Working Papers

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Jänner 1995

WIFO Working Papers, 1995, (72)

(95/015/W/9194)

1. Introduction*)

The WIFO macro model linked with an input-output model of Austria is used to simulate the impact of the Uruguay Round[1]). As in the case of the general equilibrium analysis (Breuss, 1995) the Uruguay Round results are obtained in two steps. In 1995 two commercial policy events took place at once: On January 1, Austria joined the EU. The World Trade Organization (WTO) was founded at the same time. Hence, Austria enters the common commercial policy (CCP) of the EU and has to implement the agreements of the Uruguay Round within the framework of EU's CCP. Being a member of the EU implies that Austria loses its autonomy in trade policy. Using a macroeconomic model has the advantage that one can analyse the dynamic impact of integration and liberalization. The results of the simulation experiments are compared to a base line scenario up to the year 2000. The major elements of the Final Act (FA) Embodying the Results of the Uruguay Round of Multilateral Trade Negotiations, Marrakesh, April 15, 1994 are compiled and discussed in Breuss (1995).

In this paper, the two events (EU membership and the impact of the Uruguay Round) are assessed in two separate simulation runs. The paper starts with a description of the link between the macro model and the input-output model. Then the simulation results of Austria's EU membership are reported. The next section shows how the obligations of the Final Act are

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*) Paper presented at the GATT-Symposium: „The World Economy after the Uruguay Round with some Implications for Austria", Wirtschaftsuniversität Wien, November 3-4, 1994.

1) A detailed description of the WIFO macro model can be found in Breuss-Neck-Schebeck (1993). The WIFO input-output model is explained in Kratena (1994).

implemented into the macro model as well as into the input-output model for Austria. The simulation results are presented in section 5. Conclusions are drawn in the last section.

2. The Link between the Macro and the Input-Output Model

Recent official input-output data for Austria are only available for the year 1983. Therefore WIFO has constructed a "preliminary input-output table 1988" which – by allowing some technical and structural change – can be extrapolated until the year 2000 at a highly aggregated level.

This traditional static open Leontief-system is closed in a macroeconomic sense by linking it to the WIFO macro model so that the inconsistencies between the two models are treated explicitly.

As the WIFO macro model is set up in the framework of Austrian national accounts, all volume variables are at constant prices of the base year 1983. Therefore, the input-output structure must also be deflated in order to get values at 1983 prices. In addition, the restriction must be met that variables of the input-output model have to sum up to the same aggregate values as those of the macro model (e. g.: total private consumption at 1983 prices).

In this framework of an input-output table at 1983 prices with changing structure over time the link between the two models can be setup. What is shown here is the quantity model of the input-output table, which is connected to the macro model. Furthermore, the "dual" price model is also specified and used to simulate the diffusion of cost and price changes.

Equilibrium in the goods market of an input-output analysis is given by:

$$(1) \qquad Q(A) + M = Q(H) + C + I + G + X \,,$$

$$\text{Supply} = \text{Demand}$$

where $C + I + G + X$ refers to the sum of vectors of private consumption (C), investment including changes in inventories (I), public consumption (G) and exports (X) respectively (i. e. the final demand vector F). The output of domestic activities is $Q(A)$, M are imports and $Q(H)$ is intermediate demand.

It is standard in input-output analysis, that the matrix of *technical coefficients*, A, can be calculated by dividing all elements of the columns of $Q(H)$ by the corresponding output $Q(A)$.

To solve the system, the matrix of *domestic market shares*, D, has to be calculated by dividing the output of good (i) of all activities (j) by the total supply of good (i).

If the column of goods supply ($Q(A) + M$) is divided by the total supply, Q, additional to the domestic market shares the row of import shares, m, is received. The sum of domestic market shares and import shares for any good must be unity. This restriction has turned out to be rather crucial for the solution algorithm of the linked model.

