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# Analysing Economic Systems Using Computable General Equilibrium Models: The Example of Croatia

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***Abstract:*** Computable General Equilibrium models represent a state-of-the-art multisectoral tool for policy analysis in mixed economies. Simulations of the model provide insight into the quantitative structural effects of economic policies, taking into account interactions throughout the economy in a consistent way. The aim of this paper is to illustrate the use of CGE model in the case of the Croatian economy before the country became independent in 1991.

***JEL Classification:*** B21, D58

***Keywords:*** General equilibrium, simulations, structural adjustment, economic policy

## Introduction

This paper illustrates how a Computable General Equilibrium (CGE) model can be used in analysing the structural impact of tax and tariff change in an economic system. The model we use for our analysis is the first single country CGE model describing the Croatian economy. It is built around Croatian data for 1987, which is when the last input-output table was published and for which other relevant data were also available[1]. It is the era in which Croatia was still a part of the former Yugoslavia, from which it gained independence in 1991. Some modifications of the data were

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necessary to reflect the fact that we analysed Croatia as an independent entity even within that setting. That refers primarily to treating the exchange with other republics, in goods as well as in factors of production, as foreign trade. We named the model CGECRO.

The presentation is divided into two main parts. The first part focuses on the structure of the model and how it works. Here we distinguish between the 'generic' CGE model constructed to analyse developing countries and its modified version applied to Croatia. The second part contains the description of the policy experiments and the interpretation of our simulation results.

## The Model

The model used to describe and analyse the structure of the Croatian economy in 1987 takes as its starting point the template described in the literature listed in the endnote[2]. It is designed as a set of simultaneous non-linear equations describing the behaviour of all segments of an economic system relevant in a general equilibrium analysis. In such a system, based on neo-classical assumptions, agents are individual constrained optimisers where producers maximise profits given their resources and technology, and consumers maximise utility subject to their income and prices. The agents' behaviour is represented by the model equations of supply and demand.

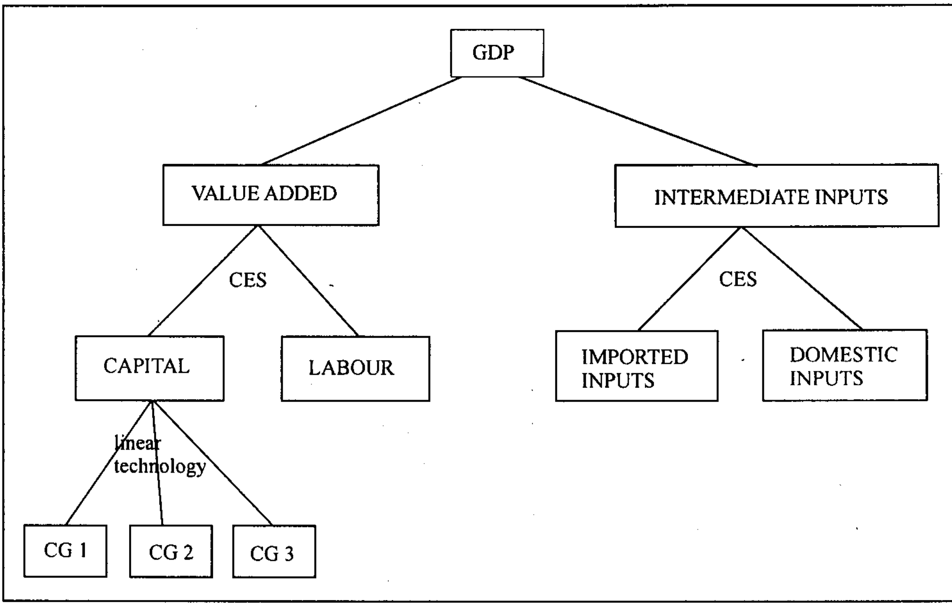
The simulation of the functioning of a market economy, conceived of as a general equilibrium system, is achieved by letting the prices and quantities for goods and factors adjust in such a way that they ensure equality between supply and demand. The general equilibrium is a set of relative prices which equate supply and demand on all markets simultaneously. In such a neo-classical model, the supply and demand functions are derived from marginal (or first order) productivity and utility conditions.

### *The General Structure: Defining Supply and Demand*

Production in the model is described by using nested production functions as represented in the Figure 1.

