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THE SCANDINAVIAN INFLATION MODEL IN FINLAND

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ABSTRACT: An economy with open and sheltered sectors is considered. A contradiction between a fair incomes policy and a fixed exchange rate policy is suggested: the fair incomes policy causes a fall in the open sector profitability. If the productivity differential between the sectors is perpetual, there is no device to restore the equilibrium - except the exchange rate policy.

The EFO model is estimated and tested in its basic and widened forms. A VAR approach with cointegrated variables is used. The basic EFO model is clearly rejected. In the widened specification two different long-run trajectories are specified. The open sector price-parity and the 'fair wage policy' conditions are fulfilled. The exchange rate movements are observed to play a key role in the long-run equilibrium.

KEY WORDS: EFO model, cointegration, VAR models

SUMMARY

The aim of the study is twofold. In the first part it is shown that if the sheltered sector production is used in the open sector as an intermediate input, a fair incomes policy suggested by the Scandinavian inflation model causes a fall in the open sector profitability compared to the case of separate wage setting.

It is suggested that that there might be a contradiction between the fair incomes policy and the fixed exchange rate policy. In the case of the intermediate input augmented EFO model the fair incomes policy lowers the open sector profitability. Although the model is static, the comparison of the static equilibriums reveals that if the fair incomes policy is maintained and if the productivity differential is perpetual, there is no device to restore the equilibrium - except the exchange rate policy.

In the second part an empirical EFO model is specified. It is first tested in its strict form by using an augmented Dickey-Fuller test. In the next stage the analysis is widened, and a VAR approach with cointegrated variables suggested by Johansen and Juselius (1990) is used.

The EFO model in its basic form was clearly rejected. In the widened empirical specification two different long-run trajectories were estimated, and the necessary and sufficient rank-conditions for the long-run identification were fulfilled.

The estimated long-run equilibrium conditions were found to be consistent with some of the EFO model relations. The price-parity in the open sector and the 'fair wage policy' conditions were fulfilled. The conditions relating the wage and productivity behaviour to each other were not satisfied. The exchange rate movements were observed to play a key role in the long-run equilibrium.

YHTEENVETO

Tutkimuksessa käsitellään pohjoismaista inflaatiomallia eli ns. EFO-mallia. Tutkimuksessa osoitetaan, että mikäli suljetun sektorin tuotantoa käytetään avoimella sektorilla tuotannon välipanoksena, samansuuruisiin palkankorotuksiin perustuva tulopolitiikka aikaansaa kannattavuuden alenemisen talouden avoimella sektorilla suhteessa sektorikohtaiseen palkanasetantaan. Kiinteän valuuttakurssipolitiikan ja solidaarisen tulopolitiikan välillä on näin ollen usein ristiriita. Jos tulopolitiikka mitoitetaan talouden avoimen sektorin työn tuottavuuden kasvun mukaiseksi ja mikäli työn tuottavuus kasvaa nopeammin talouden avoimella kuin suljetulla sektorilla, kustannusten nousu johtaa pitkällä aikavälillä avoimen sektorin kannattavuuden heikkenemiseen ja valuuttakurssin devalvoitumiseen.

Tutkimuksen empiirisessä osassa täsmennetään EFO-malli käyttäen Suomen taloutta kuvaavaa aikasarja-aineistoa. EFO-mallin ns. perusmuotoa testataan laajennetulla Dickey-Fuller -testillä. Myöhemmässä vaiheessa tarkastelua laajennetaan, ja EFO-malli täsmennetään käyttäen Johansenin ja Juseliuksen (1990) VAR-lähestymistapaa.

EFO-mallin perusmuoto hylättiin testien perusteella selvästi. Mallin laajennetussa tarkastelussa täsmennettiin kaksi pitkän aikavälin riippuvuussuhdetta. Estimoidut pitkän aikavälin riippuvuussuhteet olivat sopusoinnussa joidenkin EFO-mallin ominaisuuksien kanssa. Havaintoaineisto tuki hypoteeseja avoimen sektorin hintapariteetista ja ns. solidaarisesta palkkapolitiikasta. Valuuttakurssimuutoksilla todettiin olevan keskeinen rooli pitkän aikavälin tasapainossa. Sen sijaan EFO-mallin hypoteesit palkkojen ja työn tuottavuuden välisestä suhteesta hylättiin.

Contents

1 Introduction

The Scandinavian Inflation model or the EFO model[1] was developed in the late 1960's to explain wage and price formation in the Nordic countries. The EFO model explains interaction between wages and prices in a small open economy where the wage negotiations are based on centralized contracts which often cover most of the economy.

