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AN ANALYSIS OF ADVANCE EFFECTS OF ANTICIPATED POLICY ACTIONS: RECENT RESULTS WITH THE FINNISH MICRO-QMED MODEL

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ABSTRACT

This paper reports some policy simulations carried out with the Finnish MICRO-QMED model. This rational expectations model built at the Economics Department of Bank of Finland is used to evaluate the short-run effects of some anticipated policy actions. The role of alternative (income) policy rules is also assessed. All these experiments demonstrate the importance of advance effects. In addition, they underline the importance of knowing the nature of the policy actions and the expectations horizon of economic agents. The paper also contains a short description of the MICRO-QMED model and its computational properties.

CONTENTS

1 INTRODUCTION

This paper reports some basic results obtained with the Finnish MICRO-QMED model developed at the Economics Department of the Bank of Finland, where it is mainly used in short-term forecasting. In addition, some advice is provided on the practical use of the model; as the name of the model already suggests, this version of the model is used in a microcomputer (PC) environment. This application has been rendered possible by the new MIKRO-TEKO programme developed at the Bank of Finland.[1]

The MICRO-QMED is to a large extent similar to earlier versions of the QMED models (which, however, have been used with a mainframe computer only; see Lahti and Virén (1989) and Lahti (1989) for details). The main difference is that the MICRO-QMED model is somewhat smaller: altogether there are 18 stochastic equations, 14 identities and 60 variables (excluding the residuals) in the model. The second difference with respect to the earlier versions of the model is that the estimation period is now 1976.1 - 1988.4. The exclusion of the early 1970s is motivated by the fact that the current institutional framework (particularly in terms of the capital market) is very much different from that period (not to mention the 1950s and 1960s). Thirdly, but no less importantly, the structure of the model has been changed. Now, rational expectations also affect business investment (and thus not only consumption demand and wage formation). In addition, the (endogenous) capacity variable has been changed so that it now corresponds to the actual capacity utilization rate obtained from the Bank of Finland investment inquiry. Otherwise the model structure is fairly standard. Aggregate demand determines output (although it is also affected by endogenous capacity), wages - or more precisely wage drift - is determined by a Phillips curve and prices are determined according to a mark-up model. Export prices are linked to foreign prices via an error correction specification. In the short run, export prices are also affected by wages but the main effect of wages is revealed in the functional distribution of income and, consequently, in consumption and investment demand.

We do not intend to go through the details of the model. A short summary of the main behavioural equations of the models is, however, presented in Appendix 1. The estimates are OLS estimates. The model is also estimated by Hatanaka's (1978) two-step estimation procedure, in which the instruments are derived from the model solution. This is done although the relatively small number of observations makes this alternative estimation procedure somewhat questionable. In order to save space, the Hatanaka two-step estimates are not reported here. We may, however, note that they differ very little from the OLS estimates.[2] In addition, Appendix 1 contains some (altogether 11) diagnostic statistics for these equations. As can be seen, these test statistics do not indicate serious shortcomings, although some alarming signs can also be detected. In particular, this is true in terms of the Plosser-Schwert-White differencing test, which may reflect some problems with the dynamic specification.

In this paper we concentrate on examining the simulation properties of the model. This is done in two different ways. Firstly, we scrutinize the dynamic and static simulation paths for the estimation period (see section 2.2) and, secondly, we compute a set of policy multipliers in terms of the key exogenous variables of the model (see, e.g., Fair (1989) for a recent defence of this kind of exercise in analyzing policy alternatives; see also section 2.3). Finally, the effects of some alternative (incomes) policy rules are assessed (section 2.4). This is done both to examine the basic properties of the model and to find out the nature of the shocks which have hit the Finnish economy in the recent past. The novelty of the latter results lies in the fact that it is assumed that the changes in these exogenous variables are already known in advance.

2 SIMULATION RESULTS

2.1 Some Computational Properties of the MICRO-TEKO Model

As mentioned above, the rational expectations version of the model is solved using the MICRO-TEKO program, and more precisely the Fair-Taylor (1983) algorithm. Because the model is relatively small and the number of leads is one or two, only a few computational problems are typically encountered - this is also true when working with a PC (cf. Sulamaa and Virén (1989) for further details). This does not mean, however, that the model simulations are similar to those obtained with standard backward-looking expectations models. The simulated values for the sample period depend on the post-sample period values. Thus, if a forecast is computed for, say, the period 1990 - 1992 the values of the exogenous variables both for this period and for some subsequent periods are needed (depending on the forecast horizon and on the number of periods with which the solution path is extended in type III iterations (cf. Fair and Taylor (1983)). Thus, when rational expectations models are used in forecasting one cannot simply leave the post-forecasting period values of the exogenous variables unspecified or simply extrapolate them mechanically. In particular, if the forecasting (dynamic simulation) period is short and these future values are merely assumed to be constant, the simulation results are markedly different from the case where the future values are based on all available information.[3]