At the top level Gross Domestic Product (GDP) is generated by a linear technology linking the intermediate inputs and value added, combining them in fixed proportions to produce GDP. At the lower level there are two Constant Elasticity of Substitution (CES) production functions: one combining capital and labour in the production of value added, and the other one linking the imported and the domestic parts of the intermediate, produced inputs.

Figure 1.: Nested Production Structure




The CES functions are of the Cobb-Douglas type. The production functions exhibit constant returns to scale. Their linear homogeneity ensures that their marginals are homogeneous of degree zero, implying that they will not change if all inputs change in the same proportion. Capital itself is a fixed coefficient aggregation of capital goods CG 1, CG 2, CG 3, etc.

Thus, the domestic supply of sector *i*, , $X_i^D$ for two labour categories (agricultural and non-agricultural labour: ) and $L_1, L_2$ capital, , is given $K_i$ by the Cobb-Douglas production function:

$$X_i^D = \bar{A}_i L_{1i}^{\alpha_{1i}} L_{2i}^{\alpha_{2i}} K_i^{\alpha_{3i}} \tag{1}$$

where the share parameter $\alpha_{3i} = 1 - \sum_k \alpha_{ki}$, *k=ag, non-ag,* and the shift parameter $\bar{A}_i = constant.$

To define the dependence of domestic supply on prices and wages it is necessary to include the net or value added price of sector *i*, $P_i^{VA}$ ,

$$P_i^{VD} = PD_i - \sum_j P_j a_{ji} - td_i \tag{2}$$

where $PD_i$ are domestic prices, $P_j a_{ji}$ are prices of intermediate goods, and $td_i$ denotes indirect taxes. The subscripts *i* and *j* are used interchangeably to denote sectors. $P_{jj}$ represents prices and $a_j$ are technical coefficients derived from the input-output table.

Given the short-term time horizon of the analysis, the capital stock is assumed to be fixed and sector specific. Thus, sectoral returns on capital are not equalised across sectors.

Demand for labour is derived from the first-order conditions for profit maximisation requiring that the wage, $w$, equal the value of its marginal product. It is expressed in the following way,

$$P_i^{VA} \frac{\partial X_i^D}{\partial L_{ki}} = \alpha_{ik} w_{ki} \qquad k{=}ag,\ non\text{-}ag \tag{3}$$

In the above expression $w_{ki}$ is the average wage rate of $k$ in sector $i$. The neo-classical features of the model also imply full employment, meaning that total labour demand across sectors for each category $k$ will equal the inelastic labour supply in the same category, $\bar{L}_k^S$. The labor market equilibrium condition is given as

$$\sum_i L_{ki} = \bar{L}_k^S \tag{4}$$

labour market rigidities are explicitly built into the model, reflecting the fact that in the short run, and in a developing country, labour is not fully mobile among sectors.

The linkages among the intermediate inputs, $W_i$, are assumed to display the properties of a linear, Leontief style technology with fixed coefficients. Thus the demand for intermediate inputs is defined as

$$W_i = \sum_j a_{ij} X_j^D \tag{5}$$

It is also assumed that there exists a Constant Elasticity of Transformation (CET) function linking the domestically produced goods that are consumed at home, $X_i^{XD}$, and exported goods, $E_i$. Domestic production, therefore, consists of domestic sales and exports, or, $X_i^{XD} = X_i^D - E_i$. The transformation function is defined as

$$X_i^D = A_i^T \left[ \gamma_i E_i^{\phi_i} + (1-\gamma_i) X_i^{XD\phi_i} \right]^{\frac{1}{\phi_i}} \tag{6}$$

with $A_i^T$ and $\gamma_i$ as constants and the elasticity of transformation, $\phi$.

Deriving the export supply functions implies maximising revenue from a given output, or, maximising

$$P_i X_i^D = PD_i X_i^{XD} + PE_i E_i \tag{7}$$

subject to (6). From (6) and (7) it follows that the export supply functions depend on relative prices, the domestic price of exports, $PE_i$, and domestic prices, $PD_i$, in the following way:

$$\frac{E_i}{X_i^{XD}} = \left[\frac{PE_i}{PD_i}\right]^{\phi_i} \left[\frac{1-\gamma_i}{\gamma_i}\right]^{\phi_i} \tag{8}$$

The price of exports is different from the domestic price and is defined as

$$PE_i = \frac{PWE_i ER}{1+te_i} \tag{9}$$

where $PWE_i$ is the world (dollar) price of exports, $ER$ is the exchange rate, and $te_i$ is the export tax.

