire to compare the outcome of equilibrium
growth paths under different external conditions.
E.g. how will the space for consumption be affec-
ted by higher oil prices given that it is possible
to preserve equilibrium growth?

As is obvious from the previous section equilib-
rium growth is not assured in the model even in
the long run, if parameter values are held con-
stant. If however some of the model parameters are
assumed free to change during a simulation it is
always possible to attain equilibrium growth. This
set of parameters are called policy instruments,
control parameters or the like, and are chosen to
correspond as much as possible to instruments used
in actual economic political decision making. In
the present version of the model the following
main instruments are avilable:

Figure 5.6   Effects of Temporary World Price Increase 1982-84
(Difference from Reference Case)

a) Unemployment Rate
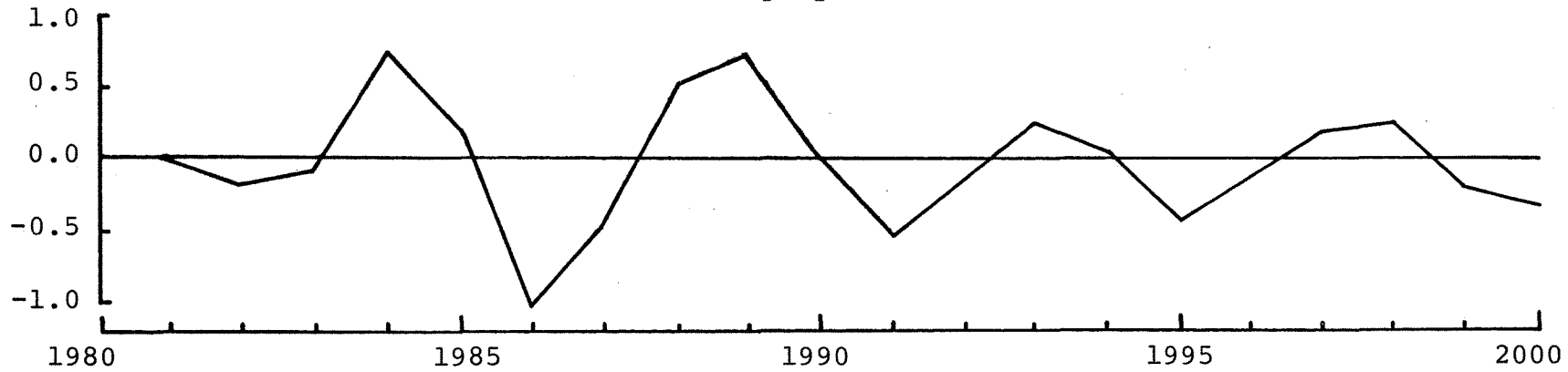
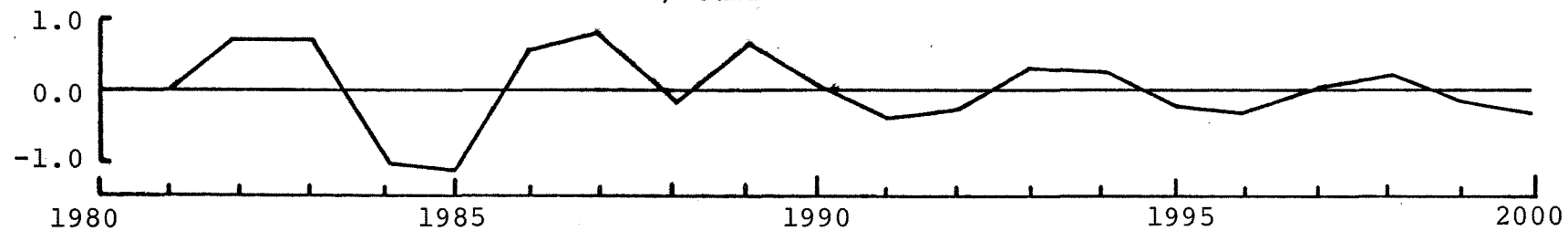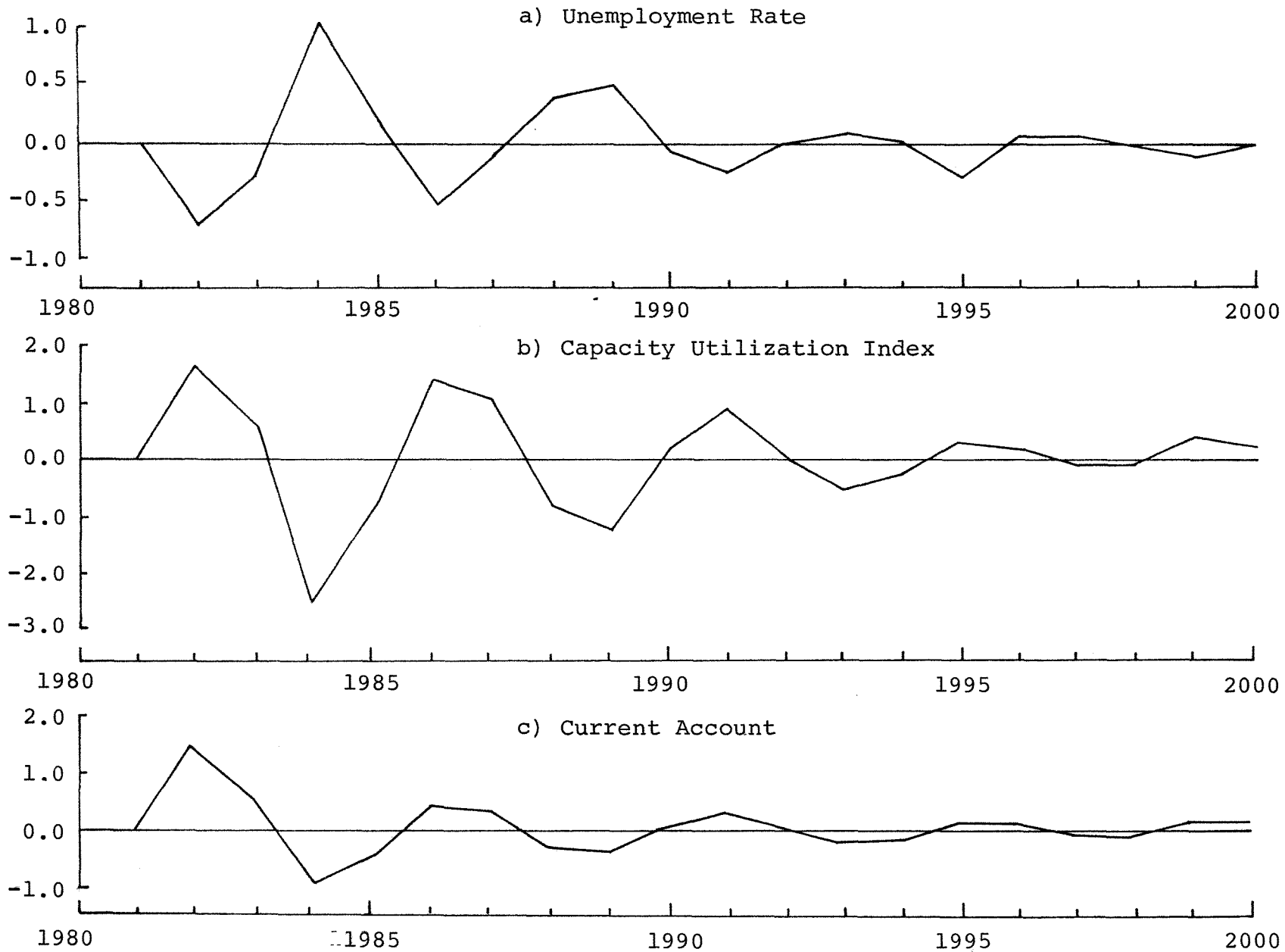b) Capacity Utilization Index
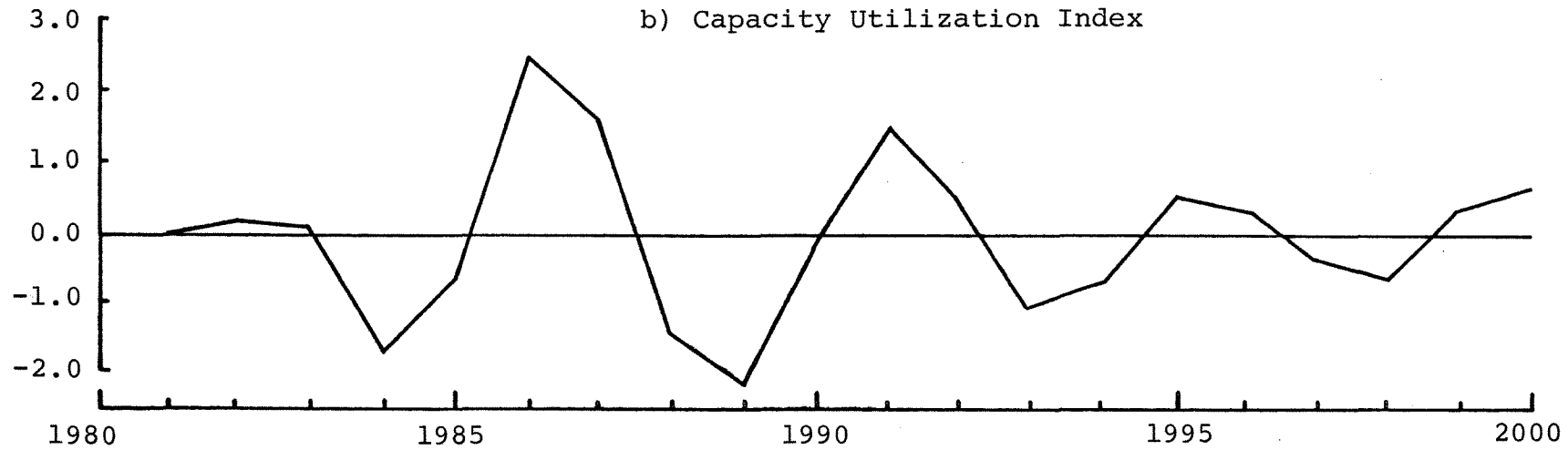
c) Current Account

Figure 5.7   Effects of Temporary 5 % World Trade Increase 1982-84
(Difference from Reference Case)

a) Unemployment Rate

b) Capacity Utilization Index

c) Current Account

- parameters in the income tax function
- wage tax rate
- exchange rate
- central government consumption and grants
- autonomous wage rate increase

Needless to say the correspondence between model and real life instruments is not exhaustive. Since the model i.a. does not explicitely include financial markets no monetary policy instruments are present.