2.2 Static and Dynamic Ex-Post Simulations

To give some flavour of the tracking performance of QMED model we first report some summary statistics from the ex post simulations performed for the estimation period 1976.1 - 1988.4. Both Mean Absolute Percent Errors (MAPE) and Mean Percent Errors (the difference between the simulated and actual values, abbreviated as MPE) are shown in Table 1. In addition, graphs for the simulated and actual values of GDP and the price deflator of private consumption are presented (see Figure 1; the contract wage, the discount rate and the exchange rate variables are exogenous in both simulations).[4]

TABLE 1

MAPE and MPE values for the estimation period 1976.1 - 1988.4

	Dynamic simulation 1		Dynamic simulation 2		Static simulation		100 * SD(Y)
	MAPE	MPE	MAPE	MPE	MAPE	MPE	
Gross Domestic Product	1.17	-0.32	1.16	-0.25	1.16	-0.45	1.64
Imports	3.90	2.59	3.63	1.38	2.36	-0.29	6.77
Exports	2.98	0.04	3.02	0.01	2.68	0.03	7.28
Private consumption	1.45	0.81	1.11	0.33	0.71	0.03	2.10
Investment	3.64	-0.06	3.71	-0.08	2.92	-2.18	5.16
Employment	1.39	-0.03	1.39	-0.03	1.16	0.01	1.75
Capacity utilization rate	1.64	-0.00	1.64	-0.01	0.45	-0.08	3.67
Consumption prices	1.20	-0.79	1.29	-0.83	0.35	-0.04	4.80
Export prices	2.08	0.07	2.22	0.10	1.45	0.01	7.00
Wage rate	0.59	0.10	1.25	-0.57	0.17	-0.00	2.80
Current account/GDP	1.41	-0.87	1.28	-0.52	1.12	0.07	1.84
Interest rate	0.56	-0.01	0.53	-0.00	0.51	-0.00	1.29

The contract wage rate is exogenous (endogenous) in dynamic simulation 1 (2) and in the static simulation. All aggregate demand components are volumes, prices are implicit price deflators. Employment is expressed in working hours and the capacity utilization rate, the current account in relation to GDP and the interest rate in percentage terms. In these cases, the MPE values are computed simply as MPE(Y) = Mean(Y(simulated)-Y(actual)).

Generally speaking, the tracking performance of the model is good (irrespective of the way the contract wage variable is treated). It may be noted that the time series of the selected endogenous variables are rather volatile, as can be seen from the standard errors computed for the deviations between the actual (log) values and the linear time trend (denoted by SD(Y)[5]). Alternatively, one can compare the MAPE values with those obtained from a larger quarterly model of the Finnish economy (Tarkka et al. (1990)). Only imports, investment and exports create some minor problems in a dynamic simulation over the 52-quarter sample period. If static simulation is carried out, fairly similar results emerge. The static simulation errors are generally smaller than those with dynamic simulation, which is obviously also due to the importance of lagged dependent variables in the model.

All in all, the difference between dynamic and static simulation results is strikingly small and the simulation errors follow a similar pattern. Although the static simulation errors are smaller they are not trivial (i.e. they are not just zeroes). This suggests that it may well be unnecessary to carry out both simulations to assess the performance of the model.[6]

2.3 Measuring the Effect of Anticipated Policy Changes

Now, let us turn to the effects of some policy actions. The relevant simulation results are reported in Table 2. All results correspond to permanent, once-for-all ceteris paribus changes in the exogenous variables mentioned in the table. (See e.g. Breedon et al. (1990) for a similar exercise with the Bank of England model.) In all cases, it is also assumed that the changes are known for 8 months in advance. This, in turn, makes it possible to examine the dynamic adjustment path of the endogenous variables of the model both before and after the policy action. Although we speak about "policy actions", some changes in exogenous variables are literally speaking not "policy actions" but merely changes in the overall policy environment.

Because price and wage adjustment is of crucial importance in the case of a small open economy (such as Finland), we also present results with a model version which includes a wage equation for contract wages. Most of the forecasting is carried out treating contract wages as exogenous, which can be justified given the highly unionized and centralized wage settlement system in Finland. However, with policy simulations, this assumption is obviously much too restrictive, particularly in the case of large changes in exogenous variables.[7]