If $E_0$ is a constant, $\eta_i$ is the elasticity of demand, and $PWE_i$ a weighted average of world prices for good $i$, export demand is a CES demand function

$$E_i = E_0 \left[\frac{PWE_i}{PE_i}\right]^{\eta_i} \tag{10}$$

Such export demand functions enable the exporting country, however small, to have some market power in some sectors. Should there be no market power at all, the export demand elasticity is infinite. The small country assumption holds on the import side as well.

The model distinguishes tradable from non-tradable goods. The existence of this distinction is important from the point of view of having some barrier between the world and the domestic prices. If all goods were tradable, the world prices would be the sole determinants of domestic prices. The CES and CET functions together with the choice of substitution elasticities enable the tradability at the sectoral level.

To reflect this reality as well as to indicate that domestically produced goods are not perfect substitutes for imported goods, we include the Armington assumption[3]. According to this assumption a 'composite commodity' $X_i$ is defined as a bundle of the imported, $M_i$, and domestic goods, $X^{XD}$, with the elasticity of substitution between them, $\sigma_i$, and its price $P_i$. The composite good consists of imports and the domestically produced goods. It is defined assuming that domestic consumers have a CES utility function over imports and domestically produced goods as in

$$X_i = A_i^C \left[\delta_i M_i^{-\rho_i} + (1-\delta_i) X_i^{XD^{-\rho_i}}\right]^{-\frac{1}{\rho_i}} \tag{11}$$

The consumers will maximise their utility by minimising the cost of obtaining it, or,

$$P_i X_i = PD_i X_i^{XD} + PM_i M_i \tag{12}$$

which, subject to (11) gives the consumers' demand for the composite good

$$\frac{M_i}{X_i^{XD}} = \left[\frac{PD_i}{PM_i}\right]^{\sigma_i} \left[\frac{\delta_i}{1-\delta_i}\right]^{\sigma_i} \tag{13}$$

The imported goods prices, $PM_i$, are again different from domestic prices and their definition is

$$PM_i = PWM_i(1+tm_i)ER \tag{14}$$

In this expression $PWM_i$ is the world price of imports and $tm_i$ is the tariff rate. The composite good price, $P_i$, is determined endogenously by the model.

The demand block of the model postulates the income balance equations by mapping the flow of income from value added to institutions and ultimately to households. The kinds of demands treated here are the already described: intermediate demand, followed by consumer, government, investment, and inventory demand.

Starting with consumer demand, the model contains only one representative household whose disposable income, $Y$, follows the relation:

$$C^{tot} = (1-s)Y \tag{15}$$

with $C^{tot}$ representing total consumption and $s$ being the marginal propensity to save. Disposable income is spent on consumer goods according to fixed expenditure shares, $\beta_1$, hence

$$C_i = \frac{\beta_i C^{tot}}{P_i} \tag{16}$$

Since no direct taxes are assumed, disposable income is equal to total factor earnings minus depreciation:

$$Y = \sum_i P_i^{VA} X_i^D - DEPR \tag{17}$$

Depreciation, in turn, is calculated as a fixed fraction of the value of capital stock, where the government demand is calculated in the same way as consumer demand, namely,

$$G_i = \beta_i^G \overline{G}^{tot} \tag{18}$$

The model is static so investment does not increase the capital stock. The level of investment is determined by total savings as the sum of household, government and foreign savings minus depreciation. This makes the model 'savings driven'. The composition of investment by sector of origin helps determine the sectoral demand for capital goods and the inventory demand is a fixed fraction of output. These equations serve only for accounting purposes and are not crucial for the results of the model.

Because the model satisfies Walras' law, the trade deficit is equal to foreign savings, $F$, or

$$\sum_i PW_i M_i - \frac{PD_i E_i}{ER(1+te_i)} = \overline{F} \tag{19}$$

The numeraire in this model is the nominal exchange rate which is fixed. Since the model is a 'real' one determining only relative prices, changes in the nominal exchange rate have no real effects. The 'real' exchange rate, however, is an endogenous variable and can be calculated as the ratio of a weighted average of the prices of tradable to the weighed average of the prices of non-tradables.