In the model the economy is divided into two main sectors, an open and a sheltered sector. The open sector competes with its export products in the world market, whereas the sheltered sector does not meet remarkable international competition. The basic idea of the model is that the increase in labour productivity is different in the two sectors. If the labour productivity growth is faster in the open sector than in the sheltered sector and if the increase in wages is based on the open sector productivity growth, this may increase the relative inflation rate.

The EFO model was not originally based on a theoretical starting point. On the contrary, the aim was to describe the essential features in the Scandinavian wage and price formation. Later the EFO model has been adapted to theoretical frameworks, which has produced the EFO model as a special case. Theoretical research in this area has been undertaken by Branson and Myhrman (1976), Paunio and Halttunen (1976), Kierzkowsky (1976) and Korkman (1977). In these studies the target has been to analyze the models and infer when the more general models produce the behaviour of the EFO model.

The EFO model has had a conclusive influence on the elementary questions concerning Finnish economic policy. This model has been used to define the corridors for the wage increases, which have, in principle, been based on an increase in the labour productivity. Furthermore, the model has had a strong normative nuance when it has been used to describe a fair incomes policy. In Finland the aim of incomes policy has often been to equalize the wage increases between the sectors. Although the fundamental setup concerning the fairness in incomes policy is now possibly changing, the questions related to the differences in the labour productivity and the passing through of the wage increases from the open sector to the sheltered sector are still most current.

The aim of the study is twofold. In the first part it is shown that if the sheltered sector production is used in the open sector as an intermediate input, the fair incomes policy

[1]The EFO model was named by its developers Edgren, Faxen and Odhner (1970). The model has also been discussed by e.g. Aukrust (1970), Calmfors (1978) and Lindbeck (1979).

suggested by the EFO model causes a fall in the open sector profitability compared to the separate wage setting.

In the second part an empirical specification for the EFO model is formulated. The EFO model is first tested in its strict or basic form by using an augmented Dickey-Fuller test. In the next stage the analysis is widened, and a VAR approach with cointegrated variables suggested by Johansen and Juselius (1990)[2] is used to specify the EFO model. The basic idea of this approach is to separate short-run dynamics and long-run relations from each other. This principle is a very crucial one, because the EFO model has to be interpreted in the terms of long-run trajectories and not short-term flcutuations. In the past the empirical work concerning the EFO model has focused on short-term analysis, which has been in conflict with the essential premises of the model[3].

In the 1980's econometric methods concerning the modelling of the non-stationary time series have been elaborated considerably. This gives a possibility to pay attention to long-term equilibrium relations between the variables while still having a look at the short-run behaviour. The new empirical approach in studying the EFO model has been applied also in Sweden (Warninger, 1991) and Norway (Rödseth and Holden, 1990), although the system approach used in this study has not been used before in the EFO context.

Section 2 briefly describes the EFO model. In section 3 the implications of the intermediate input use are introduced and discussed, and a possible mechanism for a cycle of repeating devaluations is introducd. In section 4 the EFO model is tested in its basic form, and in the following section the estimation of the model is carried out by using a cointegrating VAR-approach. Conclusions are drawn at the end of the paper.

[2]See also Johansen (1988), Johansen and Juselius (1992a).
[3]See e.g. Blomqvist (1981).

2 The EFO model

The EFO model can be described by using five or six equations (Calmfors, 1979; Lindbeck, 1979):

$$\Delta p_t = \Delta e + \Delta p_w \tag{1}$$

$$\Delta w_t = \Delta p_t + \Delta q_t \tag{2}$$

$$\Delta w_s = \Delta w_t \tag{3}$$

$$\Delta p_s = \Delta w_s - \Delta q_s \tag{4}$$

$$\Delta p_c = \alpha \Delta p_t + (1 - \alpha)\Delta p_s \tag{5}$$

$$\Delta p_c = \Delta e + \Delta p_w + (1 - \alpha)(\Delta q_t - \Delta q_s) \tag{6}$$

All the equations are expressed in relative changes. The symbol Δ stands for a relative difference operator. The variable p_t is the open sector production price, e is the currency index, p_w is the world market price or the competitors' price, w_t is the open sector level of earnings index, q_t is the open sector labour productivity, w_s is the sheltered sector level of earnings index, p_s is the sheltered sector production price, q_s stands for the sheltered sector labour productivity and p_c is the consumer price index.

Equation 1 states that the open sector in the economy is a price taker: only the exchange rate and the world inflation have an effect on the local currency prices. In other words, equation 1 is a purchasing power parity condition. Equation 2 specifies the wage corridor which guarantees that incomes distribution remains unchanged. Equation 3 defines the loyal incomes policy between the two sectors. Equation 4 is analogous with equation 2, although the logic of this equation is derived from the impact of wages and productivity on the price formation. Equations 5 and 6 are equal, but they are parametrized in different ways. The latter equation for the consumer price states that the domestic inflation in the economy is created by the world inflation, changes in the nominal exchange rate and, especially, by the difference in the labour productivity between the two sectors.