TABLE 2

Policy simulation results

	77.4	78.1	79.4	82.4
Effects on GDP				
contract wage rate	-0.14	-0.28	-0.35	0.29
	(-)	(-)	(-)	(-)
public consumption	0.00	2.29	2.22	2.28
	(0.00)	(2.28)	(2.19)	(2.31)
foreign demand	-0.00	0.56	1.21	1.29
	(0.00)	(0.56)	(1.21)	(1.32)
working-age population	0.05	0.08	0.32	0.02
	(0.06)	(0.10)	(0.38)	(-0.06)
bilateral exports	-0.00	0.35	0.32	0.47
	(-0.00)	(0.35)	(0.31)	(0.48)
social security contributions	0.01	0.01	0.00	0.01
	(0.00)	(0.00)	(-0.04)	(0.03)
oil prices	-0.02	-0.10	-0.16	-0.23
	(-0.03)	(-0.11)	(-0.19)	(-0.77)
discount rate	0.00	-0.12	-0.58	-0.77
	(0.00)	(-0.12)	(-0.57)	(-0.78)
income tax rate	-0.09	-0.18	-0.47	-0.59
	(-0.09)	(-0.18)	(-0.46)	(-0.59)
foreign prices (pf,pme,pmo)	-0.12	1.44	0.65	0.76
	(-0.17)	(1.35)	(0.48)	(0.85)
Effects on consumption prices				
contract wage rate	-0.02	2.11	6.65	6.75
	(-)	(-)	(-)	(-)
public consumption	0.00	0.01	0.03	0.01
	(0.00)	(0.02)	(0.30)	(0.18)
foreign demand	0.00	0.01	0.04	-0.01
	(0.00)	(0.02)	(0.18)	(0.11)
working-age population	0.00	0.00	-0.07	-0.06
	(0.00)	(-0.01)	(-0.81)	(-1.04)
bilateral exports	-0.00	0.01	0.01	-0.00
	(0.00)	(0.01)	(0.06)	(0.04)
social security contributions	0.00	0.18	0.54	0.54
	(0.00)	(0.18)	(0.90)	(1.12)
oil prices	-0.00	0.15	0.52	0.53
	(-0.00)	(0.15)	(0.76)	(1.04)
discount rate	0.00	-0.00	-0.02	-0.00
	(-0.00)	(-0.00)	(-0.07)	(-0.07)
income tax rate	-0.00	-0.01	-0.02	-0.07
	(-0.00)	(-0.01)	(-0.07)	(-0.05)
foreign prices (pf,pme,pmo)	-0.00	0.97	2.65	2.68
	(0.00)	(0.97)	(4.51)	(5.48)
Effects on current account/gdp				
contract wage rate	-0.00	0.76	-1.36	-1.40
	(-)	(-)	(-)	(-)
public consumption	-0.00	-0.17	-0.38	-0.03
	(0.00)	(-0.16)	(-0.41)	(-0.09)
foreign demand	0.00	0.48	1.04	1.19
	(0.00)	(0.49)	(1.05)	(1.19)
working-age population	-0.03	-0.05	0.79	-0.20
	(-0.04)	(-0.07)	0.84	0.04
bilateral exports	0.00	0.29	0.26	0.42
	(0.00)	(0.30)	(0.26)	(0.42)
social security contributions	-0.01	-0.05	-0.07	-0.07
	(0.00)	(-0.04)	(-0.10)	(-0.18)
oil prices	0.01	-0.47	-0.73	-0.74
	(0.02)	(-0.47)	(-0.76)	(-0.87)
discount rate	-0.00	0.08	0.46	0.42
	(0.00)	(0.08)	(0.46)	(0.42)
income tax rate	0.07	0.11	0.35	0.48
	(0.07)	(0.11)	(0.35)	(0.35)
foreign prices (pf,pme,pmo)	0.09	1.49	1.07	1.55
	(0.12)	(1.57)	(0.91)	(1.10)

Effects are given as cumulative percentage differences between the base (control solution) and the variant. The numbers in parentheses are results obtained with a model version with endogenous contract wages. All changes in exogenous variables are permanent and they take place at the beginning of the first quarter of 1978. The variables are then increased by 10 per cent. In the case of the working-age population the increase is, however, 1 per cent and in the case of the employers' social security contributions rate, the discount rate and the income tax rate 1 percentage point. The simulation period is 1976.1 - 1988.4. Hence, these changes are already known 8 quarters in advance. Accordingly, the first quarter represents the one-quarter-ahead anticipated effect of the respective policy actions.

The policy multipliers clearly indicate that the advance effects are not simply zero. In fact, the effects are more important and diverse than can be concluded on the basis of Table 2. For instance, in the case of an increase in contract wages there is a positive and anticipated income effect in terms of private consumption and a negative and anticipated income effect on private investment, in addition to a negative simultaneous or lagged competitiveness effect on exports and imports. The net effect in terms of GDP can, however, be almost negligible. In the same way as GDP, private consumption is also affected by two future effects - in addition to the income effect - with opposite signs, which almost offset each other: a positive real interest rate effect and a negative direct inflation effect (for further details, see Appendix 1).

In evaluating the simulation results one should bear in mind that technically the expectations horizon, i.e. the number of leads, in the equations is only one or two. Clearly, the true horizon is much longer and, thus, the advance effects generated by expected policy changes are even more important. This obvious fact can be demonstrated by extending the expectations horizon. Such an experiment is illustrated in Figure 2 where the contract wage equation is changed so that the number of leads with respect to the capacity utilization rate in the contract wage equation is extended to four quarters ahead. Now, assume that the income tax rate is increased by 1 per cent and oil prices by 10 per cent at the beginning of 1978 and that these actions are already known at the beginning of 1976. In these cases advance effects can already be discerned two years earlier although they do not become economically important until one or two quarters before the changes in taxes or oil prices actually take place.

These examples clearly indicate that even minor changes in model specification may crucially affect the short-run dynamics. In particular, the assumption that some effect is a result of forward-looking behaviour rather than backward-looking behaviour definitely has a nontrivial effect on short-term results. One should therefore treat the corresponding results from "old-fashioned" macro models with at least some caution.