Having fixed both the nominal exchange rate and foreign savings, the domestic price level adjusts endogenously. Since the 'real' exchange rate indicates the relationship of tradable to nontradables, the model determines a relationship between the 'real' exchange rate and the balance of trade.

The equilibrium or market clearing conditions necessary to solve the model are expressed in

$$X_i = W_i + C_i + Z_i + ST_i + G_i \tag{20}$$

where the composite good is the sum of intermediate, consumer, investment, inventory, and government demands. The equilibrating variables for this equation are sectoral prices.

The objective function is defined as a linear utility function, $\Omega$,

$$\Omega = \sum_i \beta_i C^{tot} \text{ (21)}$$

which serves no substantial purpose in the model other than letting it be solved as an NLP program. In other words it is not the value to be maximised. In a fully determined model in which the number of variables equals the number of equations or constraints, a unique solution will occur without optimising the objective function. This can easily be tested by having the model maximise or minimise the objective function. In both cases the solutions will be the same.

Once the model finds an optimal solution, it means that the set of solution values has been found that satisfies the boundaries imposed on solution variables and the constraints posed in the form of non-linear equations. Successful calibration of model parameters will ensure that solution values in the base run replicate the initial values describing the economy represented in the Social Accounting Matrix. When this stage has been reached, the model is ready for simulations which will reveal the ways certain economy will respond to shocks exogenous to the system.

*The CGECRO Model*

An important feature of CGE models lies in the fact that even though their main fabric is made out of general economic theory and the principles governing the functioning of a market economy, their overall structure is adaptable to the specifics of a particular country. Using the 'generic' model as the template, we modified its structure to better reflect the structure and working of the Croatian economy in 1987. We also had to adjust it to the (scarce and imperfect) data which were available.

The choice of 1987 as the year for which to apply the model was dictated by the latest available input-output table which satisfied the minimum criteria of data consistency. Some data manipulation was still necessary to make the model solve. Thus, the purpose of this model is pedagogic rather than historical. It is aimed at illustrating some of the possibilities of CGE models in policy analysis applied to the Croatian economy in 1987.

The nature of data gathering for the input-output table of 1987 is representative of the ideological paradigm that was prevalent in Yugoslavia at the time. It was based on the labour theory of value, assuming that only labour created value added, and the statistical data were gathered according to the material production methodology. This has important implications on the size of the service sector, which in our case includes both 'productive' and 'unproductive' services. Also, in a country with social ownership, all value added is assumed to accrue to the households via redistributive mechanisms. Government transfers have, therefore, been added to the model.

The highly simplified picture of the Croatian economy underlying the economy wide circular flow of income in 1987 is contained in the Social Accounting Matrix (SAM) constructed on the basis of the input-output table and the National Product and Income Accounts published for that[4] year. The schematic SAM used in this model is portrayed in Table 1.

The SAM provides the main data framework capturing all transactions among the agents represented in a CGE model. Rows show incomes to an account and columns are expenditures. In the case of a square SAM, such as this one, row and column sums balance for each account. This means that there are no leakages in the system and that the budget constraint is satisfied. This implies that Walras' law holds as well.

The SAM we are using distinguishes between commodity and activity accounts. This means that the model allows for one commodity to be produced by more than one activity, as well as for an activity to produce more than one commodity. Allowing for joint production may be an interesting feature in efforts to extend the model to analyse more complex situations.

Table 1.: The schematic SAM

Social Accounting Matrix

| | | 1 Commodi ty | 2 Activity | 3 Labour | 4 Capital | 5 Household | 6 Government | 7 Capital | 8 World |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Commodity | | Intermediate Demand | | | Household Consumption | Government Consumption | Investment | |
| 2 | Activity | Domestic Supply | | | | | | | Exports |
| 3 | Agricultural Labour | | Agricultural Wages | | | | | | |
| | Non-Agricultural labour | | Nonagricultural Wages | | | | | | |
| 4 | Capital | | Capital Income | | | | | | |
| 5 | Household | | | Labour Income | Net Capital Income | | Government Transfers | | |
| 6 | Government | Tariff | Indirect Tax | | | | | | |
| 7 | Capital | | | | Depreci- ation | | | | |
| 8 | World | Imports | | | | Household Savings | Govovernment Savings | | |