Originally the model has been specified in differences and not in levels. The contradiction raises from the fact that the relations in the five or six equations above should define the long-run relationships between the variables. For example, changes in the nominal exchange rate do not necessarily have an immediate impact on the pricing behaviour,

but in the long run the world market price and the domestic open sector prices have to be on a par. In addition, in Finland the changes in the exchange rate and the world market prices have not always caused changes in the open sector pricing. Often the causality has been thought to proceed from the domestic pricing behaviour to a change in the nominal exchange rate. The five equations describing the EFO model should not be thought of as strict causal relations, but as long-run equilibrium conditions. In the short-run, deviations from the target levels may be significant, but this should not necessarily lead to the rejection of the EFO model.

The original EFO model described above can be thought to be a simplification of the real-world model. For example, a feed-back effect from the pricing behaviour to the labour productivity is not defined, although it may be of significant importance, especially in the long run. A common opinion in Finland has been that a loss in price competitiveness has been often compensated by raising the labour productivity in the open sector. If this is the case, the productivity factors cannot be considered as solely exogenous. In other words, also the effects from the labour market conditions to the productivity behaviour should be taken into consideration. On the other hand, if the equations are interpreted as equilibrium conditions and not as structural equations, the shortcoming is not so crucial.

3 Intermediate Input and its Implications

The section gives a reinterpretation of the Scandinavian inflation model. The purpose is to show that when the sheltered sector production is used in the open sector as an intermediate input, the fair incomes policy suggested by the EFO model causes a fall in the open sector profitability compared to the separate wage setting. The open sector labour productivity is assumed to exceed that of the sheltered sector. The sheltered sector is presumed to have market power in its price setting, while the open sector is assumed to be a price-taker.

The wage setting in the open sector is assumed to follow the EFO rule, which states that the income share of wages is constant. This implies that the real wage increases are set to equal the change in the labour productivity: $\Delta w_t = \Delta p_t + \Delta q_t$, where Δ stands for a relative difference operator, w_t for the open sector wages, p_t for the given open sector prices and $q_t = Y_t/N_t$ for the open sector labour productivity. The symbol N_t

denotes the labour input and Y_t the open sector value added production. In a level form the EFO rule can be expressed as $w_t = p_t \times q_t$, which suggests a long-run cointegrating relation between the productivity and the real wage level.

Because of the productivity differential between the two sectors and the fair incomes policy $w_t = w_s$, the sheltered sector wage increases are higher than the change in the sheltered sector labour productivity. The non-competitive behaviour in the sheltered sector production allows the sheltered sector firms to pass the wage costs through to the prices. The increase in costs of the intermediate input causes a reduction in the open sector profitability.

Although the model is static, it characterizes the essential features of a cycle of repeating devaluations. Exchange rate movements are not explicitly described, but a reduction in profitability may be a good argument for devaluations, which raise domestic currency export prices and promote a recovery in profitability.

An economy with two sectors - open and sheltered - is considered. The firms of these sectors are presumed to maximize their profits. The open sector profit is

$$\Pi_t = p_t Q_t - w_t N_t - p_s(w_s) Q_s, \tag{7}$$

where p_t is the open sector production price, Q_t is the open sector gross product, $Q_t = Y_t^a Q_s^{1-a} = (A N_t^\alpha K_t^{1-\alpha})^a Q_s^{1-a}$. The gross product contains two components, the open sector value added Y_t and the intermediate input from the sheltered sector Q_s. The assumptions of Cobb-Douglas technology and constant returns to scale are maintained.

The open sector is assumed to be a price taker. When the profit function is maximized with respect to the labour input N_t, the optimal labour demand may be written in the form

$$N_t = \left(\frac{w_t}{a\alpha p_t (A K_t^{1-\alpha})^a Q_s^{1-a}}\right)^{\frac{1}{a\alpha-1}} = \left(z_1 \frac{w_t}{p_t}\right)^{\frac{1}{a\alpha-1}}. \tag{8}$$