2.4 Evaluating Alternative Income Policy Rules

Finally, we turn to an experiment in which we analyze alternative policy rules. Although this is something that is not really justified given Lucas's critique, it may help us to get some idea of both the model and the shocks which have hit the Finnish economy. Here, we only consider income policy rules. In practice, this is done by comparing the dynamic simulation paths of GDP and consumption prices with different specifications for the contract wage equation. Thus, the model is solved with (1) an exogenous contract wage variable which is set equal to the actual value of wc, with (2) an exogenous constant contract wage variable such that this constant nominal value (more precisely, growth rate) corresponds to the sample average of Δwc, with (3) a constant exogenous real wage, which, in turn, is set equal to the sample average of Δ(wc-pc), and (4) with an endogenous contract wage (see fn. 7). The corresponding sample averages (μ) and standard errors (s) for the simulated values of ΔlogGDP and ΔlogPC are reported in Table 3. The same statistics are also reported for the actual values of these two variables.

TABLE 3

Effects of alternative contract wage rules

Specification of wc	GDP		Consumption prices	
	μ	s	μ	s
wc exogenous	.00897	.02261	.01857	.00773
Δwc constant	.00904	.02309	.01905	.00521
Δ(wc-pc) constant	.00871	.02251	.01693	.01057
Δwc endogenous, fn. 7	.00897	.02292	.01870	.00701
actual data for GDP and PC	.00874	.01291	.01871	.00776

One can see that a policy based on constant contract wages would indeed lower the variability of inflation but would, in turn, increase the variability of output growth. By contrast, if the growth rate of real wages were held constant over time, this would not lead to any decrease in the variability of output growth. In fact, this would also lead to considerably higher inflation rate variability. If contract wages followed the behavioural equation with expected inflation, the past real wage gap and the capacity utilization rate as the right-hand-side variables (see footnote 7), inflation would be relatively stable but the variability of output growth would not differ from the general pattern.[8] These results give some support to the idea that most of the shocks which have hit the Finnish economy are real (demand and supply) shocks (like oil shocks, (bilateral) export demand shocks, demographic shocks and so on). Given this, fixing nominal wages or indexing real wages would not represent an optimal policy rule (cf. Blanchard and Fischer (1989) for the basic results of the theory).

3 A CONCLUDING REMARK

This model is far from complete. Even though some novel features, such as rational expectations, are incorporated in the model a lot more needs to be done. In particular, an attempt should be made to find out what is the overall role of expectations in the context of separate behavioural equations, what is the "horizon of expectations", how expectations should be treated in terms of policy rules and so on. If light cannot be shed on such issues, or if they are simply ignored, the usefulness of macromodels can be seriously questioned.

FOOTNOTES

1 Unfortunately, there is currently no proper document of the programme available. Those interested in the programme may, however, contact Jukka Syrjänen at the Bank of Finland.

2 Moreover, the model was also estimated by Huber's (1981) robust M-estimator. This exercise showed - in accordance with the outlier tests - that the coefficient estimates are not sensitive with respect to any outlier observations. Thus, for instance, the Mean Absolute Percent Errors value for the robust estimation version of the model (for the 1976Q1 - 1988Q4 period; endogenous capacity and contract wage variables) turned out to be 1.44 while the corresponding figure for the OLS version was 1.16.

3 An unpublished note describing these experiments is available upon request from the author. Note that due to purely computational reasons, forecasts for a short period and for an overlapping long period do not necassarily coincide although the difference is typically extremely small.

4 The use of static simulation (and conventional single-equation diagnostic testing (cf. Appendix 1)) is motivated by the arguments presented in Pagan (1989) and Fisher and Wallis (1990). Pagan, as well as Fisher and Wallis, takes a rather critical attitude towards using dynamic simulation in the statistical evaluation of econometric models. For instance, Pagan argues that "it is therefore very hard to utilize tracking performance for the purpose of model evaluation: a good record may be comforting, but nothing substantial can really be concluded from it about any misspecification".

5 In the case of the capacity utilization rate, the current account/GDP ratio and the interest rate, the sample standard deviations are computed.

6 We also carried out a dynamic "ex ante" simulation for a pre-estimation period 1971.1 - 1975.4 (which also includes the first "oil crisis"). The results were relatively good given the very volatile data. Thus, the following values were obtained for GDP and consumption prices: MAPE(y) = 2.43, MPE(y) = -0.77, MAPE(pc) = 1.78 and MPE(pc) = -1.78. Finally, we compared the tracking performance of the model with the accuracy of forecasts made at the Bank of Finland (by the forecasting team). This was done by computing the difference between the forecast and actual rates of change of GDP, consumption prices and the current account (current account relative to GDP). The forecasts were made late in January and they applied to the same year. The corresponding average (absolute) percentage values are denoted here as MPEF (MAPEF). They are compared with the model simulation errors computed from dynamic simulations covering four consequentive quarters in each year. This exercise produced the following results:

	MAPEF	MPF	MAPE	MPE
Gross Domestic Product	1.32	-0.22	0.69	-0.22
Consumption prices	0.40	-0.18	0.57	-0.12
Current account/GDP	1.08	0.10	0.99	0.15

Obviously, the comparison is not completely fair because, for instance, the model here uses correct values for exogenous and lagged variables. (In fact, some forecasts are also available for the exogenous variables. If these values are used in simulation the tracking performance of the model somewhat deteriorates. For instance, the MAPE value of GDP increases to 1.19). Even so, the numbers suggest that the forecasting errors are generally of the same magnitude although the annual forecasting errors produced by these two alternative systems are only weakly correlated.