Equation *(2)* shows the system of the input-output model using the two coefficient matrices, A and D . Multiplying the matrix containing A and D with the vector ($Q(A)$, Q) (output $Q(A)$ of 18 activities, total supply Q of 18 goods) and adding the final demand vector (0 F) yields ($Q(A)$, Q) .

$$(2) \qquad \begin{bmatrix} 0 & D \\ A & 0 \end{bmatrix} \begin{bmatrix} Q(A) \\ Q \end{bmatrix} + \begin{bmatrix} 0 \\ F \end{bmatrix} = \begin{bmatrix} Q(A) \\ Q \end{bmatrix} .$$

The solution of this static input-output model is derived by inverting the difference between the unit matrix and the matrix in equation (*2*). The resulting inverse matrix of this system serves to determine (*Q (A)*, *Q*) when final demand is given (see: Appendix). Final demand is determined in the macro model simultaneously with the corresponding value added aggregates and income. At the same time value added in the input-output model is given by usually fixed coefficients of value added components of each sector as percentage of *Q (A)*. The core of the problem of consistency between the two model solutions lies in the difference in value added in each model solution. The model structure and the solution algorithm to link the macro model with the input-output model are briefly described in the Appendix.

3. Austria's EU Membership: Macroeconomic and Sectoral Effects

Austria has been a member of the European Economic Area (EEA) since January 1, 1994. This implied a harmonization of competition policy with EU standards. Theoretically, the four freedoms (free movement of labour, capital, goods and services) were fulfilled in the EEA. Since the EEA does not form a customs union between EU and EFTA, in practice, border controls between both integration areas are still existing. Therefore, the EFTA countries participating in the EEA still have autonomy with respect to foreign trade and agricultural policy. On January 1, 1995 Austria has become a member of the EU. The following EU membership scenario is compared to a baseline where Austria would have stayed in the EEA as an EFTA member.

The overall integration effect of joining the EU sums up from the following partial effects[2]).

1. *Integration effects proper:*

– Participation in EU's customs union

– Removal of remaining trade costs (border controls, disadvantages in outward processing and in the rules of origin)

– Making Austria a more attractive location for foreign investment

– More competition

2. *Adjustment to the CAP:*

– Reduction of prices for agricultural products and food

3. *Budgetary effects:*

– Budgetary burdens (Austria will be a net payer)

The composition of the partial effects is given in Table 1. Besides the integration effects proper (customs union, trade costs, location, competition) joining the EU confronts Austria with two special problems:

(1) The adjustment of Austria's agricultural system to those of the Common Agricultural Policy (CAP) of the EU and the financial burden for the general government's budget. Adjusting to the CAP means that Austria has to bring down the current high price level by 20 per cent. This

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[2]) More details of the EU membership scenario can be found in Breuss-Kratena-Schebeck (1994).

Table 1: Composition of the Effects of Austria's EU Membership

	Real GDP	Consumer prices	Real GDP	Consumer prices
	1995		2000	
	Cumulative percentage deviations from the baseline (EEA) scenario			
Integration effects	+ 0.2	– 0.3	+ 2.0	– 1.8
Customs Union	+ 0.0	– 0.1	+ 0.1	– 0.2
Trade cost	+ 0.1	± 0.0	+ 0.9	– 0.2
Location	+ 0.0	± 0.0	+ 0.6	± 0.0
Competition	+ 0.1	– 0.2	+ 0.4	– 1.4
Agriculture				
Price reduction	+ 0.4	– 1.4	+ 0.3	– 1.4
Budgetary effects				
EU membership payment and compensation for farmers' income losses	+ 0.2	– 0.1	+ 0.5	– 0.1
Total integration effects	+ 0.8	– 1.8	+ 2.8	– 3.3

is good for consumer´s welfare but implies income losses for the farmers. The Austrian government has agreed to compensate farmers and producers of foodstuff for income losses .

(2) Due to its high per capita GDP level Austria will be a net payer to the EU budget by around 12 bill. AS in 1995. In addition the Austrian budget will be burdened by the transitional expenditures compensating farmers' income losses.

All in all the public sector budget will be burdened with 34 bill. AS due to EU membership and to the adjustment costs. In addition to the transitional costs in the short run, EU membership will in the short and even in the medium run push Austria into a "twin deficit" situation: The public deficit as well as the current account of the balance of payments will be deteriorated by the amount of the net payments to the EU budget.

Taking all together, in the year 2000 Austria's real GDP will be higher by 2.8 per cent than in the case of staying outside the EU. The base line scenario represents the case where Austria would have stayed in the EEA as an EFTA member. The level of domestic prices (consumer prices) would be reduced by 3.3 per cent in 2000. The macroeconomic details of the effect of EU membership can be seen from Table 2.