The presentation of the flows in the SAM follows the pattern of going from the generation of income to its receipt by the institutional agents and its redistribution via inter-institutional transfers. Accounts in the SAM document the flows on the product and factor markets (rows and columns 1 and 2), the payment of value added to primary factors (rows and columns 3 and 4), and the generation of demand for goods on the product market through inter-institutional transfers (rows and columns 5 to 9). The major macro-balances are government deficit, savings-investment, and the balance of trade. They are contained in rows and columns 7 to 9. Therefore, accounts 1 and 2 capture market transactions while accounts 3 to 7 represent transfers. Financial transactions are summarised in the 'capital' accounts containing the workings of all capital markets.

In addition to the macro SAM which traces the total income/expenditure flows in an economy, a CGE model requires also a micro SAM which breaks down those flows by sector. Like its macro counterpart, it, too, has to be fully balanced allowing no leakages.

The economy in CGECRO is divided into 8 sectors: Manufacturing (with mining and quarrying), Agriculture and fisheries, Forestry, Construction, Transport and communication, Trade, Arts and crafts, and Services. Shrinking the economy to 8 sectors from the offered by the 1987 input-output table was necessary because of the algorithmic requirements that no division by zero was allowed in a model. Some rows in the original input-output table had all zeroes (e.g. Tourism) and were integrated into another sector. We chose to integrate it into Services. Utilities also had to be integrated into Services for similar reasons. Each sector has 9 associated prices described earlier.

The model shows only real flows and there is no 'money illusion'. It is, therefore, perfectly admissible to equate all domestic prices to 1, which enables us to treat total values in the SAM as physical quantities. The initial level of prices is arbitrary because what we are interested in are only changes in relative prices.

The core of the model is represented by the four sets of equations which define the relationships between prices and quantities. Each equation is associated with one or more prices as equilibrating variables. The non-linear equations appear as constraints in the NLP form of the model. All model equations can be read off from the model presented in GAMS syntax in the Appendix.

The equations of the model describe the interrelationships between the many elements of the system. The numerical entries in the SAM are the benchmark solutions of these equations. Once specified, if the actual solutions of a model in the base run replicate the initial or benchmark values in the SAM, we can say that the model has been successfully calibrated and can be used for running counterfactual policy simulations.

Calibration of the model involves assigning values to the parameters not calculated directly by econometric estimation. Such estimates rarely exist, so a literature search is typically used to find the right values. For instance, in CGECRO, the values of elasticities of substitution of domestic and imported goods in consumption (Armington, 1969) as well as the export transformation elasticities have been calculated on the basis of those observed for developing countries by Noland, Liu, Robinson, and Wang (1998). Other parameters, such as shift and share parameters in the production functions, are automatically calibrated within the model. The model is 'square' in the sense that the number of variables equals the number of constraints. The constraints are formulated as equations and as exogenous variables whose values are fixed in the closure statement of the model.

The model distinguishes between tradable and non-tradables. The non-tradables are Forestry and Construction. Their import/export values are sufficiently small to be regarded as zero. The *numeraire* of the model is the nominal exchange rate which has been fixed to the value of 1987 US$[5]. Again, fixing the nominal exchange rate to some value is arbitrary because it has no real effect in this model.

The macroeconomic closure applied in the model is the standard neo-classical one in which savings equals investment. It is said that such a model is 'savings driven' because total investment is determined by the amount of total savings. Since CGECRO is a static model, components of investment appear merely as elements of final demand and have no other impact on the functioning of the model. Additional assumptions on the behaviour of capital would be necessary to give the model a dynamic dimension.

## Simulations and Results

CGECRO is a static model based on a 'snapshot' of the Croatian economy in 1987 as described in its corresponding Input-Output and National Income and Product Accounts. It represents a flow equilibrium in the sense that there are no assets explicitly accounted for in the system. Changing the values of certain parameters representing possible economic policy instruments, one engages in a comparative static analysis with the model. The responses of the system 'shocked' by these changes can be evaluated at the sectoral and macroeconomic level.