7 The contract wage equation applied here is of the following form:

$$\Delta wc = .615 \cdot \Delta pc(-1) - .038 \cdot (wc(-4)/pc(-4)) + .049 \cdot cap(+1)$$
$$\quad (3.55) \qquad\qquad (2.02) \qquad\qquad\qquad\qquad (2.60)$$

$R2 = .221$ D-W = 2.112 SE = .0086,

where the symbols are the same as in Appendix 1.

8 Notice that all these experiments are carried out assuming that the variability of inflation or output (income) growth does not affect the growth of output and income. This is a very strong assumption. One would prefer to assume that increased variability has a negative effect on growth.

APPENDIX 1

OLS Estimates of the Main Behavioural Equations of the QMED Model

(1)

$$x^* = \underset{(14.48)}{0.792}\cdot\log(x^*(-1)) + \underset{(1.98)}{0.483}\cdot f^* - \underset{(1.05)}{0.286}\cdot f^*(-1)$$

$$- \underset{(2.16)}{0.300}\cdot(\text{pxf})(-3) - \underset{(1.62)}{0.048}\cdot \text{d1} + \underset{(1.83)}{0.058}\cdot \text{d2} + \underset{(4.18)}{1.063}$$

R2 = 0.979 D-W = 2.186 SE = 0.0288

(2)

$$\Delta m = \underset{(6.82)}{-.678}\cdot\Delta m(-1) - \underset{(2.18)}{.219}\cdot\Delta m(-2) + \underset{(5.03)}{3.833}\cdot\Delta z$$

$$- \underset{(2.16)}{.580}\cdot\Delta \text{pmz} - \underset{(2.10)}{.196}\cdot\text{pmz}(-1) + \underset{(3.14)}{2.154}\cdot\Delta\text{cap} - \underset{(3.23)}{.145}\cdot\text{d1}$$

R2 = .723 D-W = 1.825 SE = .0425

(3)

$$c = \underset{(14.67)}{0.827}\cdot c(-1) + \underset{(2.75)}{0.170}\cdot\text{yhr}(+1) - \underset{(2.33)}{0.323}\cdot(r-(400\cdot\Delta\text{pc}(+1)))$$

$$- \underset{(2.67)}{1.473}\cdot\Delta\text{pc}(+1) + \underset{(3.16)}{0.831}$$

R2 = 0.995 D-W = 2.357 SE = 0.0090

(4)

$$\text{ih} = \underset{(2.74)}{0.317}\cdot\text{ih}(-1) + \underset{(3.43)}{0.231}\cdot\text{bp}(-1) + \underset{(1.31)}{0.101}\cdot\text{bp}(-3)$$

$$- \underset{(2.86)}{0.186}\cdot(r(-4)-(400\cdot\Delta\text{pih}(-3))) + \underset{(1.56)}{0.156}\cdot(\text{yh}-\text{pih})(-4)$$

$$- \underset{(3.45)}{0.140}\cdot\text{d3} + \underset{(4.53)}{4.371}$$

R2 = 0.720 D-W = 2.045 SE = 0.0376

(5)

$$\Delta\text{if} = - \underset{(5.98)}{0.674}\cdot(\text{if}-y)(-1) + \underset{(4.54)}{0.535}\cdot(\text{if}-y)(-2) + \underset{(1.99)}{1.028}\cdot\Delta y$$

$$+ \underset{(3.07)}{0.549}\cdot\text{cap} - \underset{(0.92)}{0.066}\cdot\Delta(r(-4)-400\cdot\Delta\text{pi}(-3))$$

$$- \underset{(1.83)}{0.876}\cdot\Delta(w-\text{pq})(+2) + \underset{(2.24)}{0.074}\cdot\text{d4} - \underset{(4.40)}{0.728}$$

R2 = 0.614 D-W = 2.203 SE = 0.0398

(6)

$$\text{lw}-n = \underset{(3.93)}{0.476}\cdot(\text{lw}-n)(-1) + \underset{(2.12)}{0.123}\cdot\text{cap} - \underset{(4.42)}{0.886}$$

R2 = 0.356 D-W = 1.813 SE = 0.0148

$$(7)\quad \Delta w = \underset{(26.85)}{1.031}\cdot\Delta wc + \underset{(1.47)}{0.017}\cdot\Delta 4pc^{*}(+1) + \underset{(3.69)}{0.004}\cdot cap$$