The Maastricht convergency criteria (public deficit 3 per cent and debt – GDP ratio 60 per cent of GDP) could be endangered in the medium run if no fiscal actions are taken to mitigate the increase of public sector defict and the debt-GDP ratio. With the consolidation program announced at the end of 1994 by the newly formed coalition government these goals could be achieved (see Breuss, Guger, and Lehner, 1995).

Table 2: Macroeconomic Effects of Austria's EU Membership

	1995	1996	1997	1998	1999	2000
	Cumulative deviations from the baseline (EEA) scenario[1])					
Real private consumption	+ 0.9	+ 1.1	+ 1.3	+ 1.6	+ 1.9	+ 2.1
Real government consumption	+ 1.1	+ 1.3	+ 1.5	+ 1.6	+ 1.7	+ 1.8
Real gross fixed capital formation	+ 2.0	+ 4.0	+ 5.8	+ 7.1	+ 8.2	+ 9.2
Real exports of goods and services	+ 1.1	+ 1.5	+ 1.9	+ 2.2	+ 2.6	+ 3.0
Goods	+ 0.8	+ 1.2	+ 1.6	+ 2.0	+ 2.5	+ 2.9
Real imports of goods and services	+ 1.8	+ 2.5	+ 3.2	+ 3.8	+ 4.4	+ 4.9
Goods	+ 2.1	+ 3.1	+ 4.0	+ 4.8	+ 5.5	+ 6.1
Real gross domestic product (GDP)	+ 0.8	+ 1.4	+ 1.8	+ 2.2	+ 2.5	+ 2.8
Current balance (per cent of GDP)	– 0.9	– 1.1	– 1.3	– 1.4	– 1.6	– 1.7
Private consumption deflator	– 1.8	– 2.3	– 2.7	– 2.9	– 3.1	– 3.3
GDP deflator	– 1.5	– 2.1	– 2.4	– 2.6	– 2.8	– 3.0
Terms of trade: goods	– 0.4	– 0.3	– 0.2	– 0.2	– 0.3	– 0.3
Household disposable income (at current prices)	+ 0.3	– 0.2	– 0.3	– 0.2	– 0.2	– 0.1
Wage rate	– 0.3	– 0.2	– 0.3	– 0.3	– 0.2	– 0.2
Dependent employment	+ 0.2	+ 0.5	+ 0.7	+ 0.9	+ 1.1	+ 1.3
Thousands of persons	+ 5.6	+ 16.0	+ 22.2	+ 29.5	+ 34.7	+ 42.3
Unemployment rate	– 0.2	– 0.3	– 0.2	– 0.3	– 0.3	– 0.3
Labour productivity	+ 0.7	+ 0.8	+ 1.1	+ 1.2	+ 1.4	+ 1.4
General government financial balance (per cent of GDP)	– 1.5	– 1.1	– 1.0	– 1.0	– 0.9	– 0.9

[1]) The figures for GDP, deflators, household disposable income, dependent employment, and labour productivity indicate the cumulative deviations of the model simulation for Austria's EU membership from the baseline scenario (EEA membership) in the *n*th year in per cent, whereas the figures for current balance, terms of trade, wage rate, unemployment rate, and financial balance are shown as percentage point deviations.

The sectoral results of the input-output model linked with the macro model can be seen from Table 3.

Overall domestic gross output would be higher by 3.3 per cent than in the baseline case and employment would increase by 1.4 per cent until the year 2000.

The sectoral output effects are dominated by the integration effects of Austria's higher attractivity for foreign investment and the removal of disadvantages in outward processing.

Activities which directly (construction, machinery) and indirectly (stone and minerals, wood and wood processing) take advantage of higher investment demand and those, which were heavily hit in their export performance by disadvantages in outward processing (chemicals, textiles and clothing) are the main winners of Austria's EU membership. These activities show an increase in domestic output above average. The service sectors with the exception of the public sector show average growth effects, whereas the sectors agriculture and foodstuff can be seen as the main losers of Austria's EU membership.

Employment develops more or less in line with domestic output. Some activities, however, show an overproportional strong reaction of productivity to growth (Verdoorn function). This is particularly the case in the sectors paper and paper processing, basic metals, energy and water supply and transport and communication where, compared to the baseline scenario, less persons would be employed. Owing to heavily increasing competitive pressure in the commerce sector an exogenous change in labour productivity is implemented, thus leading to a drop in employment by 1 per cent.