To illustrate the use of the model, we decided to change two common economic policy instruments, tax and tariff rates, and observe the effects of these changes. We run three scenarios, TAX, TAR, and TAXTAR. In the TAX scenario indirect taxes are reduced to a uniform across-the-board rate of 0.22. The TAR scenario is a trade liberalisation in which tariffs on tradable are almost eliminated by reducing them to 0.01. The third simulation, TAXTAR, is achieved by running both scenarios simultaneously. The model is run four times. The first run represents the BASE scenario, which is the benchmark equilibrium with which the results in the subsequent scenarios are compared. We present those changes in per centage form in Tables 2 and 3.

Table 2 shows the intensity of sectoral impacts of the three scenarios. We separate the effects on prices and present them in Table 2A. The effects on quantities are shown in Table 2B. Because of our domestic production specification as described in Figure 1, the domestic output remains fixed in all scenarios.

Table 2A.: Per cent change from BASE in alternate scenarios - effects on prices

INDEX 1 = **DOMPRICE (Domestic Prices)**

| | MANUFACT | AGRICULT | FORESTRY | TRANSPOR | TRADE | CRAFTS | SERVICES |
|---|---|---|---|---|---|---|---|
| TAX | 0.64 | 6.46 | -1.23 | -2.24 | 19.00 | 12.96 | 3.46 |
| TAR | -2.39 | -0.83 | -0.61 | -0.95 | 1.58 | 0.89 | -0.21 |
| TAXTAR | -1.77 | 5.46 | -1.84 | -3.32 | 20.53 | 13.78 | 3.23 |

INDEX 1 = **DIMPRICE (Domestic Import Prices)**

| | | | | | | |
|---|---|---|---|---|---|---|
| TAR | -4.72 | -3.90 | -1.47 | -2.42 | -0.99 | -1.94 |
| TAXTAR | -4.72 | -3.90 | -1.47 | -2.42 | -0.99 | -1.94 |

INDEX 1 = **DEXPRICE (Domestic Export Prices)**

| | | | | | | |
|---|---|---|---|---|---|---|
| TAX | 0.21 | 3.66 | -1.59 | 4.70 | 4.57 | 0.84 |
| TAR | -0.78 | -0.47 | -0.67 | 0.40 | 0.33 | -0.04 |
| TAXTAR | -0.57 | 3.09 | -2.34 | 5.07 | 4.84 | 0.78 |

INDEX 1 = **CAPPRICE (Capital Rent)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TAX | -0.03 | -0.13 | -0.14 | -0.08 | -1.39 | | -0.07 | -1.06 |
| TAR | -3.27 | -3.31 | -3.16 | -3.20 | -3.25 | -1.46 | -3.27 | -1.90 |
| TAXTAR | -3.40 | -3.41 | -3.38 | -3.39 | -3.40 | -2.96 | -3.40 | -3.07 |

INDEX 1 = **OUTPRICE (Average Output Prices)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TAX | 0.38 | 5.74 | 33.98 | 6.54 | -1.96 | 15.23 | 12.65 | 1.28 |
| TAR | -1.41 | -0.73 | 3.34 | 4.90 | -0.83 | 1.25 | 0.86 | -0.07 |
| TAXTAR | -1.04 | 4.84 | 37.32 | 5.72 | -2.89 | 16.46 | 13.45 | 1.20 |

INDEX 1 = **COMPRICE (Composite Good Prices)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TAX | 0.27 | 5.02 | 36.00 | | -1.69 | 15.24 | 11.81 | 0.70 |
| TAR | -3.78 | -1.49 | 3.00 | 8.00 | -1.07 | 0.84 | 0.73 | -1.59 |
| TAXTAR | -3.53 | 3.31 | 39.00 | | -2.86 | 15.91 | 12.45 | -0.92 |

INDEX 1 = **VADPRICE (Value Added Prices)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TAX | 32.81 | 3.17 | -5.18 | 4.11 | -2.47 | 395.68 | 23.93 | 80.27 |
| TAR | 12.40 | 5.14 | -2.36 | -2.00 | -0.03 | 5.86 | 2.39 | 3.30 |
| TAXTAR | 44.83 | 7.88 | -7.80 | 2.11 | -2.76 | 405.49 | 26.30 | 83.52 |