In the sheltered sector, respectively, the profit function may be written in the form

$$\Pi_s = p_s Q_s - w_s N_s = p_s(Q_s(N_s)) Q_s(N_s) - w_s N_s. \tag{9}$$

A technology assumption $Q_s = Y_s = \frac{1}{\beta}N^{\beta}$ is maintained, $0 < \beta \leq 1$. The sheltered sector capital stock is assumed to be constant. No essential information is lost with this assumption, because the aim is to allow for different labour productivities in the two sectors. The sheltered sector firms encounter a downward sloping demand curve, which allows for passing through the rise in costs to prices. The first order condition for the profit maximization may be written in the form

$$\frac{\partial \Pi}{\partial N_s} = \frac{\partial p_s}{\partial Q_s}\frac{\partial Q_s}{\partial N_s}Q_s + \frac{\partial Q_s}{\partial N_s}p_s - w_s = 0, \tag{10}$$

which leads to the following price-setting equation

$$p_s = \frac{w_s - (\partial p_s/\partial Q_s)(\partial Q_s/\partial N_s)Q_s}{\partial Q_s/\partial N_s} = \frac{w_s - \beta q_s(\partial p_s/\partial Q_s)Q_s}{\beta q_s}, \tag{11}$$

which can also be written in the markup form

$$(1+\epsilon)p_s = \frac{w_s}{\beta q_s}, \tag{12}$$

where $\epsilon = (\partial p_s/\partial Q_s)(Q_s/p_s)$ is the inverse price elasticity of demand and q_s is the sheltered sector labour productivity. The relation between the equation (12) and the EFO rule is interesting. If the EFO rule is interpreted in its original relative difference form, the inverse price elasticity ϵ and the coefficient β vanish. In this case the EFO rule is consistent with the profit maximization in any constant values of ϵ and β. Furthermore, there is no long-run trajectory for the wages. Despite the initial state of the economy the differences of the real wages and the labour productivity are always on a par. On the other hand, in the level form the EFO rule is consistent with the profit maximization only under restrictive assumptions. The rule presumes that there is no deviation from the competitive equilibrium ($\epsilon = 0$). Furthermore, the marginal productivity of labour is assumed to equal the average labour productivity ($\beta = 1$). In other words, constant returns to scale are assumed.

The productivity differential between the sectors and the fair incomes policy of the EFO type - $w_s = w_t$ - suggests that the increase in the sheltered sector wages exceeds the increase in its labour productivity. Because of the non-competitive behaviour in the sheltered sector, the wage increases may be passed through to prices, as equation

(12) suggests. The inflationary incomes policy in the sheltered sector together with the non-competitive pricing behaviour raises the price level compared to the competitive equilibrium.

If no market power existed in the sheltered sector, the sheltered sector labour demand would be lower and the prices would be unchanged on a given wage level. The pass-through effect maintains the employment in the sheltered sector. Because the open sector uses the sheltered sector production as an intermediate input, the fair incomes policy decreases the sheltered sector profitability, although the share of income in terms of the value added figures remains unchanged, as the EFO rule suggests.

4 Testing the EFO model in its Basic Form

Quarterly Finnish data from 1977/1 to 1993/1 was used in the study. The l:s in front of the empirical variable symbols denote logarithms. The competitors' price (lp_w) was defined as an import price in the OECD Europe area. The open sector production price (lp_t) was the producer price in manufacturing. The sheltered sector production price was a price index, where taxes and import prices were subtracted from the consumer price index. The net price index and the import share calculations by Ahde (1990) were used in the index construction. Because the open sector was defined to consist of manufacturing, the level of earnings index of the manufacturing was used to describe the wage formation in the open sector (lw_t). The sheltered sector was defined to cover the rest of the economy, and the level of earnings index in the sheltered sector (lw_s) was obtained by subtracting the open sector level of earnings index from the total level of earnings index. The productivity indices (lq_t and lq_s) were constructed by dividing the value added figures by the actual working hours figures. The Bank of Finland trade-weighted currency index was used as the exchange rate index (le).

First the possible non-stationarity was tested with an Augmented Dickey-Fuller test (Said and Dickey, 1984). The tests were carried out with four different lag structures with and without a time trend[4]. There was no clear indication of the rejection of the null hypothesis[5]. The choice of the lag length had some effect on the test results. The unit root tests reinforced that a cointegration approach could be a appropriate starting point for the analysis.

[4]See tables 3 and 4 in the appendix.

[5]In the Dickey-Fuller tests the null hypothesis stands for non-stationarity.

The EFO model is a set of equations where strict unity restrictions have been imposed on the parameters. The EFO model with all the restrictions could be called a basic EFO model, because it does not allow for the impacts of other variables.

The validity of the five-equation Scandinavian inflation model was tested by using a simple unit-root test (Warninger, 1991). The basic regression techniques like OLS could not be used, because the test inference familiar with the normal regression models[6] is not valid when non-stationary variables are incorporated to the analysis. Instead, the unit root tests can be used to test the hypothesis, especially when unity assumptions for the coefficients have been imposed. First, the following equilibrium conditions were calculated.

$$x_1 = lp_t - le - lp_w \tag{13}$$

$$x_2 = lw_t - lp_t - lq_t \tag{14}$$

$$x_3 = lw_s - lw_t \tag{15}$$

$$x_4 = lw_s - lp_s - lq_s \tag{16}$$

If the restrictions imposed by the H_0[7] are valid, all the equilibrium conditions, the variables x_1, x_2, x_3 and x_4 should be stationary. This can be easily tested. The augmented Dickey-Fuller -test (Said and Dickey, 1984) was carried out for the x_i variables.