Table 3: Sectoral Effects of Austria's EU Membership in the Year 2000

	Sector	Domestic Output	Dependent employment
		Cumulative percentage deviations from the baseline (EEA) scenario	
1	Agriculture & Forestry	+ 0.8	– 3.2
2	Mining	+ 2.8	+ 0.6
3	Foodstuff	+ 0.4	– 3.0
4	Textiles & Clothing	+ 4.8	+ 2.3
5	Wood & Wood Processing	+ 4.0	+ 1.8
6	Paper & Paper Processing	+ 1.6	– 1.5
7	Chemicals	+ 5.2	+ 1.4
8	Petroleum	+ 2.4	+ 0.7
9	Stone & Minerals	+ 4.4	+ 1.4
10	Basic Metals	+ 1.4	– 0.7
11	Metal processing, Machinery & Cars	+ 4.3	+ 1.4
12	Energy & Water Supply	+ 2.7	– 1.3
13	Construction	+ 6.8	+ 4.5
14	Commerce	+ 3.6	– 1.0
15	Hotels & Restaurants	+ 3.3	+ 3.8
16	Transport & Communication	+ 3.5	– 0.6
17	Banking, Insurance & Real Estate	+ 3.3	+ 2.0
18	Other Private Services (incl. Public Services)	+ 2.3	+ 2.3
	Total	+ 3.3	+ 1.4

4. Model Implementation of the Uruguay Round

The impact of the Uruguay Round is calculated in comparison with the EU scenario. It is assumed that Austria – as an EU member – will join the common commercial policy (CCP) of the EU. That means, the tariff concessions of the EU are applied in the simulation experiments. As in the case of Austria's EU membership, the loss of tariff revenues due to the Uruguay Round concessions is also estimated at around 2 bill. AS. As the tariff concessions are not fully implemented at once the loss in tariff revenue is spread evenly over the period 1995 to 2000.

In addition to this direct Uruguay Round effect indirect effects, i. e. increase in the volume of world trade and world real GDP, are taken into consideration. For this purpose exogenous information from world model simulations on the impact of the Uruguay Round has been used (see a survey on world model simulations in Breuss, 1995). Accordingly, it is assumed that in Europe real GDP will gradually increase from 1995 on, surpassing the base line level in the year 2000 by 1.8 per cent.

Outside Europe the increase will be somewhat lower (+1.5 per cent). Because of conflicting simulation results for world prices we assumed no change in world prices for our calculations.

As a special feature of the Uruguay Round one has to take into account the effects of the Agreement on Agriculture. In contrast to joining the Common Agricultural Policy (CAP) of the EU, the Agreement on Agriculture of the Uruguay Round has a dampening effect for production and welfare. First, internal production subsidies should be reduced by 20 per cent. This would result in a price increase. In the model simulations we reduced overall subsidies by 1 bill. AS but excluded the relevant price effect, assuming that price increases probably could

not be realised in the markets. Second, trade in agriculture will be affected because subsidized exports have to be reduced by 36 per cent in value terms (21 per cent in real terms) and market access (for imports) have to be improved (starting with 3 per cent of domestic consumption up to 5 per cent in the year 2000). If these measures of liberalization in the agricultural and food sectors are really implemented it will result in fewer exports and more imports, both will decrease real GDP. However, Austria as a member of the EU has to take these liberalization steps only for a share of around 50 per cent of its agricultural trade. The other part is intra-EU exchange of agricultural products obeying CAP rules.

5. Impact of the Uruguay Round for Austria in the Medium Run

The overall impact of the Uruguay Round can be summarized as follows: real GDP will be higher by 1.1 per cent in the year 2000 compared to a base line scenario without Uruguay Round. Consumer prices will be lowered by 0.3 per cent. Both, the positions in the current account and in the budget (net lending) will improve. Unemployment is expected to decrease due to positive overall demand effects (see Table 4 and Figure 1).

The sectoral impact is calculated with the input-output model. In the year 2000 gross domestic output and employment will be influenced as shown in Table 5.

Overall gross domestic output would be higher by 1.1 per cent in the Uruguay Round case than in case of EU membership which is the baseline scenario. This higher output results in an overall increase of employment by 0.6 per cent.