$R2 = 0.943 \qquad D\text{-}W = 2.136 \qquad SE = 0.0025$

$$(8)\quad \Delta pc = \underset{(4.98)}{0.243}\cdot\Delta wn + \underset{(3.37)}{0.161}\cdot\Delta wn(-1) + \underset{(4.36)}{0.210}\cdot\Delta wn(-2)$$

$$+ \underset{(1.80)}{0.057}\cdot\Delta pm + \underset{(2.43)}{0.087}\cdot\Delta pm(-1) - \underset{(2.87)}{0.044}\cdot pcx(-1)$$

$R2 = 0.727 \qquad D\text{-}W = 1.389 \qquad SE = 0.0046$

$$(9)\quad \Delta pi = \underset{(4.04)}{0.427}\cdot\Delta 2pi(-1) + \underset{(5.37)}{0.426}\cdot\Delta 2wn + \underset{(1.41)}{0.128}\cdot\Delta 2pm$$

$R2 = 0.522 \qquad D\text{-}W = 1.938 \qquad SE = 0.0111$

$$(10)\quad \Delta pg = \underset{(3.39)}{.147}\cdot\Delta pg(-1) + \underset{(10.64)}{0.664}\cdot\Delta wn + \underset{(1.89)}{0.133}\cdot\Delta pm$$

$R2 = 0.608 \qquad D\text{-}W = 2.050 \qquad SE = 0.0071$

$$(11)\quad \Delta pfx = -\underset{(2.77)}{0.239}\cdot pxf(-1) + \underset{(1.51)}{0.395}\cdot\Delta w + \underset{(2.24)}{0.013}\cdot d5 - \underset{(2.30)}{0.017}$$

$R2 = 0.195 \qquad D\text{-}W = 2.004 \qquad SE = 0.0182$

$$(12)\quad r = \underset{(4.17)}{16.024}\cdot\Delta 4pc(+1) + \underset{(6.92)}{0.859}\cdot rd + \underset{(2.22)}{4.883}\cdot\Delta(nd-pc)(-1) + \underset{(1.31)}{1.191}$$

$R2 = 0.799 \qquad D\text{-}W = 0.561 \qquad SE = 0.603$

$$(13)\quad cap = \underset{(19.12)}{1.640}\cdot cap(-1) - \underset{(8.03)}{0.704}\cdot cap(-2) + \underset{(2.88)}{0.176}\cdot\Delta y - \underset{(1.74)}{1.786}\cdot\Delta n(-1)$$

$$- \underset{(0.82)}{0.006}\cdot if(-1) - \underset{(0.79)}{0.006}\cdot\Delta(pmo-pq)(-4) + \underset{(1.87)}{0.107}$$

$R2 = 0.981 \qquad D\text{-}W = 1.634 \qquad SE = 0.0054$

All variables, except r, are expressed in logs, and all expenditures are defined in real terms. Variables marked with an asterisk are two period averages so that $x^{*} = (x+x(-1))/2$. The number of lags is shown in parentheses after each lagged variable. The numbers in parentheses below the parameter estimates are unadjusted t-ratios. E.g. (-1) refers to period t-1. Δ denotes the first backwards differencing operator and Δ4 denotes the fourth and Δ2 the second backwards differencing operator. R2 = coefficient of determination, D-W = Durbin - Watson statistic and SE = standard error of estimate.

Appendix 1 continued

LIST OF VARIABLES (exogenous variables are underlined)

<u>b</u>	building permits for residential construction
c	private consumption
ca	current account
cap	capacity utilization rate in manufacturing
<u>d1-d5</u>	dummy variables
<u>f</u>	foreign import demand
<u>g</u>	public consumption
<u>ig</u>	public investment
if	manufacturing investment
ih	housing investment
lw	wage-earners' employment
m	imports (excluding oil)
<u>n</u>	working-age population
<u>nd</u>	central government's long-term domestic debt
pc	private consumption prices
pcx	pc - px
<u>pf</u>	foreign producer prices
pg	public consumption prices
pi	investment prices
<u>pih</u>	dwelling prices
<u>pm</u>	import prices
<u>pme</u>	import prices (excluding oil)
<u>pmo</u>	import prices of oil
pmz	pme - pz
pq	GDP deflator
px	export prices of goods (excluding bilateral exports)
pxf	px -pf
pz	private demand prices
r	interest rate (government bond yield)
<u>rd</u>	discount rate
<u>s</u>	employers' social security contributions rate
<u>t</u>	linear time trend
w	wage rate
<u>wc</u>	contract wage rate (cf. fn. 5)
wn	w·(1+s)
wr	w·(1+s) - pq
x	exports of goods (excluding bilateral exports)
<u>xe</u>	bilateral exports
y	gross domestic product at constant 1985 purchasers' prices
yh	households' disposable income
yhr	yh - pc
z	private demand (lagged four-quarter average)

Data source: Bank of Finland's data bank (TAKO). The data are seasonally adjusted. The definitions of the variables and printouts of the data (also a printout of the complete model file) are avaiable upon request from Anneli Majava at the Economics Department of Bank of Finland.