One may of course also have reasonable doubts about how far the variables listed above are really available as policy instruments. The wish to use control variables analogous to those used in actual decision making has in fact been an important reason for including some submodels, such as the local government model, and for the fairly detailed treatment of taxes and transfers in the household sector model. The traditional treatment of e.g. the local government sector growth as an instrument for macro policy is obviously unsatisfactory since such an instrument simply is not available for central government decision making. The local government submodel makes it possible to affect local growth by i.e. changing grants to local authorities. When it comes to wages som kind of control is simply assumed. Note however that the wage rate control is assumed indirect through the constant term in the wage function (cf. section 3.13). "Uncontrolled" short term fluctuations in the wage rate are still possible.

Before describing the effects of different policy measures in the model a few words must be said

about how they are used. Since the model is solved year by year it would be possible to change control every year. For practical as well as theoretical reasons this is however not done. Suffice it to say that important short term mechanisms still are lacking in the model, e.g. inventory functions-, and that credit markets are not yet explicit in the model. A certain setup of policy variable values are instead assumed to be maintained for several years - in most applications of the model five or ten years. The use of control variables in the model should for that reason be seen as medium term guide lines to economic policy without regard to short term fluctuations.

Figure 5.8 shows the ten year effects of four policy instruments in terms of unemployment rate and balance on current account (as percent of GDP). The arrows show the difference in unemployment rate and current account (as percentage of GDP) between a reference simulation, PO, and simulations with different values of policy parameters. All differences are measured for the single year 1990 only. For example, the arrow P1 gives the effects in 1990 of a gradual shift upwards of the personal income tax scale during the eighties. As can be seen from the figure this will improve the current account compared to the reference simulation outcome in 1990, while leaving the unemployment rate unaffected. The immediate impact of increased taxes is to depress private consumption, which will save imports and improve the current account. The fall in domestic demand will almost totally be compensated by external demand stimulated by improved relative prices due to less pressure on the labor market and hence on wages.

Figure 5.8   Ten Year Effects of
              Policy Instruments
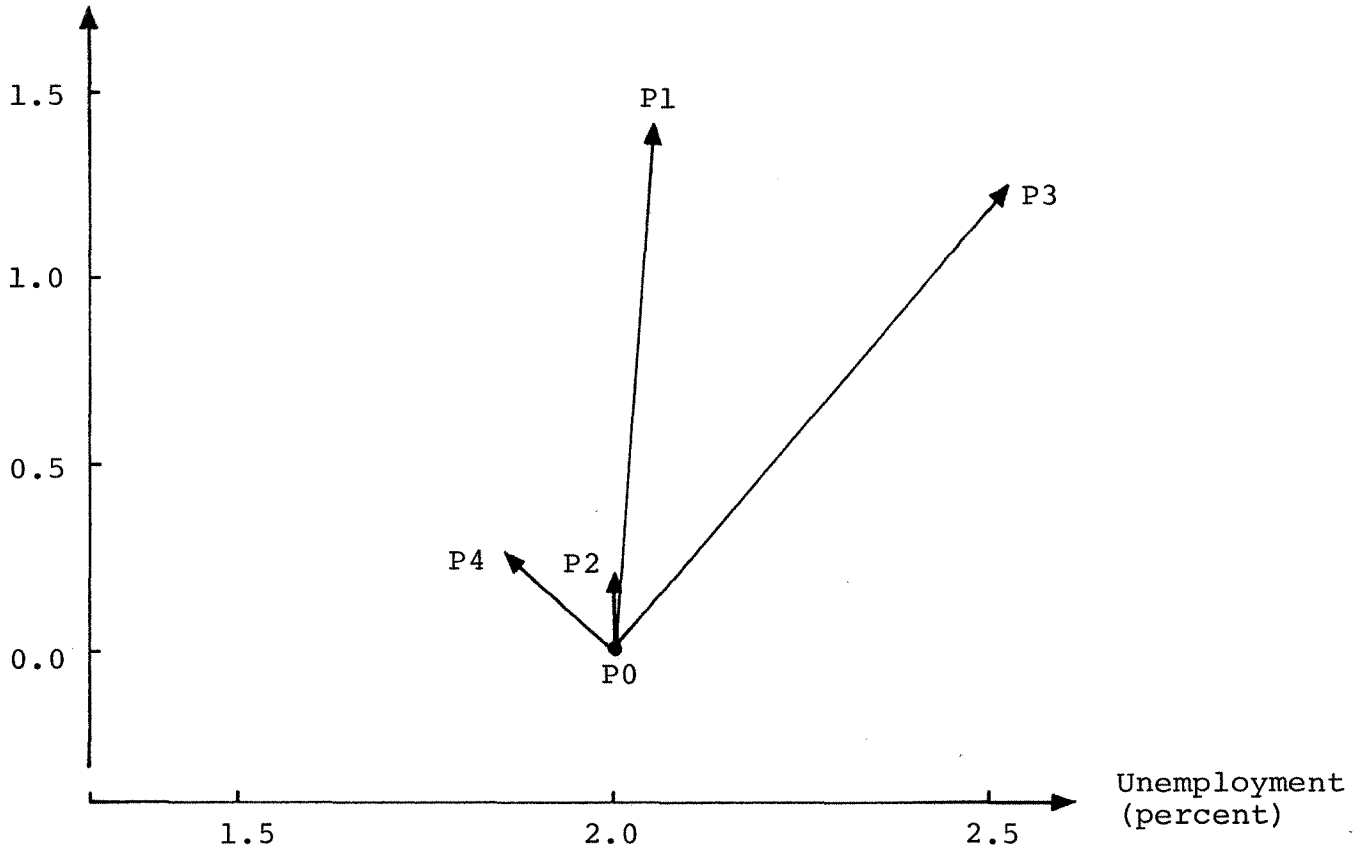
Pl: Upward shift of income tax scale by 0.5 percentage
    points   every year 1981-90

P2: Depriciation of currency by 1 % per year 1981-90

P3: Public consumption growth rate decreased by 0.5
    percentage point for the period 1981-90

P4: Autonomous wage trend decreased by 1 percentage
    point for the period 1982-90

Besides tax policy domestic demand can be directly
affected by control of public consumption growth.
The arrow P3 shows the effect of a growth rate
decrease by one half of a percentage point during
the eighties compared to the reference case. Like
P1 which reduces private consumption, this will
improve the external balance while increasing unem-
ployment. The unemployment rate will however be
considerably larger given a certain improvement on
current account. The reason is of course that the
tax increase will in itself reduce imports through
reduced private consumption, while public consump-
tion variations have small direct effects on imp-
orts. In this case the whole external improvement
will be indirect and caused by higher unemployment
rates which will reduce wages thereby improving
external competitiveness but also reducing house-
holds income and consumption.

The two measures P2 and P4 are aimed directly at
relative wage and cost conditions. With the wage
function that is used (cf. sections 3.13 and 4.2)
devaluations of the currency will be of little use
to affect the external or internal balance since
it will only produce domestic compensatory infla-
tion responses. Reducing the "autonomous" wage
growth will, on the other hand, obviously affect
current account as well as employment positively
as shown by P4.

Some words of caution should be said about the
interpretation of the "effect-arrows" in Figure
5.8. To begin with, since ISAC is a dynamic model
the effects of policy measures of the kind discus-
sed above will not be constant over time. What is
important to our interpretation and use of these
parameters as control variables is however only

that after some years the effects will stabilize
around some fixed level or rate of change. Figure
5.9 gives the development over the eighties of the
four policy measures shown in Figure 5.8. Although
there are evident cycles in some variables avarage
levels seems fairly stable and the amplitudes are
small. Therefore we feel rather safe to pick a
single year to represent the effects of different
policy measures. As shown in Figure 5.9 however
there may occur shifts in the effects between
policy instruments even after the initial impact
phase. In the particular simulations shown in the
figure this relates primarily to currency and wage
policy respectively. Much of the crossings of the
effect curves P2 and P4 however have other causes.
The wage rate is exogenous in 1981 for technical
reasons implying that wage policy is in fact not
initiated before 1982. An appropriate picture of
the stability of policy effects is obtained if the
wage policy curve, P4, is shifted one year bac-
kwards in both diagrams.