When the lag length 1 was used, some indication of the rejection of the non-stationarity null hypothesis was obtained. The fair incomes policy and the sheltered sector income share were found to be stationary. When the lag lengths 2,3 and 4 were used, the null hypothesis could not be rejected with respect to any of the x_i variables[8].

[6] E.g. F-tests and LR-tests, where restrictions to the coefficients are imposed.
[7] The Scandinavian inflation model is the null hypothesis in this case.
[8] See table 10 in the appendix for the test results.

5 Estimation of the EFO model with a Cointegrating VAR Approach

Consider a nine-dimensional vector autoregressive model with Gaussian errors,

$$Z_t = A_1 Z_{t-1} + ... + A_k Z_{t-k} + \mu + \Phi D_t + \epsilon_t, \tag{17}$$

where $Z_t = [lp_t, lw_t, lw_s, lp_s, lp_c, lq_t, lq_s, le, lp_w]_t$ and D_t is a vector of centered seasonal dummies. The model (17) can be reparametrized in the form

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + ... + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-1} + \mu + \Phi D_t + \epsilon_t. \tag{18}$$

The model (18) is actually written in an error correction form. It includes both a dynamic part in a differenced form and a long-run equilibrium target in a level form. The Π matrix describes the long-run behaviour of the model, and the long-run properties may be studied by investigating the matrix Π. Three cases can be distinguished. If the matrix has full rank, it indicates that the vector process Z_t is stationary. On the other hand, if Π is a null matrix, the model reduces to a traditional differenced vector time series model. The third and the most interesting case is when $0 < rank(\Pi) = r < p$, where p is the dimension of the model (Johansen and Juselius, 1990).

In the third case there are $(p \times r)$ matrices α and β such that $\Pi = \alpha\beta'$. Furthermore, the r cointegrating vectors have the property that $\beta' Z_t$ is stationary although Z_t itself is not. If this is the case, the model (18) can be interpreted as an error correction model[9].

The model (18) can be estimated with a method suggested by Johansen (1988) and Johansen and Juselius (1990) by calculating the maximum likelihood estimator. Briefly stated, first ΔZ_t and Z_{t-k} are regressed on $\Delta Z_{t-1}, ..., \Delta Z_{t-k+1}$, constant and seasonal dummies. The residuals R_{0t} and R_{kt} of these estimations are then used to form the residual product moment matrices

$$S_{ij} = T^{-1} \sum_{t=1}^{T} R_{it} R'_{jt}, \quad i, j = 0, k. \tag{19}$$

[9]See Johansen and Juselius (1990), Johansen (1988) and Engle and Granger (1987).

Because the likelihood function has the form $R_{0t} = \alpha\beta' R_{kt}$, the parameter α can be solved in the regression $\hat{\alpha} = S_{0k}\beta(\beta' S_{kk}\beta)^{-1}$. The β_i vectors can be estimated by solving the eigenvalue problem $|\lambda S_{kk} - S_{k0}S_{00}^{-1}S_{0k}| = 0$, which has the solution $\hat{\lambda}_1 > ... > \hat{\lambda}_p > 0$ with the corresponding p eigenvectors.

The crucial step in the estimation procedure is the definition of the rank of the Π matrix. The likelihood ratio test for the hypothesis $H_1(r < p)$ in the full VAR model H_0 is given by $-2lnQ(H_1(r)|H_0) = -T\sum_{i=r+1}^{p} ln(1-\hat{\lambda}_i)$ and it is called the trace statistics. Another test, the λ_{max} test is based on comparison of $H_1(r-1)$ against $H_1(r)$ and it is given by $-2lnQ(H_1(r-1)|H_1(r)) = -Tln(1-\hat{\lambda}_i)$[10].

In the case of the basic EFO model five cointegrating vectors are needed to test the restrictions. These could be compared with the unrestricted model by using a LR-test. Because the order of the possible EFO relations is unknown, the test should be carried out for $5! = 120$ different combinations. If none of the tests support the EFO model, it should be rejected.

In practice the test procedure can be simplified. Although the ordering of the possible EFO relations is unknown when the cointegrating vectors are considered, the most promising orderings can be easily seen by inspecting the estimated eigenvectors.