## Table 2B.: Per cent change from BASE in alternate scenarios - effects on quantities

INDEX 1 = **COMPGOOD (Composite Good Production)**

| | MANUFACT | AGRICULT | FORESTRY | CONSTRUC | TRANSPORT | TRADE | CRAFTS | SERVICES |
|---|---|---|---|---|---|---|---|---|
| TAX | 1.75 | 6.59 | -1.69 | 6.31 | -3.25 | 8.02 | 1.58 | 14.21 |
| TAR | 0.50 | 1.20 | 0.62 | -2.99 | -1.17 | 1.27 | 0.22 | 2.20 |
| TAXTAR | 2.30 | 7.91 | -1.14 | 6.04 | -4.70 | 9.20 | 1.76 | 16.68 |

INDEX 1 = **DOMSALES (Domestic Sales)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TAX | 0.80 | 3.13 | 35.63 | 6.42 | -2.99 | 3.94 | 0.33 | 8.44 |
| TAR | -3.02 | -0.44 | 4.00 | 4.81 | -1.24 | 0.39 | 0.02 | -0.49 |
| TAXTAR | -2.23 | 2.67 | 40.05 | 6.10 | -4.48 | 4.20 | 0.35 | 7.87 |

INDEX 1 = **EXPORTS**

| | MANUFACT | AGRICULT | TRANSPOR | TRADE | CRAFTS | SERVICES |
|---|---|---|---|---|---|---|
| TAX | -0.52 | -8.61 | 4.07 | -10.86 | -8.42 | -1.65 |
| TAR | 1.97 | 1.19 | 1.69 | -1.00 | -0.53 | 0.10 |
| TAXTAR | 1.45 | -7.34 | 6.09 | -11.62 | -8.95 | -1.54 |

INDEX 1 = **IMPORTS**

| | | | | | | |
|---|---|---|---|---|---|---|
| TAX | 2.42 | 19.94 | -4.07 | 8.06 | 16.13 | 15.73 |
| TAR | 3.00 | 7.41 | -0.99 | 5.35 | 2.31 | 2.90 |
| TAXTAR | 5.52 | 28.43 | -5.38 | 34.24 | 18.57 | 19.01 |

INDEX 1 = **PRIVCONS (Household Consumption)**

| | MANUFACT | AGRICULT | FORESTRY | CONSTRUC | TRANSPOR | TRADE | CRAFTS | SERVICES |
|---|---|---|---|---|---|---|---|---|
| TAX | 33.34 | 27.32 | -1.85 | 33.70 | 35.98 | 16.01 | 19.64 | 32.78 |
| TAR | 7.46 | 4.98 | 0.67 | -4.20 | 4.52 | 2.55 | 2.69 | 5.07 |
| TAXTAR | 42.21 | 32.81 | -1.25 | 37.20 | 41.25 | 18.36 | 21.91 | 38.48 |

INDEX 1 = **INVDEST (Investment by sector of destination)**

| | MANUFACT | FORESTRY | CONSTRUC | TRANSPOR | TRADE | CRAFTS | SERVICES |
|---|---|---|---|---|---|---|---|
| TAX | -21.47 | -21.35 | -21.36 | -21.38 | -20.35 | -21.39 | -20.62 |
| TAR | -3.49 | -3.61 | -3.55 | -3.50 | -5.27 | -3.49 | -4.84 |
| TAXTAR | -26.07 | -26.09 | -26.07 | -26.04 | -26.41 | -26.06 | -26.31 |

Tables 2 A and B show that through the increased demand stimulated by lowering indirect taxes, all domestic prices mainly rise, causing the quantities of the composite goods (especially domestic sales) to increase. The rise in the supply of composite good provision is accounted for mainly by the rise of imports. Private consumption also increases in all sectors. Capital rent by sector decreases and so do exports due to the rise in the domestic price of exports. Investment by sector of destination drops considerably. It follows that in this economy, an indirect tax cut leads to higher consumption rather than to an increase in investment.

Lowering tariffs (scenario TAR) leads domestic prices to generally drop together with the domestic price of imports[6]. The sectoral response of the domestic price of exports is mixed as is the case with the domestic output prices. Capital rent by sector also goes down as in the previous scenario. World prices of exports and imports do not change due to the small country assumption. Composite good prices decrease except for the non-tradables but, because of cheaper imports, composite good supply mainly increases. Domestic sales drop, apart from non-tradables, whereas the impact on imports is generally favourable. Investment by sector of destination also declines, although by less than in the previous TAX scenario.