The sectors with output losses or deviations from the baseline scenario in domestic output notably below average are agriculture and forestry (–1.4 per cent), mining, foodstuff (0.6 per

Table 4: Macroeconomic Effects of the Uruguay Round for Austria

	1995	1996	1997	1998	1999	2000
	Cumulative deviations from the baseline (EEA) scenario[1])					
Real private consumption	+ 0.0	+ 0.1	+ 0.2	+ 0.3	+ 0.5	+ 0.7
Real government consumption	+ 0.0	+ 0.1	+ 0.1	+ 0.1	+ 0.1	+ 0.2
Real gross fixed capital formation	+ 0.0	+ 0.3	+ 0.7	+ 1.2	+ 1.7	+ 2.3
Real exports of goods and services	+ 0.5	+ 1.0	+ 1.5	+ 2.0	+ 2.5	+ 3.0
Goods	+ 0.7	+ 1.2	+ 1.8	+ 2.3	+ 2.9	+ 3.6
Real imports of goods and services	+ 0.5	+ 0.9	+ 1.3	+ 1.8	+ 2.3	+ 2.9
Goods	+ 0.5	+ 1.0	+ 1.5	+ 2.0	+ 2.7	+ 3.3
Real gross domestic product (GDP)	+ 0.0	+ 0.2	+ 0.4	+ 0.6	+ 0.8	+ 1.1
Current balance (per cent of GDP)	+ 0.0	+ 0.0	+ 0.1	+ 0.1	+ 0.1	+ 0.1
Private consumption deflator	– 0.0	– 0.1	– 0.2	– 0.2	– 0.3	– 0.3
GDP deflator	– 0.0	– 0.1	– 0.2	– 0.2	– 0.2	– 0.3
Terms of trade: goods	– 0.0	– 0.0	– 0.0	– 0.0	– 0.0	– 0.0
Household disposable income (at current prices)	– 0.0	+ 0.1	+ 0.2	+ 0.3	+ 0.5	+ 0.7
Wage rate	+ 0.0	– 0.1	– 0.2	– 0.2	– 0.3	– 0.4
Dependent employment	+ 0.0	+ 0.1	+ 0.1	+ 0.3	+ 0.4	+ 0.6
Thousand of persons	+ 0.2	+ 1.7	+ 4.6	+ 8.4	+ 13.0	+ 18.1
Unemployment rate	– 0.0	– 0.0	– 0.1	– 0.1	– 0.1	– 0.1
Labour productivity	+ 0.0	+ 0.1	+ 0.2	+ 0.3	+ 0.4	+ 0.5
General government financial balance (per cent of GDP)	+ 0.0	+ 0.0	+ 0.1	+ 0.2	+ 0.2	+ 0.3

[1]) The figures for GDP, deflators, household disposable income, dependent employment, and labour productivity indicate the cumulative deviations of the model simulation for Austria's EU membership from the baseline scenario (EEA membership) in the *n*th year in percent, whereas the figures for current balance, terms of trade, wage rate, unemployment rate, and financial balance are shown as percentage point deviations.

Figure 1: EU Membership and Uruguay Round Effects on Income (Real GDP) and Prices (CPI)

(Cumulative Effects in per cent)