Appendix 1 continued

Diagnostic Test Statistics

Equation	DW	LM1	BP	JB	CHOW	RESET	RBOW	DIF	IMT	ARCH	OL
x*	57.38	19.19	19.56	30.58	..	32.99	..	0.07	..	73.28	3.00
Δm	12.16	23.95	38.51	62.95	..	24.86	..	0.00	..	72.40	..
c	78.16	4.84	28.05	59.67	9.68	4.71	13.50	0.00	8.21	1.70	2.84
ih	41.41	35.90	49.11	45.99	..	8.79	..	0.15	..	42.14	2.25
Δif	76.33	6.02	11.54	37.69	..	35.67	..	0.00	..	94.88	2.65
lw	62.82	33.21	1.25	12.24	14.68	34.39	99.38	0.03	2.39	62.82	2.75
Δw	63.11	-	0.30	13.29	11.82	0.41	0.08	10.83	8.88	6.54	3.17
Δpc	1.04	0.92	10.48	69.21	40.57	3.02	77.71	1.87	91.83	59.46	2.64
Δpi	35.27	42.98	48.54	94.60	49.11	48.71	75.70	0.08	53.25	2.78	2.99
Δpg	56.17	33.36	0.01	5.31	49.70	44.69	89.46	0.95	62.71	4.41	3.41
Δpfx	39.75	46.49	5.93	74.59	..	58.76	7.79	0.00	..	77.69	3.05
r	0.00	-	13.14	61.45	52.42	6.61	42.11	18.87	10.29	0.20	2.10
cap	3.68	8.21	33.76	75.75	28.93	22.52	9.54	0.00	65.32	13.15	2.55
Δwc	56.20	28.30	0.43	14.46	84.99	..	20.85	74.07	11.51	0.48	2.62

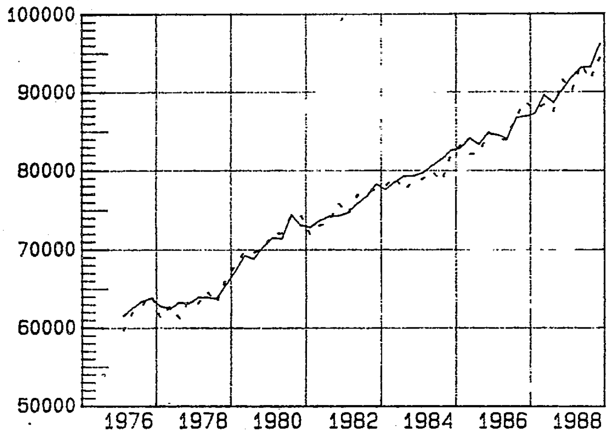
OLS estimates of these equations are reported in Table 1 and in fn. 7. The following test statistics have been computed: DW = the exact Durbin-Watson test statistic for first-order autocorrelation, LM1 = Godfrey's test statistic for first-order autocorrelation in the case of lagged dependent variables, BP = the Breusch-Pagan test statistic for residual heteroskedasticity (computed in terms of y), JB = the Jarque-Bera test statistic for normality of residuals, CHOW = Chow's stability test statistic with respect to the period 1983Q2, RESET = the Ramsey-Schmidt test statistic for functional misspecification (with respect to the powers 2 and 3 of the estimated endogenous variable), RBOW = Utts misspecification test statistic, DIF = the Plosser-Schwert-White differencing test statistic, IMT = White's information matrix test statistic, ARCH = Engle's test statistic for autoregressive conditional residual heteroskedasticity (computed for 4 lags) and OL = the Cook-Weisberg test statistic for mean-shift outliers. The numbers are marginal significance levels. In the case of the OL test, the original values of the test statistic are reported. The corresponding approximate 1 % and 5 % marginal significance levels are 3.53 and 4.06. (..) indicates that the test statistic could not be computed, and (-) that the test is not appropriate. In the case of the Durbin-Watson test one should, however, remember that it is biased when the lagged dependent variable is included in the set of explanatory variables. For further details, see Krämer and Sonnberger (1986).

FIGURE 1

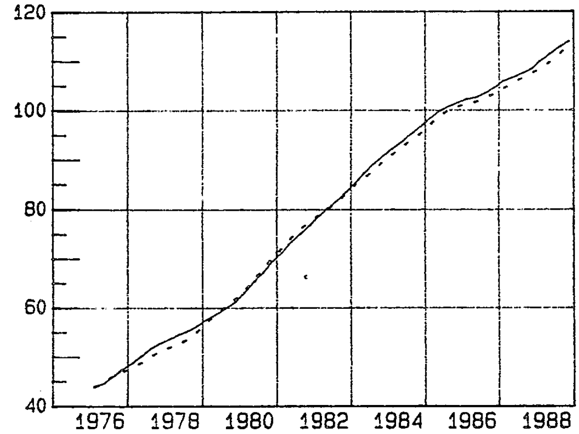
COMPARISON OF ACTUAL AND FORECAST VALUES OF GDP AND CONSUMPTION PRICES

ACTUAL VALUE -------
DYNAMIC SIMULATION ....