The basic EFO model was tested by imposing restrictions in the $r = 4$ cointegrating VAR model. The consumer price relation was not tested, because it included also other than zero and unity restrictions. Tests with some orderings were carried out, and the basic EFO model was clearly rejected.

After rejecting the basic EFO model with all the restrictions, more flexibility was allowed in the analysis. The zero and unity constraints were relaxed, and an unrestricted VAR model was used as a starting point.

First the weak exogeneity of the nine variables was investigated[11]. The test was carried out by restricting the α coefficients to zero in the estimation and using a likelihood ratio test (Juselius, 1991). Also the joint hypothesis where both the exchange rate index and the competitors' price were set to be weakly exogenous was carried out. The null hypothesis of weak exogeneity was maintained most clearly with the open

[10]See Johansen-Juselius (1990) and Osterwald-Lenum (1992) for the necessary tables for making inference.

[11]See table 1 in the appendix.

sector production price lp_t and the exchange rate index le. The null hypothesis was clearly rejected in the case of the sheltered sector production price and the productivity variables. The joint hypothesis with the exchange rate index and the world market price was not rejected at a five per cent significance level.

The tests gave an indication of endogenous productivity growth in the Finnish economy. The result is in a contradiction with the basic EFO model, which assumes exogenous productivity behaviour in the economy. Furthermore, significant differences in the price-taking behaviour were found between the two sectors. The weak exogeneity of the sheltered sector production price was clearly rejected, whereas the open sector production price was noticed to be weakly exogenous. The finding supports the EFO model interpretation of different price setting rules in the two sectors.

Because there is no reason to expect the competitors' price formation to follow the behaviour of the Finnish economy and because the processes driving the rigid exchange rate movements may be quite complicated, these variables were restricted to be weakly exogenous in the succeeding analysis, as suggested by the joint test.

After the weak exogeneity assumptions concerning the two variables had been made, the maximum likelihood estimates were calculated for the seven variable system[12]. The number of cointegrating vectors was restricted to two[13].

The problem in the VAR analysis is that the interest is concentrated on the reduced form equations, while the final interest in economic analysis should be directed to the structural equations. The basic question is whether it is possible to identify the structural equations from the reduced form presentation. When the long-run structure, the cointegrating vectors β_i, is considered, it is possible to examine the identification by using the reduced form estimates, because they are equal to the structural form estimates (Johansen and Juselius, 1992b). The common rank condition for the identification states that an equation is identified if $rank(R_1'\beta_1, ..., R_1'\beta_r) = rank(R_1'H_1\phi_1, ..., R_1'H_r\phi_r) = r - 1$, where $\beta_i = H_i\phi_i$ is a restricted cointegrating vector and $R_i'H_i = 0$. Both H_i and R_i are of full rank. In empirical applications where $r = 2$ the rank condition is satisfied if $rank[H_j'(I - H_i(H_i'H_i)^{-1}H_i')H_j] \geq 1$. In the case $r = 2$ at least one (independent) linear restriction for each of the cointegrating vectors is needed to guarantee the identification of the long-run structure. In table 6 in the appendix five different restrictions

[12]The Cats in Rats utility was used in the estimation, see Juselius (1991).

[13]See table 2 for the eigenvalues and the tests concerning them. The unrestricted eigenvectors are reported in table 5.

are outlined. In restriction A a parity between the exchange rate and the open sector production price is assumed. In restriction B the domestic market price-parity between the sheltered sector production price and the consumer price is assumed, and also the sheltered sector productivity is assumed to be exogenous. Restriction C reflects the fair incomes policy, and restriction D describes the relation between the competitors' price setting and the open sector productivity, which might result from the need to restore the price competitiveness under inflexible domestic price adjustment. In restrictions E and F the fair incomes policy and the open sector price parity conditions are combined.

Restrictions E and F satisfy the rank condition[14]. The significance level of the test also states that restrictions E and F are not rejected by the data.

Restriction E in table 6 was maintained and the estimations were repeated. The univariate residual analysis is reported in the table 7, residual autocorrelations in table 8 and the restricted cointegrating vectors in table 9.

The two cointegrating vectors obtained from the estimations describe two long-run trajectories where the economy is expected to proceed in the long-run. Different interpretations may be given to the two vectors in table 9. In the first cointegrating vector the wage relations in the two sectors are restricted to be on a par. In addition, the productivity coefficient was restricted to zero in the sheltered sector. This may indicate that the sheltered sector productivity has no major role in the wage formation. This may confirm the EFO model premise of productivity-independent wage increases in the sheltered sector.