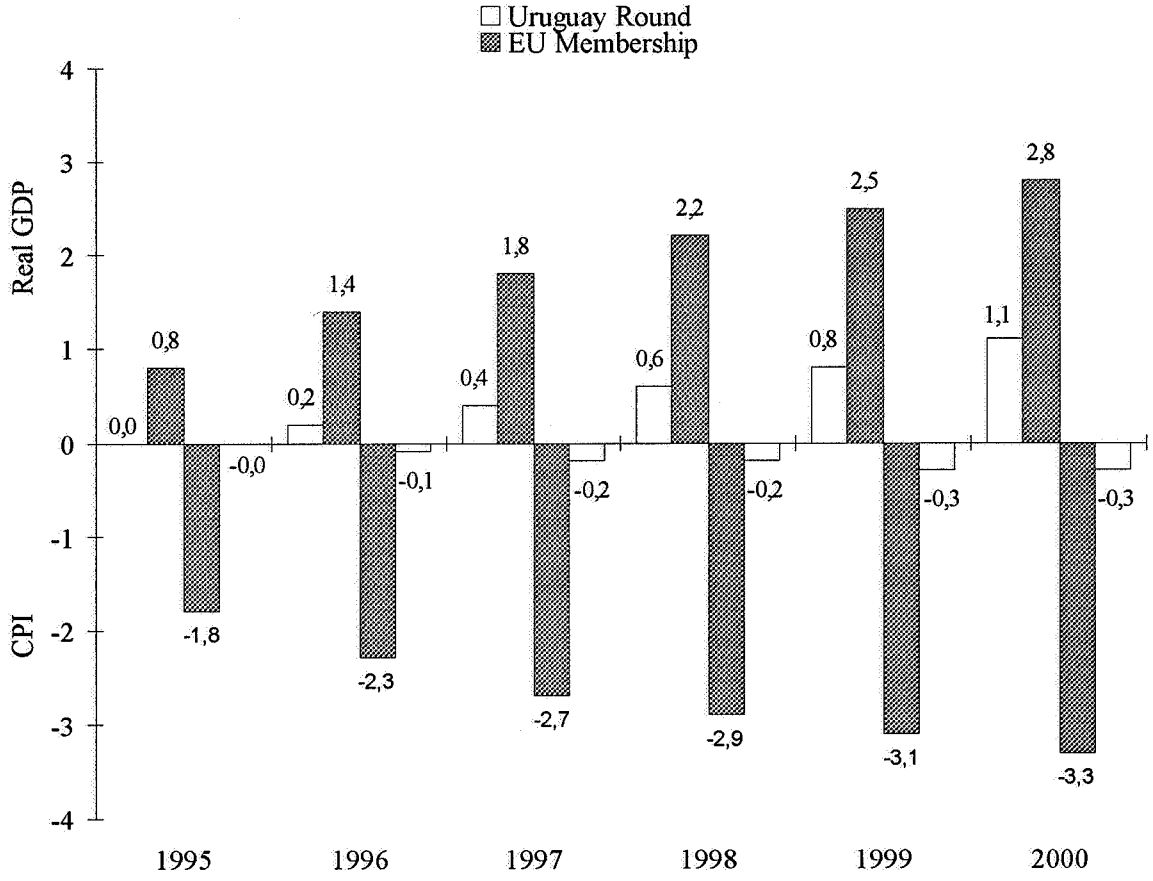

Table 5: Sectoral Effects of the Uruguay Round for Austria in the Year 2000

	Sector	Domestic Output	Dependent employment
		Cumulative percentage deviations from the baseline (EU membership) scenario	
1	Agriculture & Forestry	– 1.4	+ 0.2
2	Mining	+ 0.5	+ 0.2
3	Foodstuff	+ 0.6	+ 0.3
4	Textiles & Clothing	+ 0.7	+ 0.6
5	Wood & Wood Processing	+ 1.4	+ 0.5
6	Paper & Paper Processing	+ 1.4	+ 0.6
7	Chemicals	+ 1.4	+ 0.9
8	Petroleum	+ 0.0	+ 0.1
9	Stone & Minerals	+ 1.4	+ 0.9
10	Basic Metals	+ 1.3	+ 0.3
11	Metal processing, Machinery & Cars	+ 1.2	+ 0.7
12	Energy & Water Supply	+ 1.0	+ 0.2
13	Construction	+ 1.8	+ 1.4
14	Commerce	+ 1.3	+ 0.6
15	Hotels & Restaurants	+ 0.9	+ 0.2
16	Transport & Communication	+ 1.4	+ 0.2
17	Banking, Insurance & Real Estate	+ 1.3	+ 1.1
18	Other Private Services (incl. Public Services)	+ 0.4	+ 0.4
	Total	+ 1.1	+ 0.6

cent), textiles and clothing (0.7 per cent), petroleum (no change) and other services including public services (0.4 per cent).

Construction (1.8 per cent), wood and wood processing (1.4 per cent), paper (1.4 per cent), stone and minerals (1.4 per cent), as well as transport, finance, commerce and the metal processing sectors are exhibiting increases in domestic output above average. The drop in agricultural output is due to the effects of liberalization measures in the Agreement on Agriculture which are inserted exogenously into the model. In particular increased market access leads to pressure on domestic production.

In general, employment increases together with output, but changes in labour productivity are varying among the sectors. Rather high productivity effects have been found for the activities basic metals, wood and wood processing as well as for transport and communication. In agriculture the reduction in output is even surpassed by productivity losses thus allowing for some increase in employment.

6. Conclusions

In order to evaluate the impact of the Uruguay Round on the Austrian economy simulations with two WIFO models, the macro model and the input-output model, were run. As in the case of simulating the effects of an EU membership both models were linked partially.