Tariff cuts would in some instances act in the same direction as tax cuts by amplifying those effects on prices and quantities. Such is the case of capital rent which falls in both scenarios, as well as in the value added prices which mainly rise. Imports and private consumption rise in both scenarios, whereas investment by sector of destination decreases.

In the instances where the effects of tax cuts and of tariff cuts go in different directions, the total effect measured by running both scenarios simultaneously is dampened. Such is the case of domestic prices in manufacturing, agriculture and services, the composite good and world export prices in manufacturing and agriculture. The corresponding quantity relations for manufacturing and agriculture are also observed in the domestic sales and exports.

Table 3.: per cent impacts on macroeconomic variables

| | DISPOSABLE INCOME | GOVERNMENT REVENUE | TOTAL SAVINGS | CURRENT ACCOUNT DEFICIT |
|---|---|---|---|---|
| TAX | 33.69 | -21.20 | -17.68 | 13.22 |
| TAR | 3.40 | -5.73 | -6.14 | 6.75 |
| TAXTAR | 37.18 | -27.27 | -24.22 | 20.42 |

Impacts on macroeconomic variables are summarised in Table 3 and expressed as per centage changes in private GDP (disposable income), government revenue, total savings, and current account balance. Table 3 shows that private GDP increases in all three scenarios, while both government revenue and total savings (which determines total investment) decrease. The current account deficit widens. The tax reduction scheme decreases the trade deficit by 13 per cent, tariff reduction by about 7 per cent, and the combined effect by 20 per cent.

## Conclusions

The CGECRO model is designed to illustrate some of the possibilities of CGE models in policy analysis applied to the Croatian economy in 1987. Since it is an objective, scientific tool of modern economic analysis and planning with great potential in testing the implications of different scenarios, a complete and up-to-date database would enable the use of this model, in this or in an extended form, in analyses of current economic policy issues.

In this model we have seen the sectoral dispersion of impacts created by three 'shocks' to the economy: an across-the-board tax cut to a uniform rate of 22 per cent, tariff reduction to 1 per cent, and both scenarios applied at the same time. By Analysing the effects on the sectoral level, it is possible to design economic policy measures that would produce the desired results or, on the other hand, to be cautious with measures that might exacerbate the trends which economic policy is aiming at correcting.

However, given the limitations imposed by the inevitable data manipulation procedures as well as the ambiguities in data gathering itself, it would be overly ambitious to claim that such models can be used as exact gadgets to measure the impacts of various policy measures with complete accuracy. The main value in using CGE models is in identifying the trends of changes and, to a certain extent, their intensity.

Therefore, the most realistic way of assessing the value of a CGE model is to view it as an input in economic decision making on the economic policy level. Applied to concrete countries by using their empirical data, CGE models form a bridge between economic theory and reality. The simulation results serve as clear indicators of the desirability of different economic policy measures. Consequently, by enabling economic policy makers to assess the costs and test the consequences of their proposed measures on the economy as a whole as well as on its segments, CGE models can provide an impartial and valuable scientific supplement to better economic policy making.

## NOTES

[1] We did not update the 1987 input-output table, which is technically feasible, because of the change in methodology of data gathering that occurred in the meantime and that would have made new sectoral totals incomparable to the old ones. When the new input-output data collected by using the widely accepted System of National Accounts (SNA) methodology become available in Croatia, the model will be promptly updated and most recent trade and other data will be incorporated.

[2] See Adelman and Robinson (1978), Dervis, de Melo, and Robinson (1982), Condon, Dahl, and Devarajan (1987), and Robinson, Kilkenny, and Hanson (1990).

[3] Armington (1969).

[4] Stjepanović (1990), Društveni računi 1968-88 (Social Accounts 1968-88) (1991), Završni račun organizacija udruženog rada i radnih zajednica za godinu 1987 (Final Enterprise Accounts 1987) (1988).

[5] The exchange rate in 1987 was 1US$=736.7754 1987 dinars.

[6] In the TAX scenario, naturally, the domestic price of imports remains unaffected. Hence its non-appearance in Table 2.

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