A second point to bear in mind in connection with
the policy effects as shown in Figure 5.8 is the
difficulty to compare the power of different
policy measures. Generally the length of the
arrows can not be used for such comparisons since
one also has to consider the policy parameter
changes behind them. Strict evaluation requires a
social loss function to be specified. However one
kind of conclusion as to the usefulness of diffe-
rent measures can be drawn. Assume that the model
economy initially is out of balance in 1990. To
move it back to an equilibrium solution in terms
of the currency and labor markets generally two of
the control variables must be used. From Figure
5.8 it is obvious that changes in income taxe and

Figure 5.9   Policy Effects during the Eighties.
              Difference from the Reference Case
              in Percentage Points

a) Unemployment Rate

b) Current Account
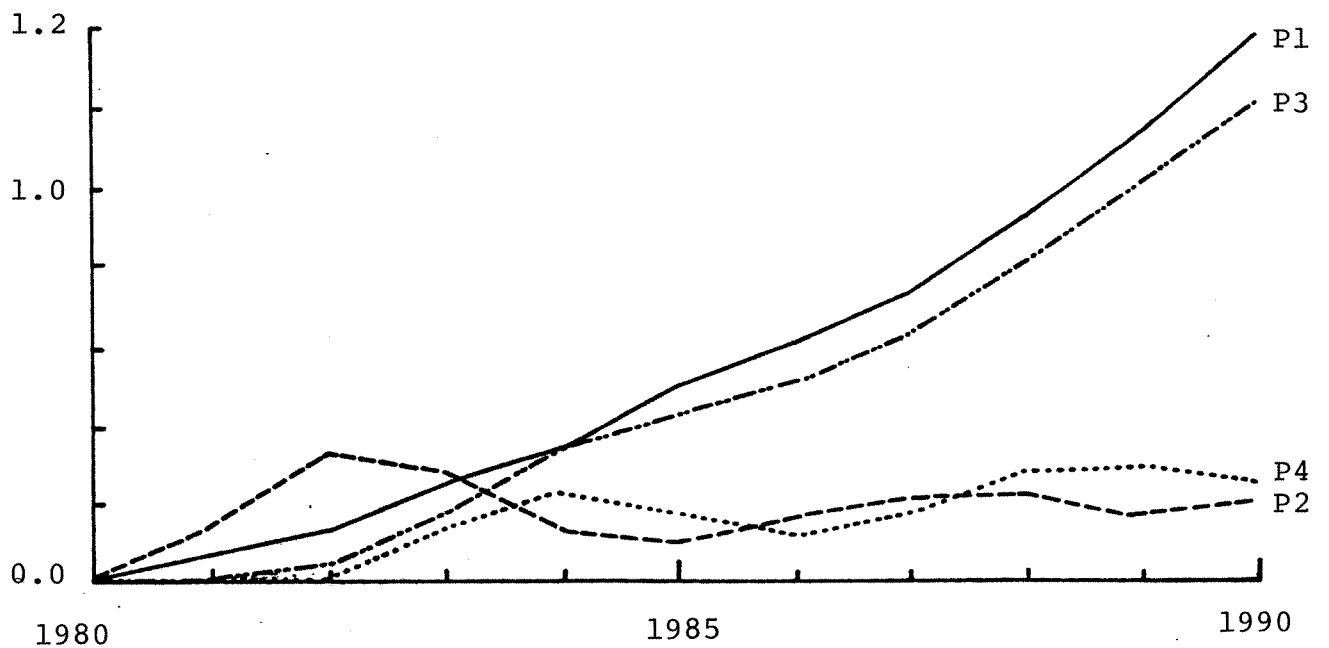
exchange rate are rather ineffective to influence
employment levels. A policy packet consisting of
only these two measures can not therefore cope
with excess demand in the labor market as the
model is specified. It is also indicated by Figure
5.8 that a combination of wage policy and public
consumption control may be the most effective
policy packet. The fact that their effect arrows
runs almost perpendicular makes it possible to
reach an arbitrary shift in unemployment and cur-
rent account with lesser changes in policy parame-
ters.

Finally, as have been indicated several times
before, there is no outright optimization procedu-
re used in controlling the model. The rough method
used to measure the effects of e.g. different
world market conditions is to steer the model to
an equilibrium solution in the currency and labor
markets, checking off the capacity gap, and then
to read off the differences over time in relevant
variables including the policy parameters. Of
course this introduces some degree of arbitrari-
ness into the analysis but seems to us to be the
practical way to use such a large model as the one
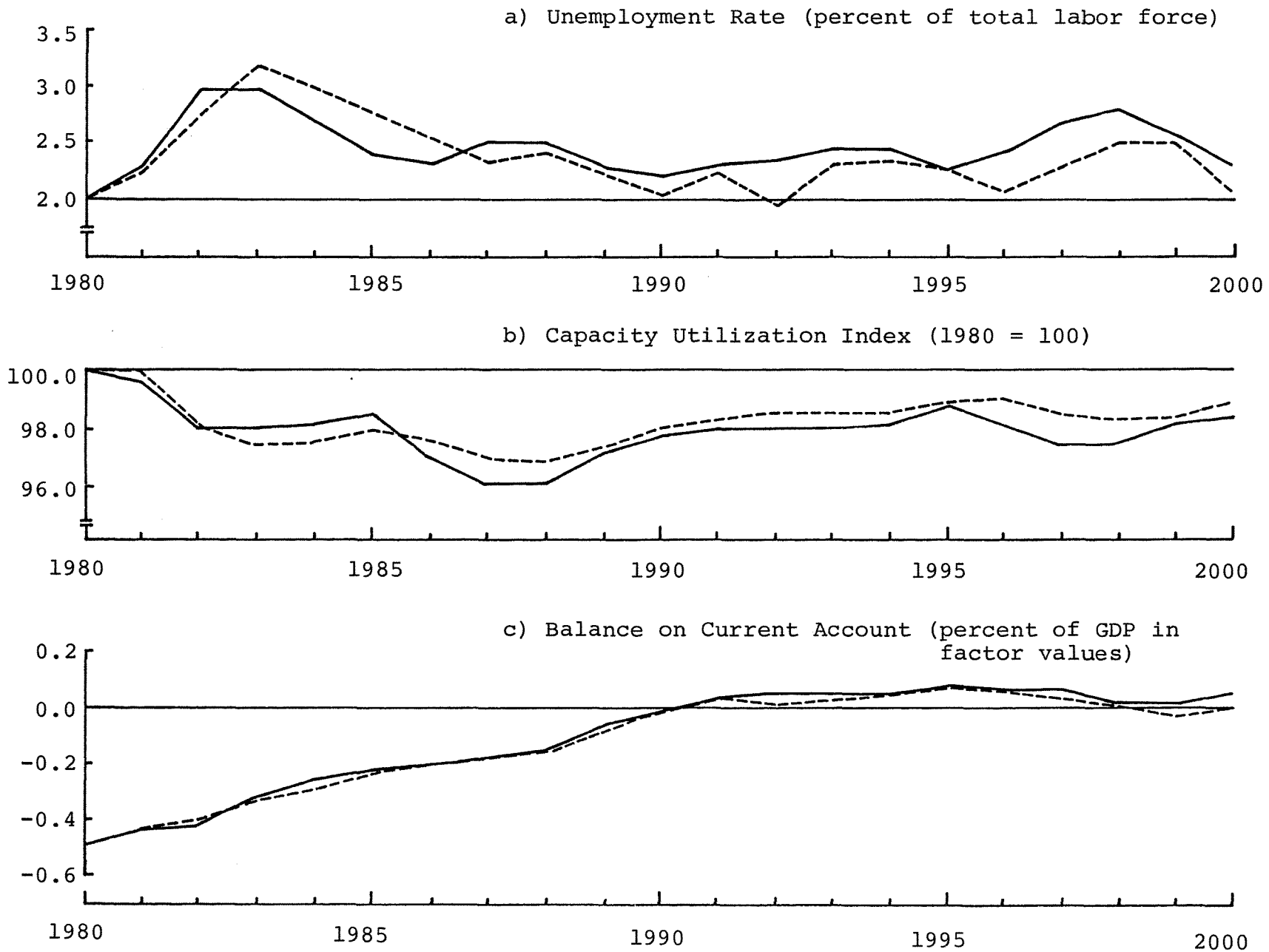described here.

5.4 Structural stability

The concept of structural stability is a more
tricky notion than it looks at first sight. To
make sensitivity tests of structural coefficients
around a given simulation path is a standard proce-
dure for any conscientious modeler. In the case of
ISAC it is intiutively obvious that the model is
structurally stable in the narrow sense that the

absence of explicit discontinuities in the model guarantees that small isolated changes in the coefficients will only result in small displacements of the simulated growth path[1].

We will illustrate this statement by three tests where some strategic parameters are changed. These relates to (A) the price setting behavior of manufacturing companies, (B) the price responsiveness of foreign demand for Swedish goods and services and, finally, (C) the extent of compensation for past inflation in wage formation.

In the first test (A) manufacturing companies are assumed pay more attention to domestic production costs than to world market price developments in setting their prices than in the standard model set up. More precisely the elasticity of prices with respect to unit costs is increased from 0.5 to 0.75 for manufacturing branches and the elasticity with respect to world market prices correspondingly reduced from 0.5 to 0.25 (excl. branch No. 12, cf. section 3.12 and Table 4.4). As can be seen from Figure 5.10 the effects on the equilibrium growth path in terms of excess demands are rather insignificant. The initial impact will be a small deterioration in utilization of resources compared to standard assumptions since the initial unfavorable cost development will to a larger extent push up export prices and thus weaken real foreign demand. However when wage and cost increases are slowed down after a couple of years the positive effects on export prices and competitiveness will be felt implying reduced unemployment and improved external balance. Dirrerences from the standard case will exist through the whole simulation period but will remain small.