Under the assumptions of

* some losses in tariff revenues

* a more rapid growth of world trade and world GDP

* a reduction of subsidies on agricultural production

* a decrease in agricultural exports and an increase in imports

in the medium term (i. e. in the year 2000) real GDP in Austria will be higher by 1.1 per cent compared to the base line scenario (EU membership). Therefore, employment can also be increased by 0.6 per cent. Consumer prices could be lowered by 0.3 per cent. According to the simulations the general government's budget (net lending) as well as the current account are showing some improvement.

The sectoral distribution of the additional domestic output (1.1 per cent) shows above average output gains in wood and wood processing, construction, chemicals, stone and minerals, metal processing. Benefits for the sectors foodstuff, mining, textiles and clothing, petroleum and other services are below average. In agriculture and forestry output is even declining.

Appendix: The Link between the Input-Output and the Macro Model

With the following equations the input-output model can be briefly described[3]):

Equilibrium in the goods market is given by

$$(1) \qquad Q(A) + M = Q(H) + C + I + G + X \ ,$$

$$\text{Supply} = \text{Demand}$$

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[3]) A detailed description of the WIFO input-output model (MULTIMAC 1) can be found in Kratena (1994).

where $C + I + G + X$ refers to the sum of vectors of private consumption (C), investment including changes in inventories (I), public consumption (G) and exports (X) respectively (i. e. the final demand vector F). The domestic output of activities is $Q\,(A)$, M are imports and $Q(H)$ is intermediate demand.

The system of the input-output model uses two coefficient matrices, A and D in the following way:

$$(2) \qquad \begin{bmatrix} 0 & D \\ A & 0 \end{bmatrix} \begin{bmatrix} Q\,(A) \\ Q \end{bmatrix} + \begin{bmatrix} 0 \\ F \end{bmatrix} = \begin{bmatrix} Q\,(A) \\ Q \end{bmatrix},$$

A is the matrix of technical coefficients and D the matrix of domestic market shares (O F) is the final demand vector.

The solution of the system of equation (2) is shown in equation (7).

$$(3) \qquad \begin{bmatrix} \tilde{V} & 0 \\ 0 & \tilde{M} \end{bmatrix} \begin{bmatrix} Q\,(A) \\ Q \end{bmatrix} = \begin{bmatrix} V \\ M \end{bmatrix},$$

$$\tilde{V} = \begin{bmatrix} l \\ l\,w \\ t\,(L) \\ t\,i \\ s \\ d \end{bmatrix}, \qquad \tilde{M} = [\,m\,],$$

$$(4) \quad ln(l) = ln(\,l(TREND)) + a(2)\,ln\,(Q(A))$$

$$(5) \quad m = a(0) + a(1)ln(Q) + a(2)\,ln(p) + a(3)\,ln(pm)$$

(6) $\Sigma_j d_{ij} + m_i = 1,$

(7) $$\begin{bmatrix} I & -D \\ -A & I \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ F \end{bmatrix} = \begin{bmatrix} Q(A) \\ Q \end{bmatrix}.$$

At the same time coefficient matrices for components of value added at current prices and imports at constant prices are given, thereby determining value added and real imports given ($Q(A)$, Q) (equation *(3)*). Here the matrix $\tilde{V}$ was specified containing the row vectors l, lw, $t(L)$, ti, s and d, where l is the labour input per unit of output, lw is the wage input (w being the wage rate per person) per unit of output and $t(L)$, ti, s and d are the same per unit of output coefficients for payroll taxes, other indirect taxes , subsidies and depreciation. The employment coefficients are explicitly modelled by decomposing the time series in a trend and in a cyclical component and making the cyclical component dependent on sectoral output, i. e. introducing some sort of inverse Verdoorn coefficient (equation *(4)*).

The matrix $\tilde{M}$ just contains the row vector of import shares m, which are also modelled in seperate equations, depending on the total product demand and on domestic and import prices (equation *(5)*).

Equation *(6)* just shows the restriction on domestic market shares and import shares. The solution of the input-output system is given by equation *(7)*. Given the aggregates and the structure of final demand F from the macro model , the vectors of output $Q(A)$ and total demand Q can be found by multiplying (0 F) with the inverse matrix of this model.

At the current stage of model development only for private consumption there exist some closed demand models (like "Almost Ideal Demand System", AIDS), which are used in different forms of the model to simulate the effect of price changes on the structure of demand.