Some evidence of the long-run parity between the open sector production price, the competitors' price and the exchange rate was obtained. On the contrary, no clear evidence of the equation (2) was attained. The relation between the open sector wage formation and the open sector price-setting had a wrong sign, whereas the exchange rate coefficient relation seemed to be quite strong. This may indicate that the limits in the wage increases in the open sector are ultimately not set by the pricing ability or the increase in productivity. Due to the results the exchange rate policy has played a key role in setting the long-run limits to the wage formation.

No easily interpretable information on the formation of the consumer price was obtained. In the CV_1 a long-run relation between the consumer price and the sheltered sector price

[14]Restrictions B, C and D do not include any restrictions for the second cointegrating vector. Although in the case A both vectors are restricted, the restrictions are not linearly independent.

was observed, but the data construction may partly explain this finding. Because the sheltered sector production price was constructed by subtracting indirect taxes, subsidies and import prices from the consumer price index, there can be similarities between these two indices due to the data construction.

6 Conclusions

The study suggests that there might be a contradiction between a fair incomes policy and the fixed exchange rate policy. In the case of the intermediate input augmented EFO model the fair incomes policy lowers the open sector profitability. Although the model is static, a comparison of the static equilibriums reveals that if the fair incomes policy is maintained and if the productivity differential is perpetual, there is no device to restore the equilibrium - except the exchange rate policy.

The study also examines the empirical specification of the EFO model. First the EFO model is analyzed in its basic form, where zero and unity restrictions have been imposed. The single equation ADF-tests and a cointegrating VAR approach were used. The EFO model in its basic form was clearly rejected.

In a widened empirical specification of the EFO model two different long-run trajectories were specified, and the necessary and sufficient rank-conditions for the long-run identification were fulfilled. This was insured by imposing restrictions on the coefficients.

The estimated long-run equilibrium conditions were found to be consistent with some of the EFO model equations. The price parity in the open sector and the 'fair wage policy' conditions were fulfilled, but the conditions relating the wage and productivity behaviour to each other were not satisfied. On the other hand, the exchange rate movements were noticed to play a key role in the long-run equilibrium. The empirical findings were on a par with the theoretical characterizations suggested in section 3.

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Appendix: Tables

Table 1: Likelihood ratio tests for weak exogeneity

Variable	$\chi 2$	df
Prod.price,open	2.72	2
Earnings,open	6.40 *	2
Earnings,shelt.	3.07	2
Prod.price,shelt.	10.74 **	2
Consumer price	7.92 *	2
Productivity, open	18.27 **	2
Productivity, shelt.	11.44 **	2
Exchange rate (*)	1.39	2
Competitors' price (x)	8.28 *	2
Joint test, (*) and (x)	9.47	4

The tests are based on an assumption of two co-integrating vectors
H0: weak exogeneity, df = degrees of greedom

* = significant at 5 per cent level
** = significant at 1 per cent level

Table 2: Eigenvalues, lambdamax- and tracetests

λ	max	trace
0.660	67.9 **	227.9 **
0.567	52.7 **	160.0 **
0.422	34.6 *	107.2 **
0.367	28.9 *	72.7 **
0.307	23.1 *	43.8 **
0.223	15.9 *	20.7 **
0.074	4.9 *	4.9 *

* = significant at 5 per cent level
** = significant at 1 per cent level

Appendix

Table 3: Augmented Dickey-Fuller tests for the unit root, no time trend

Variable	L=1	L=2	L=3	L=4
Consumer price	-2.3	-1.6	-2.6	-3.2 *
Exchange rate	1.0	0.3	0.4	0.6
Competitors' price	-0.4	-0.3	-0.5	-0.4 *
Prod.price,open	-1.7	-2.1	-2.2	-3.5
Prod.price,shelt.	-2.6	-1.8	-2.1	-2.1
Earnings,open	-2.6	-2.1	-2.6	-3.1
Earnings,shelt.	-2.7	-2.3	-2.8	-3.6 **
Productivity, open	-0.3	-0.3	-0.3	-0.2
Productivity, shelt.	-0.5	-0.3	-0.3	-0.3

H0: non-stationarity, L=lag length

* = significant at 5 per cent level
** = significant at 1 per cent level

Table 4: Augmented Dickey-Fuller tests for the unit root, time trend of 1st degree

Variable	L=1	L=2	L=3	L=4
Consumer price	-0.6	-0.3	-0.8	-1.7
Exchange rate	-0.1	-0.8	-1.0	-1.1
Competitors' price	-1.8	-1.9	-2.2	-2.0
Prod.price,open	-2.2	-2.2	-2.6	-3.1
Prod.price,shelt.	1.0	0.8	0.8	0.5
Earnings,open	0.4	0.2	0.1	-0.1
Earnings,shelt.	1.4	0.9	0.7	0.9
Productivity, open	-3.7 *	-3.1	-3.0	-3.3
Productivity, shelt.	-4.8 **	-3.2	-2.8	-2.5