Figure 5.10 Increased Cost Influence in Price Setting (A). Standard Assumption Given by Dashed Lines

a) Unemployment Rate (percent of total labor force)

b) Capacity Utilization Index (1980 = 100)

c) Balance on Current Account (percent of GDP in factor values)

In the second structural stability test (B) the immediate foreign demand response to Swedish export prices is increased. More specifically the short run elasticity of exports with respect to relative price is on avarage about 2.2 compared to 1.2 in the standard set up. The result is shown in Figure 5.11. Obviously excess demands are also in this case confined to a fairly narrow region around the reference equilibrium growth path, although fluctuations seems to increase somewhat. This is what should be expected since small changes in prices will tranform into a larger change in real demand (from abroad) than in the standard set up.

In the last structural test (C) the koefficient variation will on the other hand have a stabilizing effect. In this test the degree of compensation for (past) inflation in the wage function was reduced from 1.0 to 0.75 (cf. section 4.2). This will reduce the rate of unemployment "needed" to break the tendency to self sustaining wage inflation implied by the specification of the wage formation in the model. As is seen in Figure 5.12 the reduced compensation also permits the economy to increase the long run employment level through reduced real wages and improved competitiveness on world markets. Still the corresponding growth path is stable.

However given the likely structural stability of the model one may wish to penetrate further into the effects of different coefficient assumptions. This will be done below on basis of the three types of parameter changes discussed earlier in this section. The coefficient assumptions will be compared with respect to the developement of priva-

Figure 5.11   Increased Price Response in Foreign Markets (B).
                Standard Assumption Given by Dashed Lines

a) Unemployment Rate (percent of total labor force)

b) Capacity Utilization Index (1980 = 100)

c) Balance on Current Account (percent of GDP at
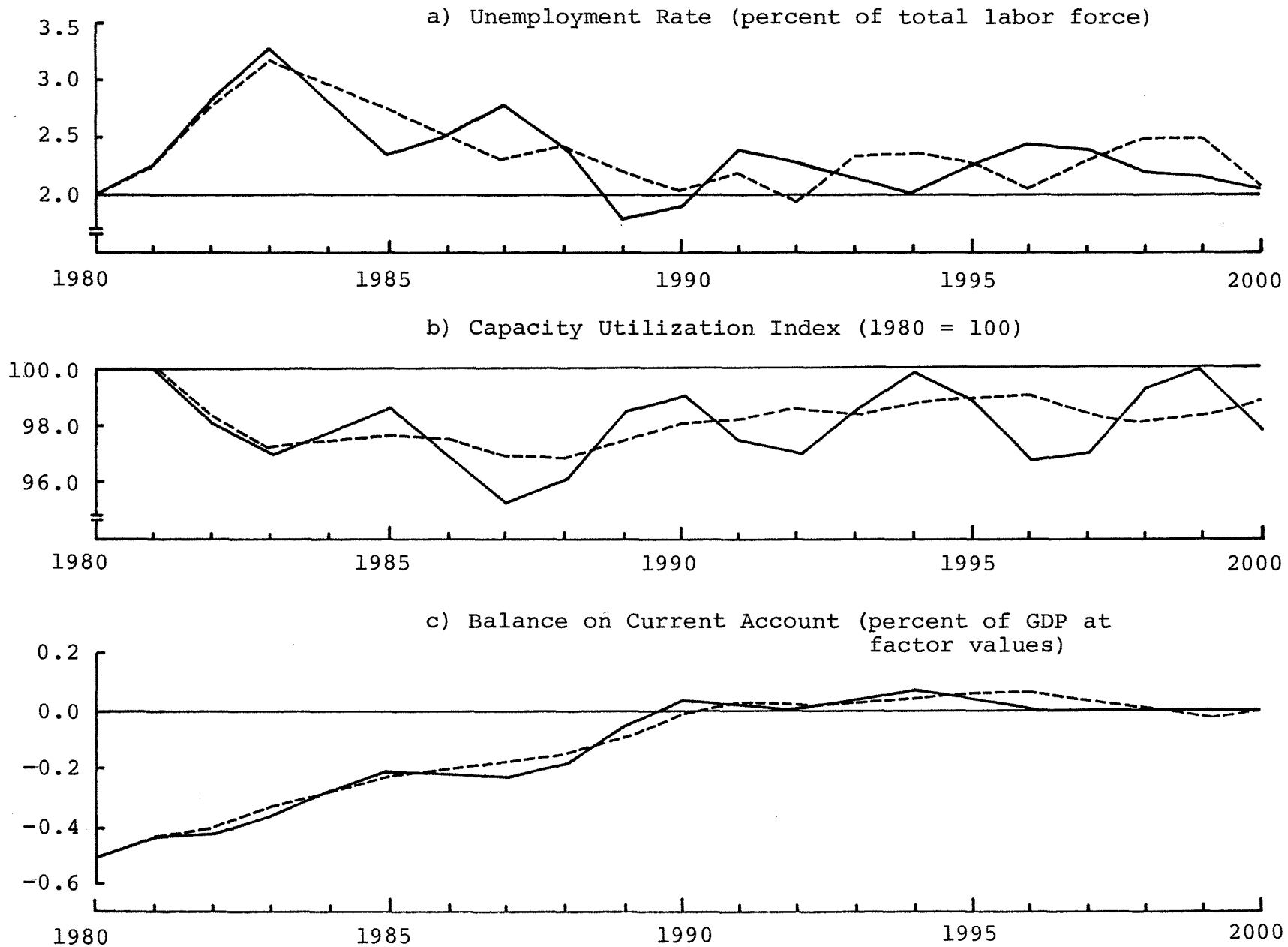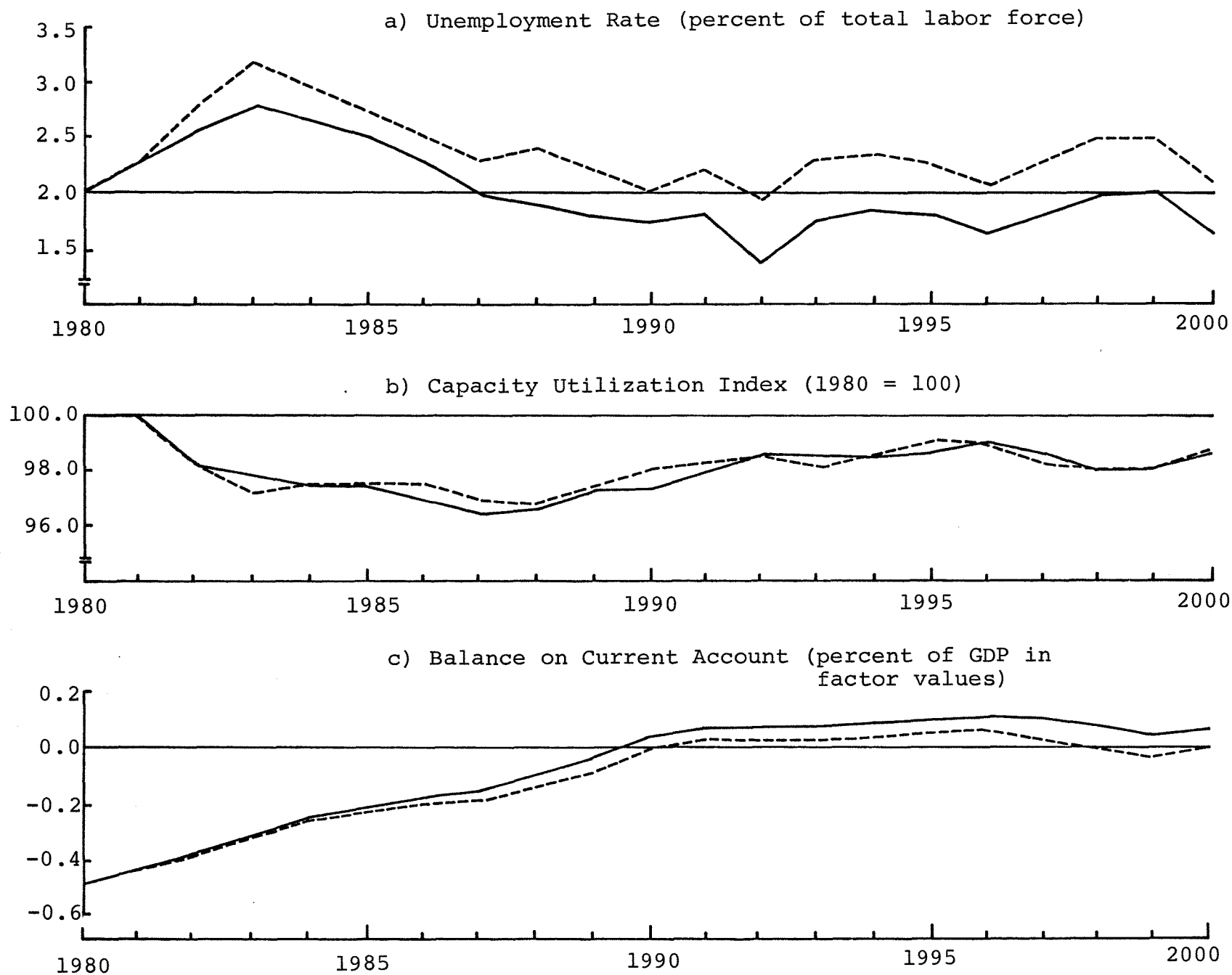   factor values)

Figure 5.12 Reduced Inflation Compensation in Wage Formation (C).
Standard Assumption Given by Dashed Lines

a) Unemployment Rate (percent of total labor force)

b) Capacity Utilization Index (1980 = 100)

c) Balance on Current Account (percent of GDP in
factor values)

te consumption, the effects of policy parameters and, finally, the resilience of the system.