For public consumption, investment and exports a fixed composition of goods structure is assumed.

The problem of simultaneous solution with the macro model arises, when $Q\ (A)$ and Q are substituted in equation *(3)*, as the derived values for employment, wages, etc. will not necessarily coincide with the solution of the macro model.

In the macro model a block for wage and price determination as well as for employment exists, so that changes in final demand (F) have some impact on the aggregate value added side in the form of dynamic adjustment processes. Since it is seen as a special advantage of the macro model to describe these adjustment processes on the aggregate, the results of the macro model shall be carried over into the input-output model.

At a first stage, the input-output model is rearranged in a form, that aggregates of value added can be directly calculated from final demand. This can be achieved by combining the inverse matrix with the coefficients for value added and thereby calculating the "Cumulative Production Structure" matrix (CPS). This method is used in some disaggregated macro models, like in the "Wharton Long Term Model" and in the disaggregated model of the "Centraal Planbureau" of Netherlands.

$$(8) \qquad \begin{bmatrix} \tilde{V} & 0 \\ 0 & \tilde{M} \end{bmatrix} \begin{bmatrix} I & -D \\ -A & I \end{bmatrix}^{-1} = [\ CPS\ ]\ ,$$

$$(9) \qquad [\ CPS\ ] \begin{bmatrix} 0 \\ F \end{bmatrix} = \begin{bmatrix} L \\ wL \\ T(L) \\ Ti \\ S \\ D \\ M \end{bmatrix}.$$

The simultaneous solution of the two models works in the following way:

Equation *(7)* gives the first solution of the input-output model with values for *(Q(A) Q)*.

$$(7) \qquad \begin{bmatrix} I & -D \\ -A & I \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ F \end{bmatrix} = \begin{bmatrix} Q(A) \\ Q \end{bmatrix}.$$

With equations *(4)* and *(5)* also coefficients for employment *(l)* and import shares are determined. The other coefficients of value added (wages, taxes, subsidies, depreciation) are calculated using sectoral spreads, estimated from time series and the overall values of the macro model.

So a first guess for the matrices for value added coefficients and import shares can be carried out (equation *(10)*). This matrices give with equation *(3)* aggregate values for value added components and real imports.

$$(10) \qquad \tilde{V},\ \tilde{M} = f(Q(A), Q\ ).$$

It can be expected, that these values at a first stage will not coincide with the values of the macro model solution. Therefore some adjustment factors are calculated by dividing the macro

model values by the input-output model values, e. g. the employment value of the macro model solution is divided by the first guess for employment L from equation *(3)*.

The resulting adjustment factors are used to correct the original CPS matrix to an "adjusted" matrix CPS^*. When this matrix CPS^* is multiplied with the base matrix of the inverse of the input-output model adjusted values for $\tilde{V}$ and $\tilde{M}$ are calculated

$$(11) \qquad [\ CPS^*\ ] \begin{bmatrix} I & -D \\ -A & I \end{bmatrix} = \begin{bmatrix} \tilde{V}^* & 0 \\ 0 & \tilde{M}^* \end{bmatrix}.$$

Now the adjusted import shares from $\tilde{M}^*$ can be set in in the restriction of equation *(6)*

$$(6) \qquad \Sigma_j\ d_{ij} + m_i = 1.$$

If the restriction does not hold, the columns of matrix D are proportionally adjusted to D^*, so that the restriction holds and a new matrix $\begin{bmatrix} I & -D^* \\ -A & I \end{bmatrix}$ is found.

From this matrix a new solution can be calculated, as the inverse matrix will also change and the process described starts again.

After four to six iterations the solution vector, $\begin{bmatrix} Q\,(A) \\ Q \end{bmatrix}$, usually converges.

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Eigentümer, Herausgeber und Verleger: Gemeinnütziger Verein "Österreichisches Institut für Wirtschaftsforschung", Wien 3, Arsenal, Objekt 20. Postanschrift: A-1103 Wien, Postfach 91. Tel. (1) 798 26 01-0, Fax (1) 798 93 86. Vorstand: Präsident: Ing. Leopold Maderthaner, Vizepräsidenten: Eleonora Hostasch, Univ.-Prof. Dr. Erich Streißler, Geschäftsführer: Prof. Dr. Helmut Kramer.

Satz und Druck: Österreichisches Institut für Wirtschaftsforschung.

Verkaufspreis: S 100,–.