H0: non-stationarity, L=lag length

* = significant at 5 per cent level
** = significant at 1 per cent level

Table 5: Unrestricted CVs

Variable	β1	β2	β3	β4	β5	β6	β7
Prod.price,open	0.73	1.00	-6.91	-73.10	-27.19	-24.75	-11.19
Earnings,open	1.00	14.04	-39.21	-11.24	-195.33	-8.44	53.19
Earnings,shelt.	-1.26	-8.68	-0.04	-103.28	180.12	16.65	-25.60
Prod.price,shelt.	-4.71	-3.12	34.91	9.53	-12.19	-112.39	-47.62
Consumer price	4.90	-3.48	-12.67	186.05	40.66	155.21	29.97
Productivity, open	1.73	2.84	16.51	14.31	-4.03	-14.69	4.72
Productivity, shelt.	-0.21	-5.74	23.79	0.00	-23.04	-1.79	8.58
Exchange rate	-0.84	-1.00	-17.46	-18.47	-14.99	-12.73	8.51
Competitors' price	-1.60	-0.43	18.97	5.09	20.26	-20.31	-14.92

Table 6: Restrictions for CV1 and CV2

	A		B	C	D	E		F	
Variable	CV1	CV2	CV1	CV1	CV1	CV1	CV2	CV1	CV2
Prod.price,open	1	1	*	*	*	*	1	*	1
Earnings,open	*	*	*	1	*	1	*	1	*
Earnings,shelt.	*	*	*	-1	*	-1	*	-1	*
Prod.price,shelt.	*	*	1	*	*	*	*	*	*
Consumer price	*	*	-1	*	*	*	*	*	*
Productivity, open	*	*	*	*	1	*	*	*	*
Productivity, shelt.	*	*	0	0	0	0	*	0	*
Exchange rate	-1	-1	*	*	*	*	-1	*	-1
Competitors' price	*	*	*	*	-1	*	*	*	-1
Significance		0.99	0.77	0.60	0.92		0.60		0.20

* = unrestricted coefficient

Table 7: Univariate residual analysis

Variable	B-P(13)	ARCH(2)	J-B(2)
Prod.price,open	15.1	1.4	2.4
Earnings,open	13.6	7.2 *	0.5
Earnings,shelt.	10.8	4.3	1.0
Prod.price,shelt.	6.9	1.1	2.5
Consumer price	10.8	0.0	0.3
Productivity, open	19.0	1.7	3.7
Productivity, shelt.	6.3	1.5	0.6

Based on the restricted cointegration relation E in table 6

B-P: Box-Pierce test for serial correlation
ARCH: Test for homoscedastic variance
J-B: Jarque-Bera test for normality

* = significant at 5 per cent level
** = significant at 1 per cent level

Table 8: Residual autocorrelations

Variable	1	2	3	4	5	6	7	8
Prod.price,open	0.00	-0.21	0.00	0.15	-0.16	0.06	0.17	-0.05
Earnings,open	0.01	-0.06	-0.32	0.00	0.09	0.13	0.14	-0.03
Earnings,shelt.	-0.05	0.05	-0.29	-0.11	0.01	0.15	0.09	-0.04
Prod.price,shelt.	-0.04	0.04	-0.16	-0.08	0.07	0.13	0.07	-0.01
Consumer price	-0.17	0.08	-0.25	0.10	-0.02	-0.06	-0.07	-0.13
Productivity, open	-0.28	-0.08	-0.01	0.33	-0.27	0.05	-0.02	0.09
Productivity, shelt.	0.00	-0.16	-0.11	0.11	-0.10	0.08	-0.14	-0.03

Based on the restricted cointegration relation E in table 6

Table 9: Restricted CVs

Variable	CV1	CV2
Prod.price,open	1.280	1.000
Earnings,open	1.000	11.419
Earnings,shelt.	-1.000	-7.203
Prod.price,shelt.	-6.175	-3.685
Consumer price	5.783	-1.552
Productivity, open	2.076	2.690
Productivity, shelt.	0.000	-4.609
Exchange rate	-0.938	-1.000
Competitors' price	-2.171	-0.756
Eigenvalue	0.658	0.568

Based on the restricted cointegration relation E in table 6

Table 10: ADF-tests for the EFO-relations

Equation	L=1	L=2	L=3	L=4
Open sector price	2.7	2.3	2.1	2
Wage share, open	-3.2*	-2.5	-2.3	-2.7
Fair incomes policy	-1.8	-1.5	-1.2	-1.3
Wage share, sheltered	-8.2**	-2.5	-1.5	-1.4

H0: non-stationarity, L=lag length

* = significant at 5 per cent level
** = significant at 1 per cent level

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