Even though structural coefficients may not affect the stability of the system the resulting growth paths may differ when evaluated in terms of some social well fare or loss function. In Figure 5.13 the three simulations A-C are compared to the reference case simply in terms of level of private consumption. Although differences to the standard growth path are small - within +/-0.5% - for all cases some pattern is discernible. For A and B the consumption path is more or less a mirror image of employment (cf. Figures 5.10a and 5.11a) i.e. higher employment leads to higher consumption and vice versa with no differences in real income per capita compared to the reference case. In (C) however, with less then inflation compensated wages even in the long run real income per wage-earner will be reduced leading to lower total private consumption despite increased employment. Since aggregate productivity is almost equal between the simulations and public consumption is the same by definition, the external balance must improve as showed in Figure 5.12c.

The consumption effects of variations in the coefficients in question may seem small with regard to the rather significant changes that was studied. The reason for this lies partly in the model specification. Since wages are assumed to respond quickly and strongly to labor market conditions close to normal employment levels are almost always assured. Also aggregate productivity does not change much unless investments are substantially increased. Finally public consumption is exogenous in the version of the model used for these experi-

Figure 5.13   Effects on Private Consumption
              (Reference Case = 100.0)
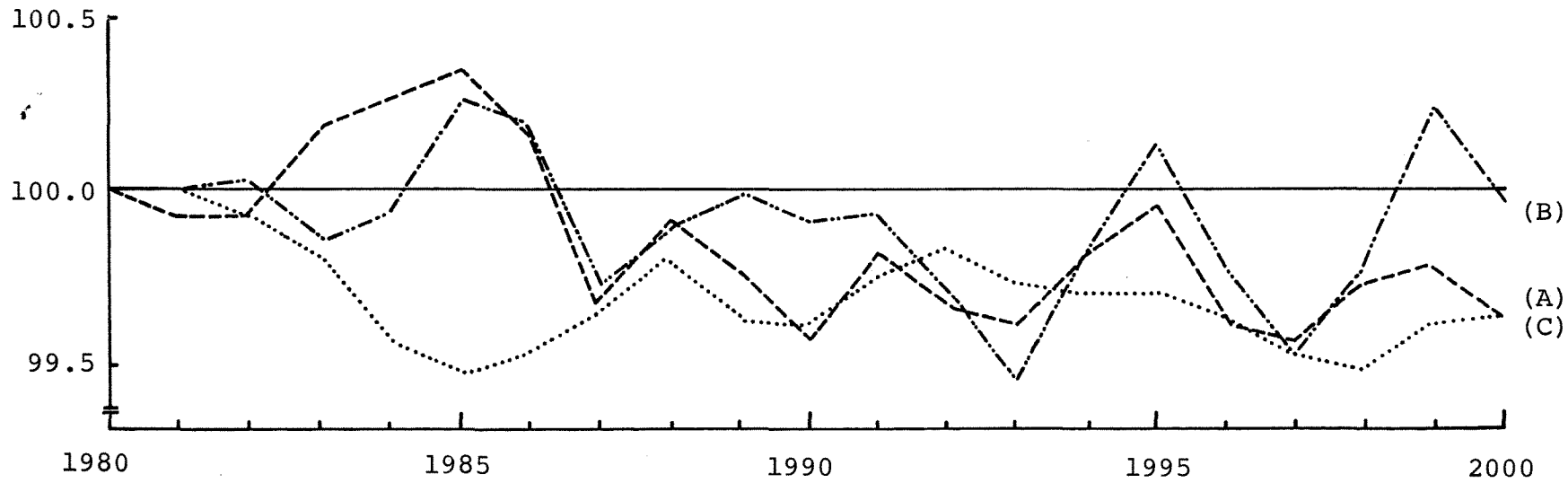
R: Reference Case
A: Change in Price Setting Behavior
B: Change in Export Price Elasticity
C: Change in Wage Formation

ments. These factors together imply that increased private consumption can only be explained by one or several of either increased employment, increased external deficit or improved terms-of-trade. The model specification however to a great extent rules out any significant contributions from the employment effect.

Hoever one might have expected fairly large effects from expecially the change in export price elasticities with amplified price responses leading to improvements in the external balance and/or a smaller necessary deterioration in terms-of-trade since foreign market demand would come forth without large decreases in relative export prices.

The fact that expected strong effects seams to be lacking in our experiments relates to more general problems than model specification in interpreting and analyzing sensitivity tests.

A first type of problem is connected with the obvious fact that the results of different coefficient variation will not be independent of each other, i.e. cannot be simply added. The effects of changing export or import price-elasticities will e.g. in general vary with variations in the income elasticity of imports. The positive effect, in a trade-deficit situation, of a more price-elastic export market is thus reduced by a higher propensity to use marginal income additions for import.

Also the effects of changed coefficients generally depend on the standard growth path used as reference point. Again a specific change in foreign trade price elasticities will affect the growth path

more or less depending on the degree of relative
price change assumed in the reference simulation.
If, for instance, world trade growth is so gener-
ous as to permit external balance without reduced
relative export prices, the effects of changes in
price elasticities will of course be insignifi-
cant.

This is the reason why the model economy reacted
so little to the elasticity test accounted for
above. Starting, instead, from significant relati-
ve price changes export and import price elastici-
ties will ber of strategic importance.

To illustrate possible changes in policy effects
of different coefficient assumptions the same
policy instruments as in section 5.3, summarized
in Figure 5.8, are used. From Figure 5.9 it is
evident that the relations between policy effects
in terms of unemployment and external balance will
change with time but stabilize after some years.
(Note the one year late execution of wage policy.)
This relative stability is necessary to discuss
ten year (or long run) effects as in Figure 5.8.
Changing structural coefficients will however to a
varying degree also change cyclical patterns in
the model economy. Therefore the relative effects
of a change in a specific policy instrument under
different coefficient assumptions are sometimes
rather unstable throughout of the simulation
period. Despite these problems of interpretation
the ten year effects of each of the four policy
instruments are indicated in Figure 5.14 for the
reference simulation (R) and the three coefficient
variations (A, B and C) described earlier in this
section.

Each of the four subdiagrams are constructed in
the following way. For the standard coefficient
set up the model is run through the eighties with
and without the specific tax scale parameter
change. The 1990 difference in unemployment rate
and current account (as percentage of GDP) gives
the arrow R. This procedure is repeated for each
of the chosen coefficient variations resulting in
arrows A-C. Then the next policy instrument effect
is analyzed in the same manner and ten year diffe-
rences market off as arrows R, A, B and C respecti-
vely, etc.

Trying to correct for cyclical effect pattern a
tax rate increase will have almost identical long
run effects on unemployment and external balance
irrespective of choice of coefficients in question.
The effect will be close to the reference case
(R) in Figure 5.14a.

Also the effects of a gradual currency deprecia-
tion seems not to depend very much on different
coefficient values with avarage effects along the
B-C arrows. It may be interesting to note however
that the long run "efficiency" of the instrument
(the length of the arrow) is insignificant in all
but one coefficient set up. The exception of
course is C, i.e. the reduced inflation compensa-
tion in wage formation. With total compensation,
potential improvements in international competiti-
veness following from depreciating the currency
will not materialize, since imported price increa-
ses will be compensated for and again push up
domestic costs and prices. The same general re-
marks are valid for the instruments shown in the
last two subdiagrams. Thus, the conclusion is that
(long run) policy effects will be fairly unaffec-

Figure 5.14   Consequences for Policy Parameter
              Effects of Changed Structural
              Coefficients
              (See Text for Explanation of Symbols)