GDP

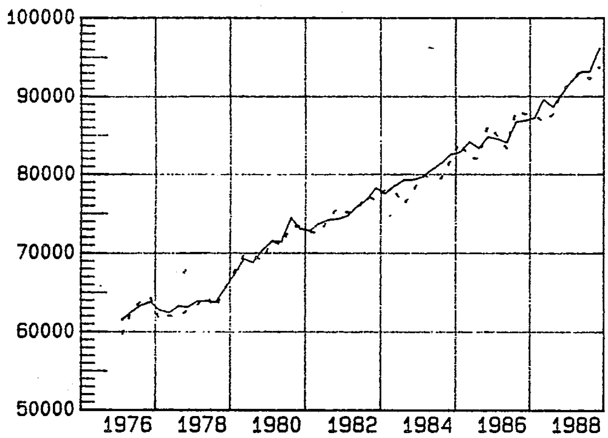


CONSUMPTION PRICES



ACTUAL VALUE -------
STATIC SIMULATION ....

GDP



CONSUMPTION PRICES

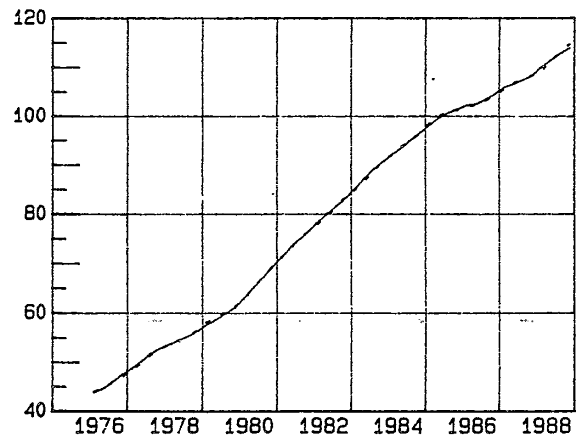
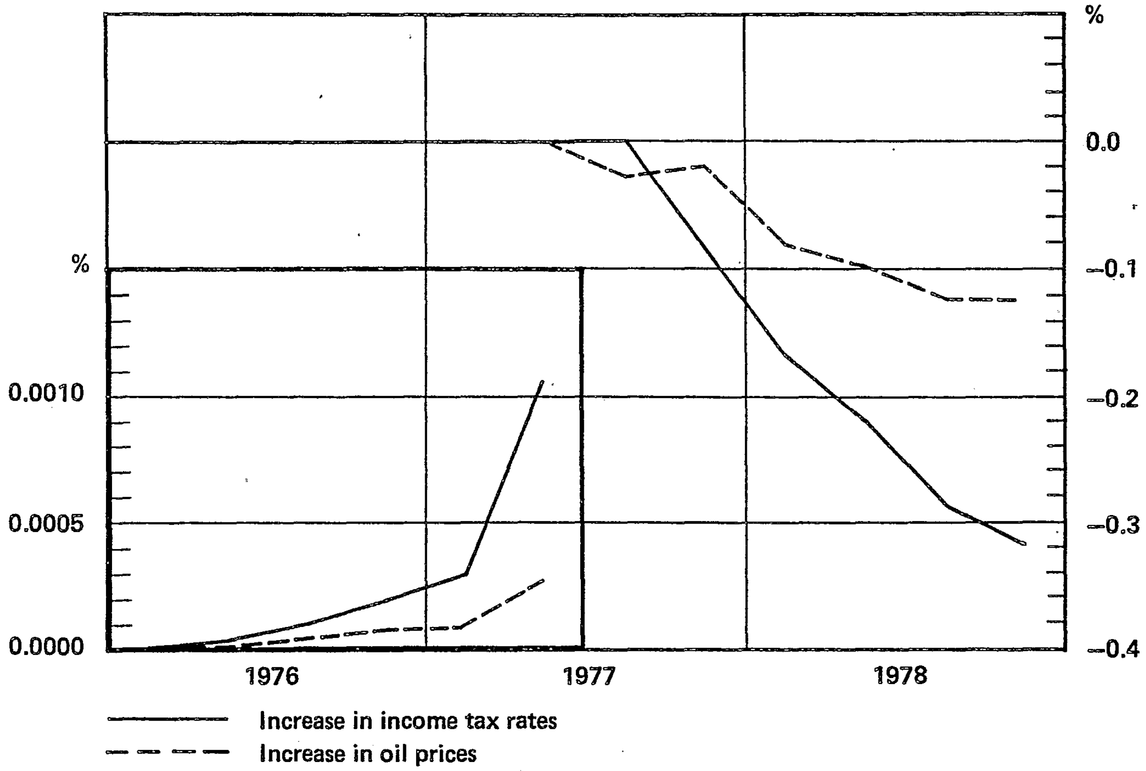


FIGURE 2

POLICY SIMULATION RESULTS WITH FOUR LEADS IN THE CONTRACT WAGE EQUATION[1)]

Increase in income tax rates ————————
Increase in oil prices - - - - - - -



1) Note that the first six observations are redrawn in the lower left-hand corner of the figure.

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