a) Tax Rate Increase
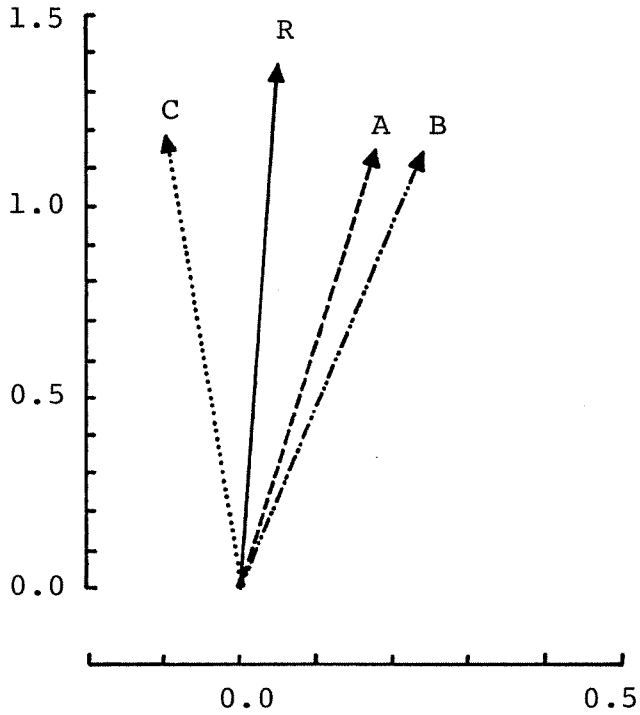
b) Depriciation of Currency
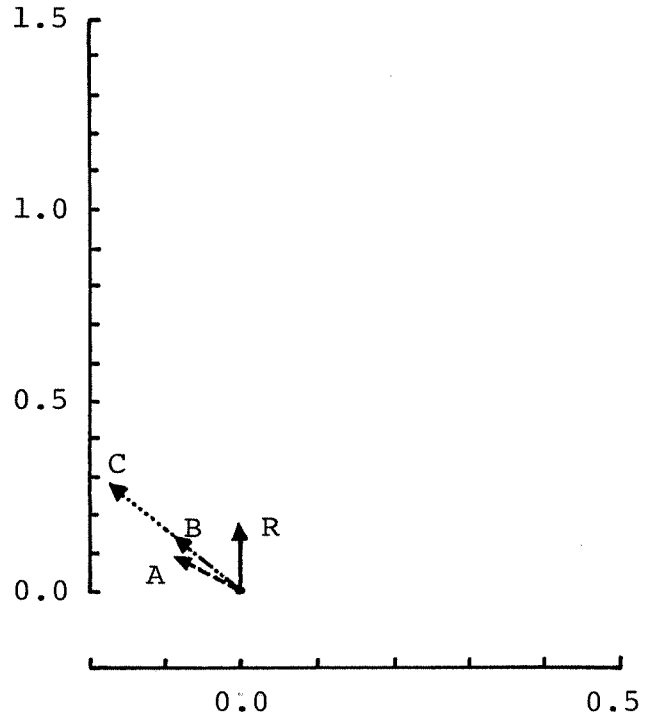
c) Reduced Public
   Consumption Growth

d) Reduced Autonomous
   Wage Rate Growth

ted by, at least, those coefficient variations
that are accounted for above.

Finally the effects of coefficient variations on
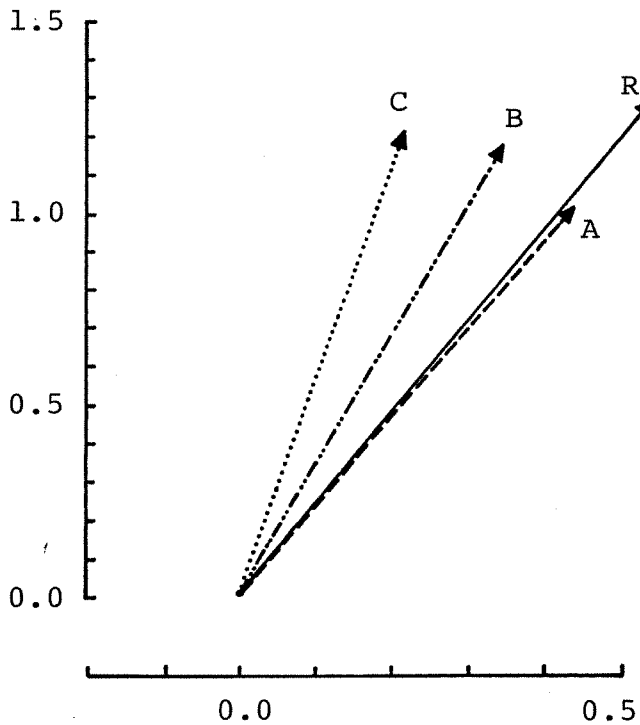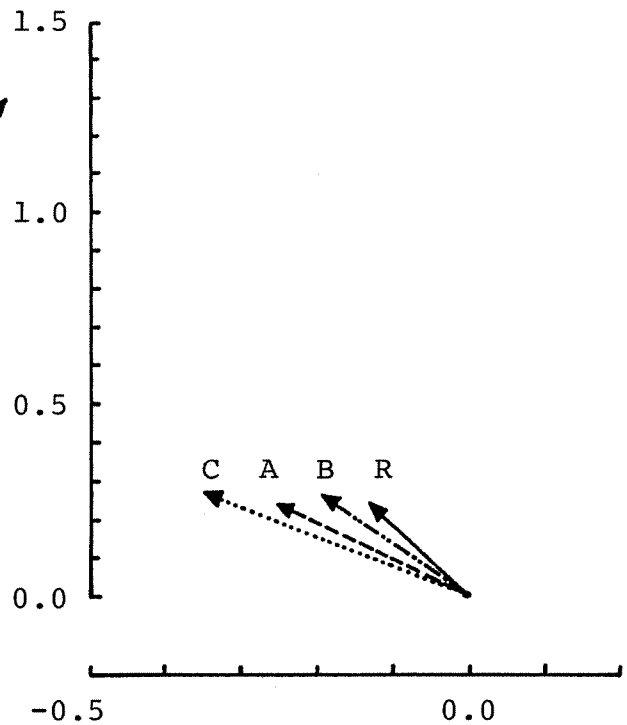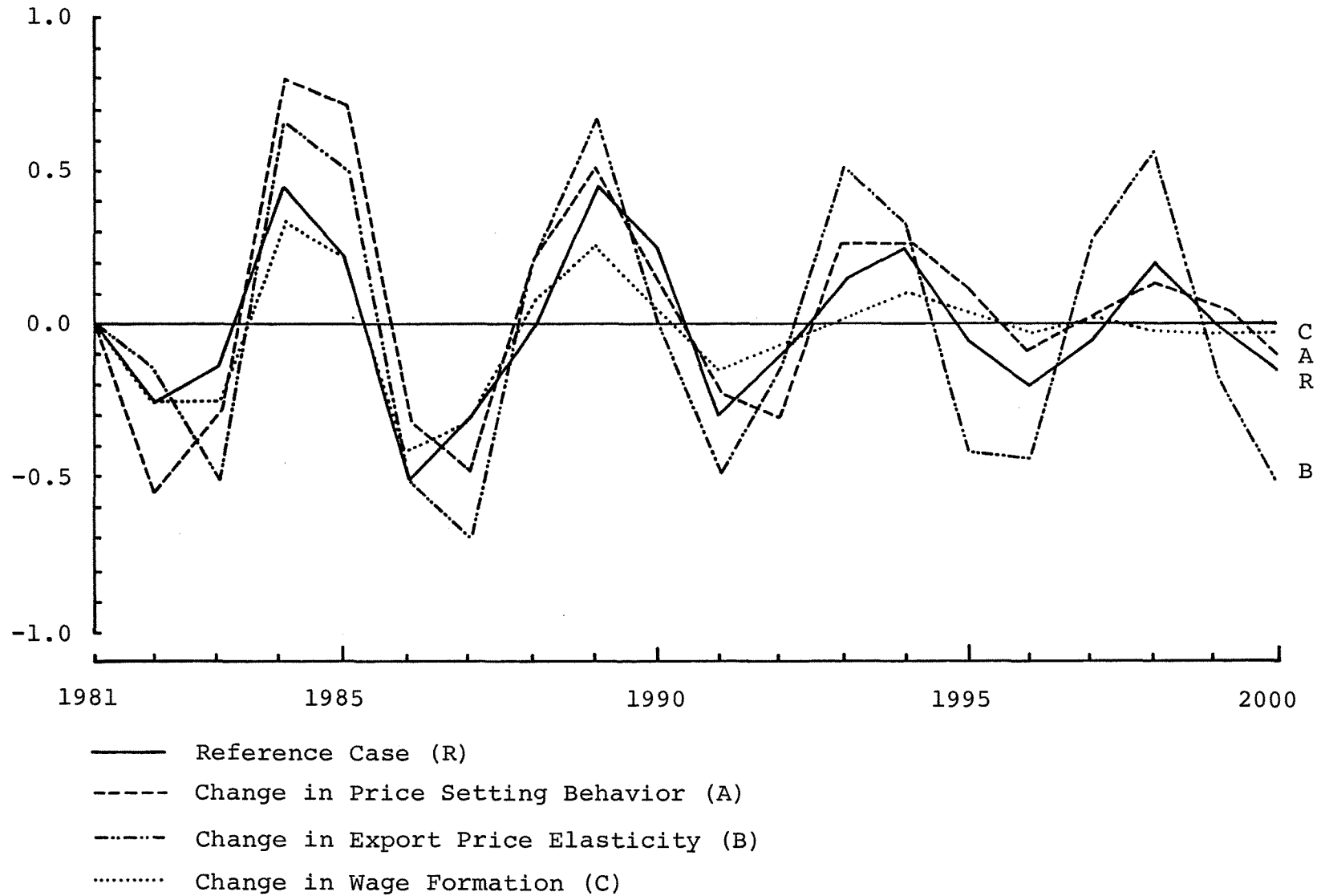the resilience of the model will be briefly discus-
sed. The testing procedure is analogous to the one
used in the policy effect experiments. The model
is run with different coefficient configurations
and for each one of these tested for the effects
of world market disturbances. These are designed
as sudden 5% general increases in 1981/1982 in
world market prices and world trade respectively
above the level assumed in the reference case. The
higher levels of prices and traded volumes are
assumed to persist (cf. section 5.2). The results
of these experiments are showed in Figures 5.15-16
in terms of differences in unemployment rates be-
tween disturbed and undisturbed simulations for
each coefficient assumption. To start with the
price disturbance shown in Figure 5.15 the resi-
lience of the system seems to be preserved altho-
ugh there are perceivable differences between dif-
ferent coefficient assumptions. With less weight
on world market prices assumed in companies' price
setting (case A) the external price shock yields a
considerable lowering of relative prices. Through
increased net foreign demand this price differenti-
al will transform into a reduction of unemployment
that is twice as large as in the reference case
(R). After the first full cycle the further deve-
lopment will however stick fairly close to the
path given by the standard coefficient set up (R).
With increased price responsiveness of foreign
demand (case B) cycle amplitude in terms of unem-
ployment differences will be still enhanced. Moreo-
ver the amplitude of the oscillations seems to
decrease somewhat although with this choice of

Figure 5.15 Effects on Unemployment Rates of 5 % World Price
Increase in 1981/82 for Different Parameter Assumptions
(Difference in Percentage Points from Undisturbed (Cases)

—————— Reference Case (R)

- - - - - Change in Price Setting Behavior (A)

—-··—-··— Change in Export Price Elasticity (B)

············ Change in Wage Formation (C)

coefficients they will be more than four times as large as in the other cases at the end of the period. In case C, finally, the limited inflation compensation can be seen to increase the model's ability to absorb an external price shock as expected.

Turning now to the effects of a trade growth shock, Figure 5.16 tells pretty much the same story. The repercussions of this disturbance will be strong throughout the simulation period in the case of increased export demand price elasticity (case B). Although the simulation path does not seem to "explode" there are no signs of dampening effects on the unemployment cycle generated by the initial disturbance.

Taken together these experiments show that resilience of the model is not always guaranteed. This is, of course, of no surprise.

5.5 Adaptivity or the limits of macro-models

A major problem in making long-term projections with a model, whose structure has been estimated from the experience of past decades, is that we do not know to what extent the attitudes and the behavior reflected in the estimated structure, will be relevant also in the future. Has the stag-flation and the stabilization problems following in the wake of the 73'-crisis caused such changes in the behavior or structure of the economy that we can no longer trust past experience and econome-tric estimates? The increasing tax-consciousness, the tendencies towards more cautious pricing and investment-reactions to advantageous cost-develop-

Figure 5.16   Effects on Unemployment Rates of 5 % World Trade
              Increase in 1981/82 for Different Parameter Assumptions
              (Difference in Percentage Points from Undisturbed Cases)
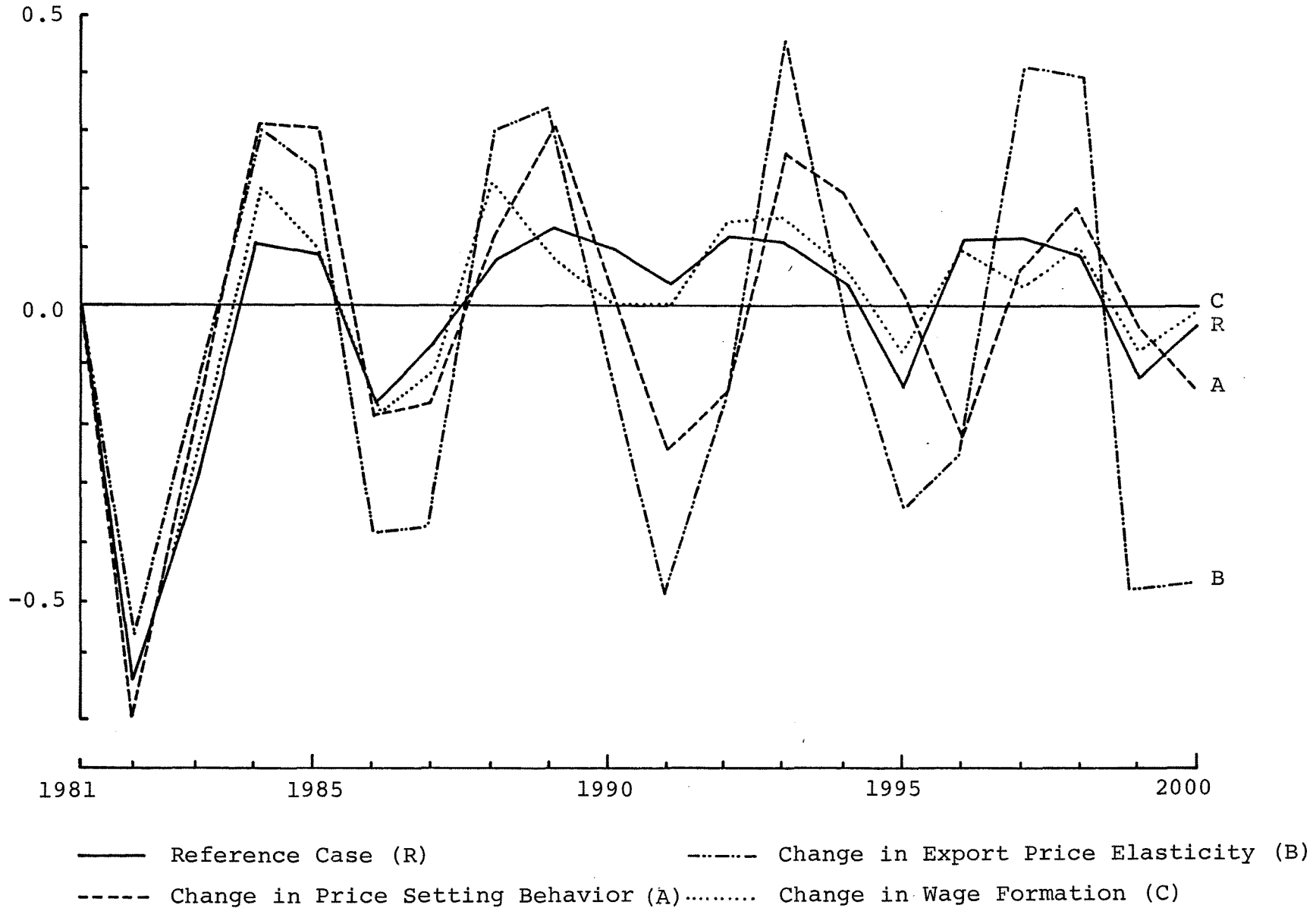
ments, the growing dominance of public employees
in the wage formation process, the increasing
extent of inflation-indexing, the new currency re-
gimes and shifts in corporative ownership and fi-
nancing are points in question for the Swedish
economy.

That these changes do not come out of the blue,
but have to be explained in terms of the economic
events in the past, seems evident. An even more
ambitious task would be to study to what extent
these institutional and behavioral changes tend to
make the economy more stable or more manageable.
Does, e.g., the increased tax-consciousness and
tax-adjustment make local authorities more sensiti-
ve to income-changes and by that less counter-cyc-
lical in spending behavior? Have the increased
price uncertainty also increased the risk-aversion
in the firms, adding new inertia to the economy?
In what degree is the economy adaptive - or the
opposite?

There is obviously no way in which we could even
attempt to answer these large questions, crucial
as they may be for any hope of basing policy on
econometric projections. We have, anyhow, probably
the wrong kind of model to even start exploring
them. The structural coefficients of a macro-
model, like ISAC, should always be thought of as
rough estimates of the aggregate outcome of under-
lying probabilistic micro-processes. The aggregate
demand curves we estimate, e.g., sum the net ef-
fects of a number of oligopolistic firms trying to
capture new markets and customers - or retain old
ones - by new prices and more differentiated pro-
ducts and attempting to get the message across to
the customers who in their turn are searching for

new and better price-product combinations. The degree of flexibility in market supply and demand with that the resilience and manageability in the exonomy will then, in the end, depend on the production, consumption and search strategies for the involved firms and households. An explanation of structural change and adaptivity will, in most cases, have to start at the micro-level. When we come up against questions of adaptivity we have reached one - of the many - limits to macro models.

Notes

[1] This is not entirely true for the local government expenditure model where e.g. liquidity accumulated above certain limits will bring about increasing expenditures.

Appendix A: The system of equations

n = 23
m = 14
u = 20

Bloc	Number of variables	Number of equations
Commodity balances	33n	3n
Production capacity etc.	(2u+15)n	(2u+39)n
Foreign trade	n	2n
Private consumption	n+2m+2	n+2
Government production etc.	0.5m+4	n+1.5m+4
Prices	n+1	4n+1
Wages	n+3m+4	2n+4m+4
Total	92n+5.5m+11	92n+5.5m+11

Commodity balances

n = 23
m = 14

Equations	Name of endogenous variables not counted before	Number of variables	Number of equations
$m+x = h+e$	$m,x,h,e,$	$4n$	n
$\hat{m} \cdot \theta p^w + \hat{x} \cdot p^x = \hat{h} \cdot p^h + \hat{e} \cdot p^e$	p^x, p^h, p^e	$3n$	n
$h = Ax+inv+pc+pu+ds$	A, inv, pc, pu	$26n$	n
		$33n$	$3n$

Production capacity and production technique

n = 23
m = 14
u = 20

Equations	Name of endogenous variable not counted before	Number of variables	Number of equations
$Q = \sum\limits_{v=t-u}^{t} Q^v \hat{\bar{x}}^{-1} \bar{x}^v$	$Q, Q, \bar{x}, \bar{x}^v$	$(u+11)n$	$5n$
$Q^t = F_Q\left[p^h(t-1), w(t-1), t\right]$	-	-	$5n$
$\bar{x}^t = (\hat{Q}_5^t)^{-1} g$	g	n	n
$d^v = F_d\left[p^x(t-1), p^h(t-1), \omega(t-1),\right.$ $\left. Q^v, \bar{x}^v(t-1)\right]; v=t-u,\ldots,t-1$	d^v	$(u-1)n$	$(u-1)n$
$\hat{\bar{x}}^v = (I-\hat{d}^v)\hat{\bar{x}}^v(t-1); v=t-u,\ldots,t-1$	-	-	$(u-1)n$
$\bar{x} = \sum\limits_{v=t-u}^{t} \bar{x}^v$	-	-	n
$\hat{ur} = \hat{x} \cdot \hat{\bar{x}}^{-1}$	ur	n	n
$A = F_A (Q)$	-	-	$23n$
$g = F_g\left[ep(t-s), ur(t-1), k(t-1)\right];$ $s = 1,\ldots,4$	ep	n	n
$\hat{ep} = (\hat{p}^x - \hat{p}^h A - \hat{\omega}\cdot\hat{\ell} - \hat{i})(\hat{p}^k \hat{k})^{-1}$	k	n	n
$p^k = F_p(p^h, r)$	p^k	n	n
$\hat{k} = \hat{Q}_5 \cdot \hat{\bar{x}}$	-	-	n
$inv = G \cdot g$	-	-	n
		$(2u+15)n$	$(2u+39)n$

Note: a) Only 20 different vintages are distinguished in each branch.

   b) Q_r is a vector of capital output koefficients.

Foreign trade

$n = 23$
$m = 14$

Equations	Name of endogenous variable not counted before	Number of variables	Number of equations
$e = F(p^e/\theta p^W(t-s), wm); s=0,1$	–	–	n
$m = F_m(p^{xh}/\theta p^W(t-s), h); s=0,1$	p^{xh}	n	n
		n	$2n$

Private consumption

$n = 23$
$m = 14$

Equations	Name of endogenous variable not counted before	Number of variables	Number of equations
$pc = F_{pc}\left(y_{11}, pc(t-1), p^h, p^h(t-1), besk\right)$	$y_{11}, besk$	2	n
$y_{11} = w' \cdot \ell + w^{p\,'} \cdot \ell^p$	ℓ, w^p, ℓ^p	$n+2m$	1
$besk = F_{besk}\left(y_{11}\right)$	-	-	1
		$n+2m+2$	$n+2$

Government production and investment

$n = 23$
$m = 4$

Equations	Name of endogenous variable not counted before	Number of variables	Number of equations
$pu = (SG,LG) \cdot xp + (sg, \ell g) \cdot ip$	ip	2	n
$xp = \begin{matrix} xs \\ x\ell \end{matrix}$	$x\ell$	$0,5 \cdot m$	m
$ip = \begin{matrix} i_s \\ i_\ell \end{matrix}$	i_s, i_ℓ	2	2
$i_s = F_{si}(xs)$	-	-	1
$x\ell = F_{\ell p}(besk, utd, w^\ell, p^h)$	-	-	$0,5 \cdot m$
$i_\ell = F_{\ell i}(x\ell)$	-	-	1
		$0.5m+4$	$n+1.5m+4$

Prices

n = 23
m = 14

Equations	Name of endogenous variable not counted before	Number of variables	Number of equations
$p^e = F_p e \left(\theta p^W, uc, ur(t-1) \right)$	uc	n	n
$p^{xh} = F_p xh \left(\theta p^W, uc, ur(t-1) \right)$	–	–	n
$\dot{uc} = {}^{\shortmid}A^h \hat{\cdot} p {}^{\wedge} + Q_4 \cdot \hat{w} + Q_5 {}^k \hat{\cdot} p$	–		n
$\hat{p}^x = \left[\hat{e} \cdot p^e + (\hat{x} - \hat{e}) \cdot p^{xh} \right] . \hat{x}^{-1}$			n
$cpi = p^h \cdot pc / \sum_{i=1}^{n} pc_i$	cpi	1	1
		n+1	4n+1

Employment and Wages

$n = 23$
$m = 14$

Equations	Name of endogenous variable not counted before	Number of variables	Number of equations
$\ell = \hat{Q}_4 \cdot x$	ℓ	n	n
$q^P = \dfrac{q^s}{q^\ell}$	q^P	m	m
$\ell^P = \hat{q}^P \cdot xp$	ℓ^P	m	m
$u = (\ell_s - x' \cdot Q_4 - xp' \cdot q^P)/\ell_s$	u	1	1
$\dot{w}_o = F_w[\dot{cpi}(t-1), u, \dot{\Pi}^m(t-1),$ $\dot{Q}_4^m(t-1)]$	$\dot{\Pi}^m, \dot{Q}_4^m, \dot{w}_o$	3	1
$\dot{\hat{w}} = \dot{w}_o \cdot I$	–	–	n
$w^P = \dfrac{w^s}{w^\ell}$	w^P	m	m
$\dot{\hat{w}}^P = \dot{w}_o(t-1) \cdot I$	–	–	m
$\dot{\Pi}^m = \sum\limits_{i=1}^{14} [p_i^x - (A'p^h)_i - i_i]x_i / \sum\limits_{i=1}^{14} x_i$	–	–	1
$\dot{Q}_4^m = \sum\limits_{i=1}^{14} \dot{Q}_{4,i} \cdot x_i / \sum\limits_{i=1}^{14} x_i$	–	–	1
		$n+3m+4$	$2r+4m+4$

Notes

[1] The income tax function in the model is specified in the following way (cf. section 4.7)

$$Y_{41} = t \cdot [a_{41} \cdot skind \cdot n_b \cdot (besk/skind/n_b)^{b_{41}} + $$

$$+ utd_o \cdot besk]$$

where

Y_{41} = total income tax
a_{41} = constant
skind = inflation compensation index
n_b = number of taxpayers
besk = taxable income
b_{41} = central government income tax elasticity
utd_o = local government tax rate in 1980
t = policy parameter

This specification of the tax function is used when local governments are exogenous and included in the policy arsenal. With endogenous local sector also the local tax rate is endogenous. This will of course greatly reduce the effects of changes in t.

Appendix B: List of symbols

Symbol	Meaning	Dimension
	COMMOCITY BALANCES	
$*^{l}x$	Domestic production	23
$*m$	Imports	23
$*e$	Exp-orts	23
$(*)A$	I/o coefficients	23x23
$(*)inv$	Demand for investment goods	23
$*pc$	Private consumption demand	23
$(*)pu$	Public sector demand	23
ds	Change in inventor stocks	23
$*p^{x}$	Price of domestic production	23
p^{m}	Price of domestic production	23
$*p^{h}$	Price of domestic absorption	23
$*p^{e}$	Price of exports	23

	THE I/O MATRIX	
$*Q^{v}_{m,i}$	Aggregate input coefficient m in vintage v in manufacturing^{2} branches i	m=5, i=14
$*\bar{x}^{v}_{i}$	Production capacity in vintage v in manufacturing branches i	i=14, v=20
$*d^{v}_{i}$	Rate of scrapping in vintage v in branch i	i=14, v=20
$*ur$	Capacity utilization ratio	23
$*q^{f}_{j,i}$	Fuel input coefficients in business sector	i=23, j=2

Symbol	Meaning	Dimension
	INVESTMENTS IN THE BUSINESS SECTOR	
$(*)g$	Gross investments in the business sector	23
$*ep$	"Excess profits" in manufacturing sector	14
$*va$	Value added at fector cost	23
$*p^k$	Cost of capital in manufacturing sector	
r_w	External rate of interest	1
	FOREIGN TRADE	
p^w	World market prices in foreign currency	23
θ	Exchange rate	1
wm	World market volume index	23
$*p^{xh}$	Domestic producers' prices on domestic markets	23
	DISPOSABLE INCOME AND CONSUMPTION EXPENDITURES IN HOUSEHOLD SECTOR	
$*y_{11}$	Total wages	1
$*cpi$	Consumption price index	1
$*besk$	Taxable household income	1
$*utd$	Local tax rate	1
$*p^c$	Household consumption purposes	14

Symbol	Meaning	Dimension
	GOVERNMENT SECTOR (s=central, ℓ=local)	
(*)xs, xℓ	Production	7
(*)cs, cℓ	Consumption	7
(*)fs, fℓ	Demand for commodities from business sector	23
(*)i_s, i_ℓ	Gross investments	1
	STOCK BUILDING	
ds_a	Change in total stocks	1
s_a	Total stock demand	1
	PRICES	
*uc	Average costs incl capital cost	23
*p^x	Price of domestic production	23
*p^e	Price of exports	23
*p^{xh}	Domestic producers' prices on domestic markets	23
*p^h	Price of domestic absorption	23
p^w	World market prices in foreign currency	23
p^m	Price of imports	23

Symbol	Meaning	Dimension
	WAGES AND EMPLOYENT	
$*\dot{w}_0$	Wage rate increase	1
$*w$	Wage rates in business sector	23
$*w^s, w^\ell$	Wage rates in central (s) and local (ℓ) government sector	7
(w^p)	$w^p = [w^s, w^\ell]$	
$* \ell$	Employment in business sector	23
$(*) \ell^s, \ell^\ell$	Employment in central (s) and local(ℓ) government sector	17
$*u$	Unemployment rate	1
$* \Pi^m$	Gross profit share of value added in manufacturing sector	1

NOTES

[1] Endogenous variables are marked by *. Paranthesis denote that only part of the vector or matrix is endogenous.

[2] There are 14 branches in the manufacturing subsector of the business sectopr (cf Section 4.1).

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